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Alternatives to Equilibrium Analysis

by

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> "Here is Edward Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin. It is, as far as he knows, the only way of coming downstairs, but sometimes he feels that there really is another way, if only he could stop bumping for a moment and think of it."
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> **A.A. Milne, Winnie-the-Pooh**
> **(New York: Dutton, 1961), p. 1**

Economists, too, often seem to yearn for another way. It is not only that assumptions are "unrealistic" or techniques "inadequate," but sometimes even the approach itself appears to be a straightjacket which lacks the necessary flexibility to deal appropriately with the problems at hand. Thus Georgescu-Roegen [6, p. 319] sees the economic "method" largely transferred from classical mechanics, as the primary source of the current malaise, if not crisis, in Economic Science. And Hicks' complaint [9], that much of economic theorizing is, to its detriment, "out of time," may also be laid to similar shortcomings. To understand the issues involved, it is necessary to introduce some concepts.

The purpose of an analysis is to explain or make sense of what is happening in the world. This notion of analytical objective is meant to be sweeping, intentionally including such possibilities as the exploration of hypothetical policy options and prediction. Moreover, regardless of whether explicitly stated, each analysis comes fully equipped with both methodological and epistemological supports. The methodology of an analysis is the conceptual means by which the analysis is put together. Its epistemology elucidates how the analysis does its explaining or, in other words, how it is able to produce knowledge.

Traditionally, epistemology has been based on the presumption of a dichotomy between observations of reality and thoughts about those observations. From the rationalist perspective (Descartes), knowledge is gained by first thinking or theorizing about reality and then fitting what is seen into the thoughts or theories already secured (reality is made to correspond to thoughts). Alternatively, the empiricist (Locke) would argue that one obtains knowledge by looking first, and then building thoughts and theories to understand what has been seen (thoughts are made to correspond to reality). Thus these approaches dichotomize thinking and seeing, and produce knowledge or truth by taking one to be the "cause" or "essence" of the other. In this sense, traditional epistemology may be called "essentialistic" (reductionistic).

There is, however, an alternative epistemology which does not recognize the dichotomy between observation and thinking.[1] Unlike rationalism or empiricism, no single unique procedure generates knowledge. Knowledge, rather, comes from discourse that recognizes the interrelatedness of observation and thinking, and hence the nonunique and nonessentialistic character of truth. On this view, the ability to organize and understand the patterns of happenings in the world rests on deeply penetrating interdependencies. The challenge to economists is to consider whether and how such a pervasive interaction between events and contemplations of them impinges on established modes of economic analysis.

The notion of essentialism also arises with respect to methodology. A methodology is essentialistic if explanation obtained through its use elucidates the conceptual phenomenon in question as the outcome of a single cause or set of causes, that is, in terms of an "essence". Contrariwise, a nonessentialistic or nonreductionistic methodology bases explanation on the idea that each and every conceptual phenomenon exists only as the combined result of the interactions of all other conceptual entities. Conceptual phenomena, then, cannot be said to have single causes since they are understood to codetermine each other. They are distinct but not independent.

The mainstay of the economic approach is, of course, the notion of equilibrium. In its static form, equilibrium is simply the outcome of the timeless interaction of forces, the resolution of simultaneity. In dynamic contexts, it appears in the guise of either the stationary or the steady state. Most economic theorizing takes place through the construction of (usually mathematical) models in which equilibrium, in one of these forms, is studied. And most empirical investigations are propped up by such a construct. Thus the methodology of today's equilibrium analysis is the essentialistic methodology of model building in which all variables and relations among them are assumed to be (at least probabilistically) known and stable over time. Furthermore, although rarely mentioned in specific applications, the epistemology of current equilibrium analysis is either rationalism (e.g., Robbins [13]) or empiricism (e.g. Friedman [5]).

Economists searching for another way, then, may be uneasy with standard equilibrium analysis for (among several possibilities) one of the following three reasons: First they might believe that the methodology and epistemology of typical equilibrium analysis are sound, but that the emphasis on equilibrium is misplaced. Second, while subscribing to either

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rationalism or empiricism and to essentialism in methodology, they may feel that the particular essentialistic methodology of current equilibrium analysis is flawed. And finally, they may be uncomfortable with the essentialistic nature of both the methodology and epistemology on which the usual equilibrium analysis rests.

But what are the options if standard equilibrium analysis is rejected? Under such conditions, how might economic inquiry proceed? Without attempting to be exhaustive, the purpose of this paper is to compare and contrast three alternatives, each of which responds, respectively, to the dissatisfaction of those economists who reject current equilibrium analysis for one of the three reasons listed above. After an initial description of the workings of standard equilibrium analysis, discussion turns to so-called "disequilibrium analysis" in which both the essentialistic methodology and epistemology of typical equilibrium analysis are retained. Next to be taken up is an approach whose methodology, though still essentialistic, emerges from the notion that the nature of time is "historical" as opposed to the "logical" time required in the methodology of current equilibrium analysis. The paper concludes with the presentation of an analytical perspective based on a nonessentialistic methodology and epistemology that focuses on the "mutually interactive" character of all aspects of reality, including the analysis of reality itself.

