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**A
SURVEY OF
AGRICULTURAL
ECONOMICS
LITERATURE
VOLUME 2**

A Survey of Agricultural Economics Literature
VOLUME 2

The three volumes in *A Survey of Agricultural Economics Literature* have been prepared by and published for the American Agricultural Economics Association. The general editor of the survey volumes is Lee R. Martin.

Volume 1, *Traditional Fields of Agricultural Economics, 1940s to 1970s*. Lee R. Martin, editor.

Farm Management and Production Economics, 1946-70 by Harald R. Jensen.

The Analysis of Productive Efficiency in Agricultural Marketing: Models, Methods, and Progress by Ben C. French.

Policy for Commercial Agriculture, 1945-71 by G. E. Brandow.

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Technical Change in Agriculture by Willis Peterson and Yujiro Hayami.

Volume 2, *Quantitative Methods in Agricultural Economics, 1940s to 1970s*. George G. Judge, Richard H. Day, S. R. Johnson, Gordon C. Rausser, and Lee R. Martin, editors.

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ECONOMICS
LITERATURE**

VOLUME 2

*Quantitative Methods
in Agricultural Economics,
1940s to 1970s*

*George G. Judge, Richard H. Day, S. R. Johnson,
Gordon C. Rausser, and Lee R. Martin, editors*

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Foreword

In March 1968 C. E. Bishop, president of the American Agricultural Economics Association, appointed a committee to investigate the need for a major survey of the agricultural economics literature published from the 1940s to the 1970s. The committee found that an extensive assessment of this body of literature would indeed be of value to research workers, teachers, extension workers, and graduate students in agricultural economics; teachers, research workers, and graduate students in economics and economic statistics, sociology, geography, political science, and anthropology; and teachers, research workers, and graduate students in technical agriculture. In the end the committee was assigned the responsibility for planning the project and commissioning authors to prepare the papers.

The members of the committee were Glenn L. Johnson (Michigan State University), M. M. Kelso (University of Arizona), James E. Martin (Virginia Polytechnic Institute), M. L. Upchurch (Economic Research Service of the United States Department of Agriculture), and Lee R. Martin, chairman (University of Minnesota). Early in 1969 James E. Martin resigned from the committee, and several new members—John P. Doll (University of Missouri), Peter G. Helmberger (University of Wisconsin), J. Patrick Madden (Pennsylvania State University), and Edward W. Tyrchniewicz (University of Manitoba)—were appointed.

As its first step, the committee tentatively identified the fields to be covered and commissioned highly regarded members of the profession to draw

up outlines of the coverage to be undertaken in the different fields. These outlines were used in the selection of economists to prepare the surveys and in negotiating agreements with prospective authors. Once the surveys were prepared, the committee again obtained assistance from highly competent members of the profession to make critical, constructive evaluations of each survey draft. In the case of the preparation of outlines and the review of papers, the committee sought to strike a representative balance among differing viewpoints in each field. For the preparation of the papers themselves, the committee obtained the services of outstanding agricultural economists with special competence in the respective fields.

In connection with the papers published in this volume, substantial assistance was provided by the following individuals:

PART I. Estimation and Statistical Inference in Economics. *Preparation of outline:* John P. Doll and Oscar R. Burt. *Review of paper:* Richard J. Foote and Wayne A. Fuller.

PART II. On Economic Optimization: A Nontechnical Survey. *Preparation of outline:* John P. Doll and Oscar R. Burt. *Review of paper:* Verner G. Hurt. **Optimization Models in Agriculture and Resource Economics.** *Review of paper:* Oscar R. Burt. **Agricultural Production Function Studies.** *Review of paper:* Chester B. Baker, Harold O. Carter, John C. Crecink, Lee M. Day, Richard J. Edwards, Irving F. Fellows, Burton L. French, Earl O. Heady, George D. Irwin, Earl W. Kehrberg, Luther H. Keller, W. W. McPherson, D. D. Mason, Ronald L. Mighell, Frank Orazen, G. A. Peterson, W. B. Sundquist, Earl R. Swanson, and W. D. Toussaint.

PART III. Systems Analysis and Simulation in Agricultural and Resource Economics. *Preparation of outline:* S. R. Johnson and Gordon C. Rausser. *Review of outline:* Ludwig Eisgruber, Earl Fuller, Tom Manetsch, Thomas H. Naylor, and Warren H. Vincent. *Review of paper:* Oscar R. Burt, Ludwig Eisgruber, Albert N. Halter, and Thomas H. Naylor.

