

The State of Economic Science

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THE STATE OF ECONOMIC SCIENCE*

Wassily Leontief

IN the author's own words these three essays present the results of his "reflections about economics in the present phase of its development." They are addressed to the "general economist"; his own position Professor Koopmans defines as that of an armchair theorist working primarily with mathematical tools. At a time when methodological disputes between mathematical and non-mathematical economists tend to generate more heat and acrid smoke than light, it is a pleasure to read an important contribution to such a controversial subject conceived in a mood of thoughtful contemplation and presented in the form of calm non-combative discourse. Professor Koopmans does hold very definite opinions on the subject of his principal concern, which is the logical structure of economic theory and its relation to empirical research and to the formulation of practical policy decisions. He knows, however, and states so several times, that the answer which one gives to these basic methodological questions is essentially intuitive.

The first of the three essays, entitled "Allocation of Resources and the Price System," is of a strictly expository nature. Its immediate purpose is to acquaint the mathematically unsophisticated reader with the application of certain new formal methods of analysis to problems of what traditionally would be called the Pure Theory of Value and Production. The more general aim of the finely wrought piece of theoretical exposition is to demonstrate — on the basis of that particular example — what the author considers to be the nature and function of economic theory. The specific contents of this first, very long essay are well described by the headings of its four chapters: (1) Point Sets, Linear Functions, and the Decentraliza-

* A review article of *Three Essays on the State of Economic Science*, by Tjalling C. Koopmans. New York: McGraw-Hill Book Company, Inc. 1957. Pp. 231. \$6.50.

tion of Economic Decision; (2) Competitive Equilibrium and Pareto Optimality; (3) Productive Efficiency and Price System; (4) Production Over Time, Capital and Interest.

The second essay, entitled "The Construction of Economic Knowledge," draws a moral from lessons offered in the first. Professor Koopmans elaborates here his thoughts on the importance of rigorous theoretical analysis; he also extends in a somewhat sketchy manner the basic approach presented in the first essay to the treatment of the more difficult questions connected with the phenomena of uncertainty and of increasing returns.

The emphasis on the importance of consistent, rigorous theoretical reasoning is carried over to the discussion of "The Interaction of Tools and Problems in Economics" in the third essay. This is mainly a critical survey of selected recent applications of theoretical economic models to the solution of business management problems and to empirical research. In the latter field Professor Koopmans has singled out for special comments the well known Klein-Goldberg statistical econometric model of the United States economy and some of the empirical input-output work (certain theoretical properties of the open, static input-output model are discussed in the first essay).

Professor Koopmans' lucid presentation of the formal basis, the inner structure, and of the principal applications of the "linear approach" can be commended as an excellent introduction to the "new look" which in recent years has been successfully competing with marginal analysis in economic theory.

The obvious virtues of what he calls the postulational method can hardly be disputed. Who would indeed object to clear statement of the premises (postulates) on which any particular chain of deductive reasoning is based

or to a concise formulation of the conclusions to which it leads? Dissenting voices notwithstanding, it is by now also pretty clear that this type of logical articulation is greatly facilitated by the use of mathematical language, particularly if the number of variables involved in the argument is large and the chain of reasoning is long and fragile.

The concern for "correct tracing of the implications of given postulates, and with efficient arranging and recording of the conditional, tautological but useful, truths so found" (page 143), however, so dominates Professor Koopmans' entire discussion that one is led to believe that the prevalence of illogical or at least untidy thinking constitutes the most vulnerable aspect of our discipline in its present state. To alleviate this ill he recommends an even greater functional separation than that which already exists, between pure theorists and empirical investigators. The first should build internally consistent models; the second, test them on the race track of observed facts.

I find it difficult to accept this as a correct diagnosis, and I am afraid that the remedy which Professor Koopmans prescribes is likely to produce ills much more dangerous than those which it is intended to cure. Let us imagine that a team of mathematicians and mathematical logicians were given the enormous task of reviewing the entire theoretical economic literature of the last thirty years with the specific assignment to clean up the sloppy and to eliminate the inconsistent arguments, to recast the sets of badly defined assumptions and to correct or, whenever necessary, qualify all inadequately derived conclusions.

The resulting body of logically certified economic theory, I submit, would differ very little in its operational contents from what we have now, that is, its immediate usefulness for explanation of observed fact would be approximately the same. An investigator looking for suggestive leads moreover would be well advised to rummage through the heap of scraps of superfluous assumption and unwarranted conclusion which the crops of logical inspectors will have trimmed away.

Professor Koopmans admits as much himself when he says that "in some intuitive sense the 'distance' between A. P. Lerner's *The Eco-*

nomics of Control and the mathematical formulation of the proposition of welfare economics reviewed in the first essay of this book is, I believe, not large," and then observes that, "If there is a difference, it is one of succinctness of expression rather than of content, concept, or objective."

The distance between that first essay and Paul Samuelson's *Foundations of Economic Analysis* (published in 1947) is even shorter. The theorems concerning production, pricing, and resource use derived by Professor Koopmans are typically narrower, i.e., more specific in their content, than the corresponding propositions developed in Samuelson's book, because the axiomatic assumptions of the linear approach are typically more restrictive than those conventionally employed by neoclassical theory. In other words Professor Koopmans has chosen to start with a set of less general postulates and thus has been able to arrive at more specific implications. The question naturally arises what gain there is in this for immediate or possibly for later explanation of observed facts.

The principal, not to say the only, virtue of linear formulation lies, I submit, not in its internal logical consistency or the intrinsic truth of its basic postulates, but in its particular adaptability to computational manipulation of the imperfect quantitative data with which economists now have to work. This brings us back to the central problem of the relationship between model building and model testing.