I

The following paragraphs are intended not so much to deal with methodological and epistemological questions (although implicit and some explicit reference to them is unavoidable) as to present a recipe that shows how to do equilibrium analysis. Hereafter, the phrase "equilibrium analysis" is understood to include the construction of an equilibrium-type model and the examination of its properties, along with the standard methodological and epistemological baggage (described above) that usually accompanies such a model.

Static equilibrium analysis requires a model such as, for example,

$$x_j = f^j(x_1,\ldots,x_{j-1},x_{j+1},\ldots,x_I,\rho), \quad j = 1,\ldots,J, \tag{1}$$

where x_i is a scalar variable for $i = 1,\ldots,I$, the f^j denote single-valued functions for $j = 1,\ldots,J$, and ρ represents a vector of parameters. Time does not appear. A very common assumption in this model is that $I = J$, or that the number of variables and equations is the same. Given a value for ρ, an equilibrium (solution) of (1) is a vector $x = (x_1,\ldots,x_I)$ which satisfies all equations of (1) simultaneously. Thus at equilibrium, all forces "balance out" and the system is "at rest." It is often possible to solve (1) so as to secure equilibrium as a function of the values of ρ.

Dynamic equilibrium analysis can be expressed in the language of either continuous or discrete time. Although at a sufficiently abstract level there is no formal difference between them, the distinction is still worth

maintaining here. To pursue dynamic equilibrium analysis in continous time necessitates the specifications of a system of first-order differential equations such as

$$\frac{dz_k}{dt} = g^k(z,\rho,t), \quad k = 1,\ldots,K, \tag{2}$$

where $t \geq 0$ varies over real numbers representing (scalar) time, ρ remains a vector of parameters, $z = (z_1,\ldots,z_K)$ is a vector of scalar variables z_k, and the g^k are functions of z, ρ and t. Frequently (2) is abbreviated to

$$\frac{dz}{dt} = g(z,\rho,t), \tag{3}$$

where $\frac{dz}{dt} = \left(\frac{dz_1}{dt},\ldots,\frac{dz_K}{dt}\right)$ and $g = (g^1,\ldots,g^K)$. The counterpart of (2) in discrete time is the system of first-order periodic or "difference" equations

$$z_k^t = g^k(z^{t-1},\rho), \quad k = 1,\ldots,K, \tag{4}$$

where t now assumes as values only the positive integers, z_k^t denotes the value of z_k at time t, $z^{t-1} = (z_1^{t-1},\ldots,z_K^{t-1})$, and the functions g^k are defined in terms of z^{t-1} and the parameter vector ρ. The shortened form of (4) is

$$z^t = g(z^{t-1},\rho), \tag{5}$$

where $z^t = (z_1^t,\ldots,z_K^t)$ and $g = (g^1,\ldots,g^K)$. Note that it is not necessary here to consider higher order systems of differential or periodic equations since they all may be reduced to larger, equivalent systems of the first order.

Given a value for ρ, a time-path (solution) of (3) starting at z^o is a function

$$z = \theta(z^o,\rho,t) \tag{6}$$

which satisfies (3), that is,

$$\frac{d\theta(z^o,\rho,t)}{dt} = g(\theta(z^o,\rho,t),\rho,t),$$

for all $t > 0$, and which passes through the starting point: $z^o = \theta(z^o,\rho,t)$;

Observe that the symbolism in (6) is a truncation of

$$z_k = \theta^k(z^o,\rho,t), \quad k = 1,\ldots,K,$$

with $\theta = (\theta^1,\ldots,\theta^K)$. By contrast, a time-path of (5) starting at z^o (for fixed ρ) is a sequence of points $\{z^t\}$, one for each $t = 1,2,\ldots$, generated by starting (5) at z^o:

$$\text{(7)} \qquad \begin{aligned} &z^o \\ &z^1 = g(z^o,\rho) \\ &z^2 = g(g(z^o,\rho),\rho) \\ &\quad\vdots \end{aligned}$$

Implicit in the way these time-paths are used in dynamic equilibrium analysis is the concept of logical or clock time through which "machines" (3) and (5) run as they crank out (6) and (7). Either machine may be started over and over again at z^o, and in every case the same time-path results. The machines themselves, i.e. the functions g, are definitionally independent of time although, of course, they are still functions of t, for all t.

With ρ fixed, a time-path starting at z^o is a stationary state when none of the values of the variables along that time-path are changing. For continuous time, stationary states are defined in terms of (6) by the equation

$$z^o = \theta(z^o,\rho,t),$$

for all t. In the case of discrete time, a time-path from (7) is a stationary state provided that

$$z^t = z^o,$$

for all t. With either continous or discrete time, variation in ρ shifts the stationary state.