PART IV. Developments in Agricultural Economic Data. *Preparation of outline:* Earl Houseman, Fred Abel, and Harry C. Trelogan. *Review of outline:* James T. Bonnen, James P. Cavin, Wayne Dexter, Clark Edwards, and Warren Grant. *Review of paper:* James T. Bonnen, James P. Cavin, Karl A. Fox, and Nathan M. Koffsky. **Technical Developments in Agricultural Estimates Methodology.** *Review of paper:* Lee R. Martin. **Assessment of the Current Agricultural Data Base: An Information System Approach.** *Review of paper:* George G. Judge and Lee R. Martin. **Rural Economic and Social Statistics.** *Review of paper:* James T. Bonnen, George G. Judge, Lee R. Martin, and Luther G. Tweeten.

This list includes only the official reviewers who acted on behalf of the association and the committee. Many other individuals who assisted the authors of the papers in various ways are cited in the notes preceding each paper. The authors were urged to incorporate into their papers the comments and suggestions provided by the respective reviewers, but final decisions about the content of the papers were left to the discretion of the authors.

The Committee on Publication of Postwar Literature Review arranged for publication of the three-volume set of literature reviews. The members of this committee are Emerson M. Babb (chairman), J. P. Madden, Lee R. Martin, and John C. Redman. Neil Harl provided valuable assistance in the publication phase to both committees.

On behalf of the members of the association and the Literature Review Committee I wish to express sincere gratitude to the authors of the papers in this volume and the the advisors, reviewers, and others who participated in the planning and implementation of the project as a whole.

Finally, I would like to direct readers' attention to current literature reviews of some closely related fields of agricultural economics—reviews that both complement and supplement the reviews in this volume and the two companion volumes. The following reviews have been published in an Australian journal, *Review of Marketing and Agricultural Economics*:

- G. Weinschenck, W. Henrichsmeyer, and F. Aldinger (1969). "The Theory of Spatial Equilibrium and Optimal Location in Agriculture: A Survey." 37:3-70.
- Ulf Renborg (1970). "Growth of the Agricultural Firm: Problems and Theories." 38:51-101.
- John L. Dillon (1971). "An Expository Review of Bernoullian Decision Theory in Agriculture: Is Utility Futility?" 39:3-80.
- Roger W. Gray and David J. S. Rutledge (1971). "The Economics of Commodity Futures Markets: A Survey." 39(4):57-108.
- Harold F. Breimyer (1973). "The Economics of Agricultural Marketing: A Survey." 41:115-165.
- Jock R. Anderson (1974). "Simulation: Methodology and Application in Agricultural Economics." 42:3-55.

An additional article commissioned by the *Review of Marketing and Agricultural Economics* but not yet published is "Public Utility Pricing" by David Gallagher.

Another important set of literature reviews in agricultural economics is being published in the British *Journal of Agricultural Economics*. To date the following review articles have been published:

- G. H. Peters (1970). "Land Use Studies in Britain: A Review of the Literature with Special Reference to Applications of Cost-Benefit Analysis." 21:171-214.
- D. S. Thornton (1973). "Agriculture in Economic Development." 24:225-287.
- T. E. Josling (1974). "Agricultural Policies in Developed Countries: A Review." 25:229-264.
- C. S. Barnard (1975). "Data in Agriculture: A Review with Special Reference to Farm Management Research, Policy and Advice in Britain." 26:289-333.
- D. I. Bateman (1976). "Agricultural Marketing: A Review of the Literature of Marketing Theory and Selected Applications." 27:171-225.

Also worthy of note is Marguerite C. Burk's 1967 "Survey of Interpretations of Consumer Behavior by Social Scientists in the Postwar Period," *Journal of Farm Economics* 49:1-31.

Lee R. Martin
Survey Editor

June 1977

Introduction

In the evolution of modern economics from nineteenth-century political economy many have expressed the ideas that “(1) mathematics, however useful it may have proved in the physical sciences, can play no essential role in the development of the social sciences because the phenomena studied are somehow different—‘human beings are not amenable to mathematical law’—and (2) the judgment and intuition of the skilled investigator are fundamentally more useful in the social sciences than mathematical formulas based on quantitative observation” (Arrow [1951]). In a letter in 1906 Alfred Marshall advised A. L. Bowley to “use mathematics as a shorthand language rather than as an engine of inquiry.”