Professor Koopmans concludes his survey of recent econometric work in the United States with the melancholy observation that "the literature contains so many more problems than tested models" (page 219). This, alas, is very true. "It may be desirable" — Professor Koopmans continues — "that this [testing] activity be pursued separately from model construction, provided the full flow of information between builder and tester is not thereby inhibited." This recommendation reflects a basic point of view with which I cannot agree. The proposed greater division of labor between the pure theorist and the empirical investigator instead of alleviating the trouble is bound to make it very much worse.

While stressing over and over again the importance of logical consistency, which is a virtue

of a very general kind, Professor Koopmans expresses little concern with the, for any empirical science much more difficult and because of that more crucial, problem of effective operational relationship of theory to observed facts. His frequent passing references to the greater or lesser "realism" of various theoretical postulates seem to presume the existence of a uniquely described, or at least in principle unequivocally describable, reality which a theoretical model should be expected to fit. Actually a typical abstract economic model can be related to so-called reality only through an intricate system of basic definitions, classifications, and rules of measurement which logically can be neither right nor wrong, but without which a most rigorously constructed model can have no empirical significance of any kind.

Far from being a peripheral operation of subordinate importance the conceptual stratification of the amorphous, loosely observed facts is the very core of the empirical science. A happy conjecture at this early stage translated into an apt set of basic definitions leads to effective theoretical formulation and from there — through a second round of sharper observation — to satisfactory analytical explanation; an inappropriate set of starting definitions yields a confusing picture of reality which ends up in an analytical *cul de sac*. It is most improbable that such critical choices and decisions can be arrived at successfully through a process of negotiation between an expert in deductive reasoning and a specialist in observing facts.

This explains why none of the investigators whose names have been associated in the last forty years with major contributions to empirical econometric research have employed ready-made theoretical models but invariably have found it necessary to construct their own. These models, of course, have incorporated on a selective basis many of the basic general ideas of contemporary economic theory. On the other hand they have also made much use of well defined special techniques of quantitative analysis; in the past these were mainly various methods of statistical inference.

The division of labor that seems thus to emerge is not that between the model builder and model tester, but rather between the economist and the applied mathematician. The first

is concerned both with empirical analysis and the requisite general theoretical formulation. He should possess a sufficient knowledge of mathematics to translate, whenever necessary, his problems into concise symbolic terms and to make appropriate use of special tools developed by the applied mathematicians. In addition to methods of mathematical statistics mentioned before, these now comprise linear programming procedure and various techniques of large-scale computation. Occasionally the economist might profitably use even the counsel of a pure mathematician.

The "flow of information" referred to by Professor Koopmans will have to pass not between the model builder and the model tester, but between the mathematically literate economist and the applied mathematician. The latter will feel free or feel obliged, as the case may be, to state and to solve his mathematical problems in appropriate mathematical — not quasi-economic — terms. The economist will on the other hand have to face squarely the necessity of himself relating his own theoretical constructions to the facts which they are supposed to fit.

The great nineteenth century economists were in the enviable position of being able to theorize about the general, well known, some called them obvious, aspects of economic life. By now these ubiquitous raw materials of economic knowledge have been fairly well exhausted; the advanced, more refined analysis requires special kinds of detailed factual data that just do not lie around. Because of the resulting chronic raw material shortage a large portion of the processing, i.e., of the model building capacity of modern economics is used mainly to re-grind at high speed the same old stuff. Vertical integration of economic inquiry from the abstract-analytical down to the empirical-raw-material-extracting stage seems to offer the only effective remedy against the perpetuation of its present imbalanced state.

To justify the opposite recommendations which he makes Professor Koopmans cites the example of physical science in which "a considerable degree of differentiation has developed between experimental work, devoted to observation, and theoretical work, devoted to reasoning and to the construction of premises from which to reason" (page 131). Such strict division of

labor is however typical only of classical physics, a well advanced, not to say nearly closed, field characterized by the extreme simplicity of its empirical basis. The situation appears to be very different in such areas as quantum mechanics or atomic physics. Here the empirical-inductive and the analytical work are so closely interwoven that the distinction between the two can hardly be legitimately made.

Admittedly the ability to reason in abstract terms is often not combined in the same person with the interest in description and manipulation of observed facts. This only means however that modern economics is a difficult and for many aspiring scholars a frustrating field.

The fatal separation of theorists from fact finders could be mitigated by ever wider adoption of economics curricula requiring each graduate student to gain command of basic mathematics and at the same time to do substantial empirical work. In organized economic research effective balance can possibly be best established and maintained through team work involving intimate day-to-day collaboration be-

tween the theoretically-minded investigator and his more empirically-oriented colleagues. Consistent with his fundamental point of view Professor Koopmans takes a very different position on this important practical question too. As said before he sees great promise in sharper separation of model building from model testing projects and only recommends establishment of "cooperative arrangements" between the two.

*"Ces deux parties, je veux dire la Théorie et l'expérience, qui se concilient parfaitement bien, lorsqu'elle se trouvent réunies dans une même personne, se sont de tout tems [temps] mais en vain, livré une guerre continuelle, lorsqu'elle se trouvent séparées."*¹

Francois Quesnay made this observation in the Introduction to his first book, *Essai physique sur l'economie animale* (Paris, 1736). It is as true today as it was two hundred years ago.

¹ "These two points of view, I mean that of Theory and observation, which are reconciled perfectly, if combined in a single person, whenever they are separated wage against each other an incessant but futile war." The orthography of the quotation is the original.