Whereas stationarity is characterized by variables that do not change as time passes, the concept of steady state permits these same variables to increase at set rates over time. Thus constancy in the steady state occurs with respect to the growth rates of the variables rather than with respect to the variables themselves, and the stationary state is the special steady state in which all growth rates are zero. Once again, let ρ be fixed. A continuous time-path (6) starting at z^o is a steady state if

$$\text{(8)} \qquad \theta^k(z^o,\rho,t) = z_k^o e^{\psi^k(\rho)t}, \quad k = 1,\ldots,K,$$

for all t and some functions ψ^k of ρ. Since (8) implies

$$\frac{\frac{dz_k}{dt}}{z_k} = \psi^k(\rho), \quad k = 1,\ldots,K,$$

along the steady state each variable z_k is growing at the constant rate $\psi^k(\rho)$. For the discrete time-path (7) starting at z^o to be a steady state it is necessary that

$$\text{(9)} \qquad z_k^t = z_k^o[\psi^k(\rho)]^t, \quad k = 1,\ldots,K,$$

for all t. Using (9) with $t \geqslant 1$,

$$\frac{z_k^t}{z_k^{t-1}} = \psi^k(\rho), \quad k = 1,\ldots,K,$$

whence, as before, each z_k grows at the constant rate $\psi^k(\rho)$. In either case, changes in ρ modify the steady state.

Equilibrium analysis -- static or dynamic -- presumes an underlying vision of the way the "word" operates in terms of the models decribed above. Although sightings in actuality are epistemologically distinct from conceptualized equilibria (which lie in the realm of thinking as opposed to seeing), the creation of explanation (knowledge) proceeds by linking them in either a rationalist or empiricist union. In the static case, then, observations of reality are identified with unique equilibria in the model. Therefore, the thrust of static equilibrium analysis is to explain what is seen as determined by simultaneously interacting forces like those described in (1). From a dynamic perspective, observations can be interpreted either as lying on a unique stationary or steady state time-path, or as falling on another not-necessarily-unique time-path which is converging to a unique stationary or steady state. Thus what appears in reality is understood as the outcome of dynamic processes such as those of (3) or (5) which, if not initially placing the world in a stationary or steady state, are at least pushing it towards one. Furthermore, since the methodology of equilibrium analysis takes (1), (3) or (5) to be stable over time, formal predictions of future observations may be made by extrapolating along the time-path currently pursued or by adjusting that time-path for expected parameter changes. Note that if all sightings of the world are taken to be observations of, say, unique stationary states, then it is not possible to watch empirically the dynamic processes at work which force convergence. Regardless, for both static and dynamic equilibrium analysis the role of equilibrium is central: From both rationalist and empiricist points of view, equilibrium is the organizing concept through which observations of, and thoughts about, reality derive their meaning. Of course, the relevant form of equilibrium must exist uniquely and, when appropriate, be stable in models (1), (3) or (5) if an equilibrium analysis based on any one of them is to have genuine explanatory significance.

Another aspect of dynamic equilibrium analysis has to do with movements from one equilibrium position to another. Suppose, for example, the world is understood to be at some unique stationary state. Let an exogenous change in the parameter vector ρ occur which results in an altered, but still unique, stationary state. Then subsequent development is taken to follow a time-path, called a traverse, which converges to the new stationary state.[2] The laws of motion governing the traverse (say, (3), or (5)) provide an explanation of how reality progresses from a position of being in the old stationary state to a location at the new stationary state. Once again, if all real world sightings are interpreted as lying on unique stationary state time-paths, then the traverse cannot be seen. In that case, observations made after successive changes in ρ yield pictures of one stationary state after another.

It frequently happens in equilibrium analysis that one or more of the x_i or z_k in (1), (3) or (5) are thought of as random variables, each with a defineable probability distribution. Under such specification, the standard approach is to use the probability distributions to sum or integrate out all random variation. The result is expectational systems of equations which are formally similar to (1), (3) and (5). Definitions of the various forms of equilibrium remain as before, and both static and dynamic equilibrium analysis proceeds as depicted above. The introduction of randomness, then, complicates but does not really change the character of equilibrium analysis.

Also worthy of mention is the fact that equilibrium analysis does not depend on an ability to measure the variables involved. Although differential equations like (3) and steady state time-paths like (8) and (9) surely require numbers for their coherent expression, little else does. The static model (1), the periodic model (5) and its time-path (7), the specification of unique equilibrium for (1) and of unique stationarity for (5), and the notion of convergence in the case of (5), are all meaningful in the absence of measurement.[3] Therefore, static and dynamic equilibrium analysis may be applied as described earlier to explain and understand qualitative, nonnumerical phenomena.