In the face of these propositions perhaps we should ask why Bowley ignored Marshall’s advice and went on to write a treatise restating the basic postulates of economics in mathematical form and why economists should try to measure “things.” What does measuring accomplish that nonmeasuring does not? It is costly to obtain measurements. Are the returns from the efforts worth the cost?

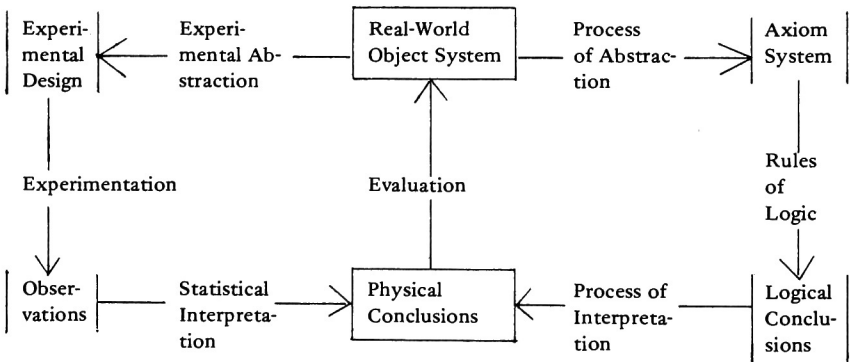
It is important to realize that in order to explain the relations among so-called economic variables, economics has become essentially a general theory of choice. Moreover, in situations where the choices of individuals are reciprocally dependent, we have been forced to develop a general theory of strategy. Consequently, one ultimate purpose of economic research is to generate in-

Note: Some of the material in this section is based on Judge [1968].

formation that may be used to improve economic decision making or strategy formation. A consumer seeks the best way to buy. A firm seeks the best way to produce. A government seeks the best way to regulate. As Dreze [1972] has noted, these decisions are typically made under uncertainty and formal analysis of the problems reflects the *states*, which describe the environment; the *consequences*, which describe what happens to the decision maker; and the *acts*, which are functions that assign a consequence to each state. A decision involves the choice of a “best” element from a set of acts.

As the “decision machine” runs on information, we might say, following Marschak [1953], that “knowledge is useful if it helps us make the best decisions.” For most decision problems it is not enough to know that certain variables are related, because in the economic sphere the rallying cry seems to be that “everything depends on everything else.” This means that if information is to be useful in a decision context we must understand the fundamental structural aspects of the problem, we must know in what direction the relationship runs, and we must be able to estimate *how much* or at least the probability of how much. Thus, cardinal and ordinal measurements appear operationally necessary.

Given the need for quantitative knowledge in economics, how do we go about capturing it? In the history of science two approaches have been employed in the search for knowledge: (1) postulation or logical argument, and (2) experimentation or measurement. The structure of the search process for



The role of postulation and experimentation in the search for knowledge. (Adapted from Thrall, Coombs, and Raiffa [1954].)

both routes to knowledge is given in the accompanying diagram. The two routes have been used individually and in combination. Moreover, they are

tied together in the sense that conclusions or hypotheses reached via the logical route form the basis for experimental models.

From the standpoint of economics the way to knowledge through the logical route noted in the diagram is clear: *economic theory* and *mathematical economics* are the result. The logical route, of course, only gives us the consequences of the axiom system and tells us nothing about the truth or falsity of the knowledge relative to real-world phenomena. Alternatively, the measurement or experimentation route provides a basis (1) for refuting, refining, or modifying the axiom set of conclusions reached by the logical route and (2) for attaching signs, numbers, and reliability statements to events so that they can be used as a basis for decisions.

The experimental restrictions in the search for knowledge become apparent at the left side of the diagram. Experiments give reproducible knowledge, and within the framework of the experimental design the outcome of an experiment can be forecast. Even though the objectives of the economist are the same as those of the engineer or the physicist (for example, to estimate or predict the effects of a change in structure), the economist's models for the most part are of a nonexperimental nature and his data are like those of the meteorologist. As Marschak [1950] observed, the economist is usually asked to estimate the impact of a change in the mechanism which produces his data, and none of these changes can be produced beforehand in a laboratory experiment. Data are thus generated according to society's experimental design, and the economist can observe the outcome but can affect that outcome very little. This situation means, according to Marschak [1950], that "economic data are generated by systems of economic relations that are in general stochastic, simultaneous and dynamic. Occurring jointly, these three properties give rise to unsolved problems of statistical inference from the observed data to the relations. Yet these very relations constitute economic theory and knowledge of them is needed for economic practice."