Returning to the numerical world, perhaps the most common example in economics of static equilibrium analysis is the determination of (short-run) observed market price and quantity through the forces of supply and demand. This analysis is extended in Walrasian microeconomics to explain observations of outputs produced and inputs hired by firms, final outputs consumed and factors supplied by individuals, the relative prices of all goods, and the distribution of income, in terms of profit maximization by firms, constrained utility maximization by individuals, and the simultaneous interaction of supply and demand in all markets. The latter model also serves as the basis for dynamic equilibrium analysis of the perfectly competitive microeconomy by adding dynamic rules of the form of (3) or (5) which make the above static equilibrium correspond to the stationary state, and which explain how prices adjust when the system is out of equilibrium. (This Walrasian construction rests on the assumption that all individuals have "complete" or "perfect" information of the past, present and future about all relevant economic matters.) Observations of the actual economy are now interpreted either as located on a unique stationary state, or as placed on a time-path which converges to a unique stationary state. In both cases, sufficient assumptions are imposed so that the time path along which observations are assumed to lie exists within the model.

Those economists who employ equilibrium analysis with a rationalist epistemology are likely to accept the statement that economic inquiry requires "... an equilibrium notion to make precise the limits of economics...."[4] For them, economic knowledge is obtained through the construction of models in which equilibrium exists and gives meaning to economic reality. By contrast, the equilibrium analyst with an empiricist bent would assert that, "Only factual evidence can show whether [equilibrium analysis] is 'right' or 'wrong'...."[5] But regardless of epistemological orientation, there are economists (as suggested earlier) who consider equilibrium analysis to be seriously defective. Some[6] take the position that, although there is nothing wrong with models such as (1), (3) and (5), with the equilibrium methodology, and with an essentialist epistemology, the real world either has too many structural and institutional barriers preventing the attainment of equilibrium, or is in such rapid structrual and institutional flux that the notion of equilibrium is irrelevant. Thus the focus in models (1), (3) and (5) should be on nonequilibrium positions, or on either time-paths which do not converge to stationary or steady states or converging time-paths along which, for some reason, convergence is blocked. Others[7] accept the essentialist epistemology of equilibrium analysis and its essentialism in methodology, but still complain that its methodology is inappropriate. The particular usage of functions and probability distributions and the notion of time employed renders impossible in equilibrium analysis the taking into account of certain fundamental facts of life: that time is irreversible, that novelty is unpredictable, and that human beings live in ignorance of, and hence with uncertainty about, much of the past and present, and all of the future. Moreover, the models of equilibrium analysis abstract too far from the actual institutional environment in which the phenomena they are to explain is set, and are not themselves sufficiently stable over time to permit their use for more than the immediate moment of analysis and certainly never in prediction. Thus knowledge of the real economy gleaned from equilibrium analysis is faulty because its methodology is blemished. Analysis reflecting a different essentialistic methodological flavor is required. Still[8] others reject the essentialism in both methodology and epistemology of equilibrium analysis. In this last view, knowledge of the economy derives from discourse in which the interrelated complexities of "actuality" are not reduced to a single set of "causes," and which does not recognize a dichotomy between observations and thoughts about them.

The alternatives to which each of the above groups subscribes are now considered in turn.

II

What is usually referred to as "disequilibrium" analysis in the economics literature generally employs the same essentialist epistemology, the same essentialist methodology, and the same kind of models as those used in equilibrium analysis. But the question of the existence of the relevant form of unique equilibrium is no longer of major consequence since analysis here proceeds from the construction of the model to an explanation within it of what is seen in the real world, often without explicit reference to equilibrium at all.

Consider the static case first. Suppose a unique equilibrium exists in a system such as (1) but certain independent "outside" forces prevent the attainment of that equilibrium. For example, (1) could represent the typical supply and demand equations of an isolated market in which the government has imposed a minimum price above the equilibrium price (e.g., minimum wage laws) or a maximum price below the equilibrium price (e.g., price controls designed to stop inflation). Alternatively, the pressures encapsulated by (1) could be insufficient by themselves to ensure the existence of a unique equilibrium. In the isolated market example, supply and demand curves might be coincident, distinct but parallel or, if extended beyond their usual domain, might intersect only at a negative price and/or quantity. In all of these situations, to explain happenings in the real world (market), it is necessary to add outside (nonmarket) elements which, together with (1), determine a unique vector of variables in the model. Such unique vectors must then be identified with actual observations either rationalistically or empiricistically. Only then can static disequilibrium analysis provide an explanation of what is seen.

Similarly, disequilibrium analysis frequently ignores stationary and steady states in its construction and study of models like (3) and (5), even when present.[9] It locates all sightings of reality on non-stationary, non-steady-state time-paths that do not converge to stationary or steady states. Divergent and constant oscillatory time-paths are two possibilities. It might also permit consideration of time-paths which would normally converge to stationary or steady states, but for which convergence is either too slow to have any "practical" meaning, or is prevented from occuring by certain outside forces. Prediction proceeds as in equilibrium analysis. In such circumstances as these, disequilibrium analysis has to discern the nature of the actual time-path along which the real world is moving, for otherwise it cannot furnish much understanding of reality.

Examination of nonconvergent time-paths for prices and quantities in a cobweb model of an isolated market is an example of dynamic disequilibrium analysis. As a second example, consider the dynamic version of the model of the Walrasian microeconomy described earlier in which trading transpires before stationarity is reached. After the auctioneer announces a set of prices, trades take place regardless of whether the prices are equilibrium prices or not. These trades affect initial endowments in the next round, which begins with the auctioneer announcing a new set of prices. Disequilibrium analysis involves the working out of this process for not-necessarily-convergent time-paths and the identification of one such time-path with actual behavior in the economy.

Although the proponents of each approach may believe that theirs is the only correct way, it is clear that, in many respects, equilibrium and disequilibrium analysis are quite similar. In addition to relying on identical methodological and epistemological foundations, the concept of equilibrium can be (though it not always is) defined in either case. The primary difference between them is that equilibrium analysis interprets reality in relation to equilibrium in these models, while disequilibrium analysis elucidates it with respect to ideas having little to do directly with equilibrium, even when a unique equilibrium may be available. However, static disequilibrium analysis may still be viewed as "equilibrium analysis" with an altered system of equations, since, in order to explain observations, new relations must be added to or substituted in (1), and the unique solution of the modified system (i.e., its "equilibrium") can then be identified or related to the seen thing. Likewise, dynamic disequilibrium analysis might be thought of as "equilibrium analysis" with respect to nonequilibrium and nonconvergent time-paths. By contrast, the remaining forms of analysis discussed below make a clean methodological and/or epistemological break with equilibrium analysis. Not only do the models employed have a different meaning and applicability, but the notion of equilibrium as defined in Section I can not arise in exactly the same way within their frameworks.

III

The second alternative presented here retains the essentialistic epistemology and the essentialism in methodology of equilibrium analysis, but is methodologically distinct in its focus only on, and in the nature of, its dynamics. Since all of life's events take place in real time, posing static questions is not considered meaningful. Moreover, the notion of logical time is also thought irrelevant. Time, in reality, can never be started over as in the "machines" of (3) and (5). Rather, it is irreversible and historical: time flows in a single continuous stream along which each moment is unique. Thus, explanations or understandings of any one moment at that moment are necessarily different from those at all other moments. To employ Hicksian terminology [9], analysis which rests methodologically on the idea of historical time is called "in time," while the equilibrium and disequilibrium analysis of Sections I and II are "out of time."

Throughout the passage of historical time, the present is the boundary separating the past from the future. The past, being past, is capable of historical description, and hence information about the past is obtainable. But such information is always nonunique and imperfect, even if expressed probabilistically. On the other hand, information about the future is impossible to secure because the future cannot be known until it is past. (Thus $g(z,\rho,t)$ and $\theta(z^0,\rho,t)$ in (3) and (6), and $g(z^{t-1},\rho)$ and $z^0,z^1,z^2,\ldots$ in (5) and (7), cannot even be specified probabilistically for all t beyond, and including, the present.) Not only is the investigating economist confronted by such large information gaps, but so too are the decision-makers whose behavior may be part of the subject-matter of his investigation. In spite of this ignorance and the uncertainty it imposes, these latter decision-makers still imagine and guess about the future, using their faulty information about the past. Such imaginings and guesses also serve as the springboard for decisions or behavior in the present.

Individuals arrive at each moment of decision with a unique background of history, and with thoughts derived from that history. The environment in which the decision-maker decides is also unique because it, too, has its own singular history. The same environment, the same background of the individual, and hence the same decision opportunity, can never arise again.[10]

Suppose now an in-time explanation for happenings in the real world is desired for the period between time t^o and time t'. Denote the present moment, i.e., the moment at which the explanation is to be developed, by t^P. It may be supposed that $t^o < t' \leqslant t^P$. Then t^o is the moment at which the explanation breaks into the stream of time, and t' is the moment it breaks out. The explanation itself necessarily depends on the (historical) information available at t^P. The situation in which $t' = t^P$ may be considered a special case.

At first, in the construction of an explanation for the period between t^o and t', in-time analysis may be conceived to proceed analogously to both dynamic equilibrium and dynamic disequilibrium analysis: A model such as (3) or (5) in which decision-makers (if present) are subject to the ignorance and uncertainty described above may be built up, its time-paths (solutions) studied, and one of them identified (either rationalistically or empiricistically) with observed reality between t^o and t'. Then, by pursuing the latter time-path beyond t', one possible description of what could happen next may be provided. However, unlike equilibrium and disequilibrium analysis, such a model itself would be thought of as time dependent. Once t^o, t' or t^P changes, one cannot expect the same model to be appropriate. If, say, t' were to increase to t'', then the history of reality at t' is modified by the passage of time, and if t^P were to rise to t^{P*}, then the information upon which explanation is founded would be different. In the special case $t' = t^P$, understanding of occurrences between t^o and the present undergoes such profound change as time moves on (due to the unforeseen and unpredictable novelty that enters the fabric of life) that the analytical structure of that understanding is unlikely to hold up in its wake. Clearly the methodology of in-time analysis does not allow formal prediction as permitted by the methodology of equilibrium analysis.