In addition, we know so little about the mechanisms at work in the economic sphere that there is enormous arbitrariness in any specification. Economic theory provides several alternative models for explaining economic behavior and does not really help to narrow the range of hypotheses. Furthermore, passively generated data, for which we cannot control variables and isolate relations, are often consistent with a variety of hypotheses. This means that there is considerable difficulty in discriminating among alternative hypotheses and some question about whether our theories can be tested and whether the quantitative results have validity for any broader body of data.

Given these pitfalls, should we despair and take our alphas, betas, and

imaginary numbers and go home? The papers contained in this volume provide a historical answer to this question and make suggestions of possible future responses in the areas of both theory and practice.

In the first essay Judge reviews attempts over the last three decades to cope with the problems of measurement in economics and discusses within the context of a time path the analytical methods developed and employed in analyzing and learning from economic data. Noting the early contributions to measurement in economics, the essay starts with a detailed review of attempts in the 1940s to develop statistical models and procedures for estimation and inference that are consistent with the endogenous nature of economic data. The refinement of these procedures in the 1950s is discussed and their application in estimating the parameters of a variety of micro and macro economic regulations is reviewed. The period of the 1960s is viewed as an era in which economists concentrated on the question of how to make systematic use of both sample and external (prior) information in learning from economic data. In this period the theory and practice of econometrics helped to make transparent the estimation and inferential implications of both sampling theory and Bayesian approaches in searching for quantitative economic knowledge. The early 1970s are viewed as a period in which the search for estimators that are appropriate for economic decision problems was continued, in which the estimators proposed under a range of measures of goodness were superior to traditional estimators, and in which systems analysis and control theory provided a framework for joining the separate problems of estimation, optimization, and design of experiments. The chapter closes with a discussion of the contributions of econometrics to the science of economics and the identification of some of the changes in econometric models and tools likely in the decades ahead.

In the second paper Day reviews developments since the 1950s in optimization theory and methods that underlie much of the applied work in agricultural and resource economics. Day begins with a brief discussion of the relationships among classical, neoclassical, and modern theories of economizing. The point of view established and alluded to throughout the paper is that modern concepts of optimization incorporate, unify, and generalize the seminal insights of the classical and neoclassical founders of economic theory. The remainder of the paper is divided into sections that summarize the basic concepts and provide key references to the following topics: alternative optimization models, parametric programming and comparative statics, the duality of choice and imputation, economizing or optimization algorithms, economic efficiency and games, decomposition and coordination of complex economic decisions, economizing with multiple goals, risk and uncertainty, dynamic or

intertemporal optimization, recursive optimization or suboptimizing with feedback, and the relationship between optimization and economic behavior. In the last section we are reminded that optimality is a logical property of formal models; whether or not it is a meaningful characteristic of human behavior is of course a subjective matter. This reservation becomes stronger when we contemplate the difficulty of extending the concept of intertemporal optimality to resource allocation problems that ultimately involve future generations, whose preferences are yet to be formed. The epilogue, however, emphasizes that, subject to such reservations, optimization theory and methods occupy key roles in the understanding and control of human economic affairs.

This paper is followed by Day and Sparling's survey of optimization models in agricultural and resource economics. They begin by recalling von Thünen's classic development of marginalist and budgeting principles in the context of optimal farm management. The introduction is followed by a survey of selected contributions to economic analysis in the following areas: food and nutrition, farm and agribusiness management, farm growth and development, production response studies at national and regional levels, spatial economics, natural resource management, and agricultural development problems in less developed countries. This survey illustrates the extensive and varied applications of the spectrum of optimization concepts and methods outlined in the preceding chapter.

Building on the previous chapters, Woodworth assesses applied research concerned with developing optimum conditions in farm production. Starting with the historical background, he presents an overview of the broad range of production function studies in agriculture, including studies of farms and marketing firms that use cross-section or time series data. The major emphasis of Woodworth's chapter is an assessment of production function studies relating inputs to crop and livestock production. These studies, which reached a peak in numbers of projects and general interest in the 1950s, brought about a unique degree of multidisciplinary cooperation among plant and animal scientists, statisticians, and economists.