Still, stretches of time may unfold during which real-world newness does not appear to impinge substantively on the particular phenomena under investigation. The lack of impact could be reflected in at least two ways. First, it may be that the equations of a model seem to be roughly stable over time in the sense that for a while as t' expands, a single time-path generated by the model continues to approximate observations of reality reasonably well.[11] Here equilibrium or disequilibrium analysis, though coming from a different methodological perspective, is capable of furnishing the same formal picture of the real world as analysis in time. Furthermore, it is only in cases like these that the possibilities, exposed by the in-time models, of what could happen in the future actually transpire. But this, of course, does not mean that the employment of in-time models for predictive purposes is viable in general.

Second, and perhaps less likely, stability over time could also arise with respect to the variables $z = (z_1,\ldots,z_K)$, even as the equations of the model modify. Regardless of whether the components z_k are quantifiable or not, criteria can be given for determining whether any pair, z' and z'', are "significantly different from" or "essentially the same as" each other.[12] With these criteria specified, it may happen that all points z observed between t^o and t' are essentially similar. Hence reality between t^o and t' could be viewed as in a pseudo-stationary state:[13] Novelty occurs, but either not to sufficient extent or not in the ways that significantly affect the variables of the analysis. What is seen can therefore be explained in terms of an equilibrium analysis with a single model and a unique stationary state, or in the language of in-time analysis, with a "model" whose equations might modulate, but whose solutions remain essentially the same over time.

During intervals of rapid transformation, the two approaches also supply quite distinct explanations of real-world phenomena. Equilibrium analysis can only explain unforeseen change by asserting, after the fact, that "outside" forces caused alteration in the parameter values ρ. But the idea of a continually modulating equilibrium responding to repeated variations in ρ is not a very satisfying way of conceptualizing the effects of novelty. In-time analysis, on the other hand, cannot provide much of an understanding of unforeseen change either. Yet the acknowledgement of such change is part of the internal structure of its methological tissue. In-time analysis expects change and leaves room for it. By comparison, equilibrium analysis makes room for change only after it has occurred.

As an illustration of in-time analysis, Vickers [18, Ch. 8] examines a decision-maker's choice among investment projects by considering the returns on these projects, the "potential surprise" to the decision-maker of every possible return for each project, the decision-maker's "project-attractiveness" trade-offs between returns and potential surprises, and his preferences among the different attractivenesses of the projects under scrutiny. It should be emphasized that Vickers' analysis cannot be integrated into equilibrium or disequilibrium analysis in any meaningful way. In another example, Bausor [3] investigates the choice of consumption baskets by consumers in terms of a functional loop in which the existing outcome of the previous round of decision-making determines (not-necessarily-quantifiable) perceptions for the next round. Perceptions, in turn, determine (also nonquantifiable) expectations which, again in turn, determine strategies. Lastly, decisions are made and strategies are turned into outcomes.

IV

The third and final approach to be considered denies the possibility of analyzing any one piece of reality in isolation from any other piece or collection of pieces.[14] Everything in actuality -- physical, social, mental, etc. -- is assumed to interact in a mutually constitutive manner with eveything else. Each entity, that is to say, exists only as the result of the combined effects on it of all other entities. This perspective clearly requires a different methodology from those described earlier. Moreover, the assertion that such interdependence or mutually constitutive determinations extend to the intellectual as well as the material and social is the point at which the proponents of this approach depart from epistemological tradition and formulate their own distinctive epistemology. Because of these interdependencies, no single event can be understood by detaching it from the milieu of all events. No phenomenon can be described as the outcome of independently construed (static or dynamic) forces. (An "economy," for example, cannot be conceived except as in relation to all cultural, social, political, psychological and, of course, economic factors of which it is comprised.) Furthermore, mental constructs such as concepts, variables, functions and analyses (also a part of reality in the present sense) cannot exist apart from all other concepts, variables, functions and analyses, nor can an analysis be disentangled from that which it purports to analyze. Thus there is no dichotomy between observations of the real world and thoughts about those observations, and it is not possible to explain a particular observation as the outcome of a single set of causes or an essence. Analysis coming from such an angle will be labelled "mutually interactive." Evidently, the methodology and epistemology of mutually interactive analysis are nonessentialistic.

At the moment at which a mutually interactive study is begun, the investigator has a specific meaning of the idea of an "analysis" in mind. His particular meaning has been developed over time in relation to his past experiences, including his interactions with other scholars and their work, and his interactions with previous investigations in which he himself has engaged. In addition to having an idea of what an analysis is, he must also determine what language he will use and what rules of reasoning he will follow. Due to the mutually interactive nature of the elements upon which the analysis operates, neither deductive nor inductive logic can be applied. Rather, the investigator establishes and employs his own standard or logic of mutually interactive analysis indicating how to proceed from one sentence to the next. These principles set his guidelines for identifying what he considers to be "correct" reasoning as opposed to that which is "incorrect" and "inconsistent."[15] All of this is considered to be an integral part of the analysis he is undertaking.

During the course of completing his analysis, the investigator's conception of analysis, appropriate language, and appropriate rules become modifided as he interacts with the real world and with his study. Meanings change as the development of discourse and knowledge proceeds, and thus it is possible that his investigation may end up by turning into a different analysis from that originally planned.

Unlike equilibrium, disequilibrium and in-time analysis in which explanation is based on the construction of models as described in Sections I - III, the mutually interactive perspective does not admit of explanations of economic reality that are reducible to formal models like (1), (3) and (5). As suggested above, the pieces of such models, indeed the models themselves, are mutually interactive with all facets of actuality (including thought processes), and the thing being explained cannot, therefore, be understood as the result of the single cause

characterized (as in equilibrium analysis) by the determination of certain parameter values in an independent simultaneous equations system. Thus variables in the mutually interactive approach are defined as being constituted in and through the effects of all other variables of the analysis. They do not exist as detached, isolated, independently specified entitites. The same is true of the values that variables may take on. Because variables and their values condition each other's conceptual existence, a change in the value of any variable transforms (among other things) the variable of which it is a value. The price of a good, then, represents the good's price only as it stands in relation to everthing else. (Recall Footnote 15.)

Relations among variables are also interactive with each other and are modified when brought together in the conduct of analysis. A relation between two variables is characterized by the unique way in which these variables and the relation itself are affected by all other variables and relations. It is a focal point in a myriad of interlocking effects which continually modulates in the mind of the investigator as the effects are explored. As in the case of variables, each relation can exist only in conjunction with the totality of all such relations, since each is literally produced by the effects of all others on it. For example, the relation describing the way technology transforms inputs into outputs (what would be called the production function in equilibrium analysis) is understood to be the combined result of the interactions of all technological, economic, social, political, and even psychological forces which come together to determine how inputs are transformed into outputs.

Following the usual parlance, collections of relations are called systems. In parallel with variables and relations, systems can be conceived of only as they relate to other systems and all other aspects of the analysis. To illustrate, a university is a system defined by all of the relations that make it up. Reflected in this construction are the vast variety of pressures operating on and interacting with it, both inside and outside the University.

The occurrence of change in the real world is explained in mutually interactive analysis in terms of systemic variation, i.e., the alteration of the multiplicity of material, economic, socio-cultural, intellective and other variables and relations of which the systems are constituted. Systems become modified in that old ones break down and new ones emerge from them in their place. Such modulation arises from the interaction of all elements of the systems with each other and with the remainder of reality, including the investigator conducting the analysis, and the investigation itself. Since all of these interactions progress continually as the phenomena under investigation unfold through time and as the analysis develops, both the elements of the analysis and the analysis itself are always in continuous flux. In this sense mutually interactive analysis, even though it projects its own methodological and epistemological moorings and orientations, is similar to analysis in time.

It is important to understand that because of their interactive properties, the variables, relations, systems and "laws" of motion of mutually interactive analysis cannot be represented by formal mathematical symbolism in the usual manner. For example, the very act of manipulating or interpreting an equation interacts with all other aspects of the analysis and with the equation itself in such a way that the meaning of the equation is changed. But at any analytical moment, one can still "abstract" from these mutual interactions to obtain standard mathematical variables, relations, systems, and laws of motion. Such abstractions might usefully serve as heuristic devices and metaphors, illustrating certain components of the analysis. Models put together in this way would be like those employed in equilibrium, disequilibrium, and in-time analysis. But it must be recognized that the process of abstraction interacts with and hence changes both the analysis and the model. Thus the metaphor may lose its relevance immediately upon construction. Metaphors are not unique. No one metaphor is intrinsically better than another.[16] Any "result" secured from a particular metaphor is pertinent only to that metaphor and is entirely dependent on it. For reasons described above, such a result can never be thought of as a "complete" explanation of the phenomena under investigation.

To illustrate the role that mathematical models play in interactive analysis, consider the general problem of explaining prices in the microeconomy. (A description of the variable "price" that might be employed in an interactive study has already been given in the second part of Footnote 15.) It clearly makes no sense to think of prices as "determined" by independently specified "forces" at work in the microeconomy. Rather, prices emerge from the interaction of all mutually constitutive variables, forces (relations), investigations, etc. One may abstract a (mathematical) Walrasian model of the microeconomy from these mutual interactions as a metaphor for price determination, but it is subject to all of the limitations described above. Thus the metaphor is not unique; many others (e.g., class conflict) can also provide equally priviledged illustrations of price determination. Moreover, one must be conscious of taking a snapshot of an on-going process of change. This changing process includes not only the phenomena under investigation and its interface with other phenomena, but what is going on in the mind of the investigator as well. For once the particular Walrasian model is built, things may be noticed which had not been seen before, and the model may, as a result, be modified by adding or subtracting variables and revising equations. Alternatively, the model may no longer seem appropriate. Thus, immediately upon construction, the metaphor may be dismantled, subsequently to be replaced by an altered version or discarded entirely.