Johnson and Rausser review the applications and developments of an approach more recent in origin than econometrics or optimization. Systems analysis and the simulation of systems models has become a popular method of studying economic problems and the generation of information about economic relationships. With the advent of the modern computer the possibility of operating and monitoring the outcomes of large models has become a reality. Taking advantage of this technology, the early workers in the system and simulation area used comparatively detailed models to study a wide range of

economic problems. The approach was and is characterized by the use of highly flexible models based on various sources of prior and sample information and operated in an exploratory manner.

Applications of systems and simulation concepts are grouped in six categories defined on the basis of research areas in agricultural and resource economics. These include gaming, firm and process, market and industry, aggregate, economic development, and resource models. The review focuses on the method of model formulation, corroboration of models with the systems they are designed to represent, model type, and simulation method. Noteworthy developments in methods which have occurred in agricultural economics are identified.

As the systems and simulation approach is new, a major portion of the chapter is devoted to a review of the method itself. This is necessary to provide a framework for reviewing the applications. The discussion makes it apparent that the flexibility of the approach is paid for in research results which are highly personalized. It is interesting that not only the process of depersonalizing model formulation but also the specialization of models to particular systems and the simulation of systems models lead directly to problems in the theory of optimal control. Research strategies based on the notion of systems and simulation modeling can thus be viewed as crude approximations to the solution of the control problems. Nevertheless, viewing systems analysis and simulation in this context provides a basis for identifying common threads in the various approaches to quantitative economic problems; useful insights on these approaches might be modified to augment their potential value.

In the concluding chapters Upchurch, Trelogan and his colleagues, Bonnen, and Bryant trace out and interpret from different points of view the development in agricultural economic data since World War II. Emphasis is placed on the recurring national statistical series most often used by agricultural economists. Much of the periodic statistical data originated before World War II. The agricultural depression of the 1920s and the urgent economic problems of the 1930s led pioneers in the profession to seek data that would help them describe, diagnose, analyze, and test economic relationships. The problems of the 1940s brought special demands for additional kinds of data and for more reliable data. For example, rationing of food during the war made apparent the need for better knowledge of food consumption, and rationing of farm machinery prompted further development of data on resources used in production. Requirements for price support programs led to refinements in data on prices received and paid by farmers. These developments and others provided the raw material for expanded economic analyses. During the past three decades improved methods of collecting and processing

data have increased the accuracy, capacity, and reliability of the information available to decision makers. For the future, it appears that remote sensing, computers, improved sampling techniques, and other technology will make possible important improvements in collecting and analyzing data. More important to the usefulness of the information, however, will be new concepts and definitions of the food and fiber industry and its parts, different populations for demographic data, and different problems for agricultural economists.

Over recent decades there has been a growing separation of the agricultural economic analyst from the agricultural statistician. This compartmentalization or specialization accounts in part for the relative scarcity of articles on data in our literature, and it may have contributed to the dissatisfaction many agricultural economists now feel toward much of their data. A substantial change may occur in the decade ahead. Bonnen's paper builds on this theme and traces some of the impacts of the greater specialization and organizational fragmentation on information system design and the corresponding difficulties of maintaining a coherent, integrated information system. Bonnen further points to some growing obsolescence of the concepts which serve as the basis of our data system and the corresponding measurements. Even though knowledge of the uncertainty surrounding the possible payoffs or losses for a range of agricultural decisions was often repressed by policy action during much of the period since World War II, Bonnen concludes that, for today's decision needs, we have undervalued our agricultural information system. Consequently, we have not invested adequately in some subsystems and we have allowed others to decay seriously. Because the returns to careful decisions about data and information appear to be high, the case is made for each agricultural economist, and perhaps especially for those in academia, to take more responsibility in shoring up the conceptual underpinnings of the agricultural information system and in keeping those underpinnings in close harmony with the dynamic sector.

In the area of economic and social statistics Bryant notes the increasing resources allocated to social experiments and experimental design, to basic data collection, to the training of economists in statistical measurement and data collection techniques, and to training in working with longitudinal panel data. He makes some suggestions on how to accelerate the process of bringing the information system for the rural sector closer to what is needed for improved decision making. He concludes optimistically that the 1980s may become the "data decade."

In the epilogue an attempt is made to combine the contributions in the various areas and to assess their joint impacts on the discipline of economics and the subject matter area of agricultural economics.

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