In mutually interactive analysis, then, variables, relations, systems and laws of motion are built up and used to explain that portion of reality for which understanding is desired. The purposes and limits of the analysis, the time interval to be covered, the language, the rules of reasoning and the use of metaphors are all determined as part of the analysis. Since there is no dichotomy between observations and thinking, there is no gap to bridge (as there is in equilibrium, disequilibrium, and in-time analysis) by identifying sightings in reality with particular elements in a model. What is seen in the real world is automatically understood in terms of the mutual interaction of the relations, systems and laws of motion of the analysis.

An illustration of mutually interactive analysis is the Marxian explanation of the transition from feudalism to capitalism in Western Europe between 1100 AD and 1500 AD given by Resnick and Wolff [11]. Whereas others have argued that this transition was triggered by a single ultimate cause like, for example, the conflict between feudal lords and peasants over rents, or the opening up of external trade to Western Europe, Resnick and Wolff do not accept the idea that one or more determinants caused the decline of feudalism and the rise of capitalism. Rather, they conceive of feudalism as a social system of relations existing in change. Contained in this system were lords, classes of people subsumed to lords, and peasants. Over time, interactions among these different groups modified the entire social and economic fabric in ways that gradually destroyed feudalism. Using the vocabulary developed above, the original system was repeatedly broken down and replaced by new systems as time went on. In the process, new relations among new groups emerged and, by the end of the period, the transition to capitalism was well under way.

V

Each of the three alternatives to equilibrium analysis described here constitutes a distinct conceptual foundation upon which an economic analysis can be built. All three make appropriate place for formal mathematical models. Yet they differ markedly in their approach to time and uncertainty, in their interpretation of the nature and role of variables, relations, systems, and laws of motion, and in the way they deal with the complex interrelatednesses of analysis and reality. Each, together with equilibrium analysis, provides a basis from which a separate and competing explanation, and hence knowledge, of happenings in the world can be constructed. Rejection of the equilibrium perspective, then, does not destroy the economist's ability to theorize and understand. Unlike Winnie-the-Pooh, who never did find another way to negotiate the stairs, economists actually do have viable alternatives to equilibrium analysis. The only question is the extent to which they will be used.

Footnotes

1. Resnick and Wolff [12], and Rorty [15].

2. Hicks [8, pp. 81-82].

3. Katzner [10, Ch. 5].

4. Hahn [7, p. 38].

5. Friedman [5, p. 8].

6. e.g., Benassy [4, p. 9].

7. e.g., Bausor [3], Shackle [17] and Vickers [19].

8. e.g., Amariglio [2], Resnick and Wolff [12], and Ruccio [16].

9. See, for example, Allen [1, pp. 76, 77] and Benassy [4].

10. See, for example, Bausor [3], Hicks [9], Robinson [14], Shackle [17] and Vickers [19].

11. Even if all variables between t^0 and t' were constant, this time-path would still not be the stationary state defined in Section I because at each t' there is no presumption of rest, i.e., that the same model and time-path will remain relevant for the next moment beyond t'.

12. Suppose that the values of z exhibit, to one extent or another, a given collection of properties. Then z' may be said to be *essentially the same* as z" provided that z' and z" exhibit each property to the same degree. Further, z' and z" may be referred to as *significantly different* from each other whenever they are not essentially the same. See the concept of "closeness" in Katzner [10, pp. 61-68].

13. Bausor [3, pp. 173-177] calls it "historical equilibrium."

14. The ideas of this section are elaborated by Amariglio [2, Ch. 1], Resnick and Wolff [11], [12], and Ruccio [16].

15. An example of deductive reasoning (taken from equilibrium analysis and mentioned in Section I) is the argument explaining the formation of observed (relative) prices in terms of preferences, endowments, and technology through constrained utility maximization by consumers, profit maximization by firms, and the equilibration of demand and supply in all markets. In this argument the connotation of prices is given and there is a clear separation between observations of prices and the explanation (or thoughts) of how observed prices arise. Such logic may be contrasted with the following illustration of reasoning in interactive analysis about the connotation of prices themselves: Prices only exist in that the effects of all economic and noneconomic parts of life -- including preferences, endowments, technology, consumers, firms and markets -- come together to produce them. Also to be reckoned here are the interactions between the intellectual processes involved in thinking about the connotation of prices and the objects (some have been listed above) on which the processes act. Prices cannot be understood except in reference to all of these consequences: They are the unique points of convergence in this web of interlocking effects having the properties usually attributed to prices. (Similarly, preferences, endowments, technology, consumers, firms and markets only exist, in part, as a result of prices. Therefore each of these elements mutually determines, again in part, the conceptual existence of each of the others.) The general notion of variable, of which price is a particular instance, is described in the second paragraph below.

16. This follows from the rejection of traditional epistemology and its consequence that there is no longer such a thing as unique truth.

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