Analytical Tools and the Development of Quantitative Methods (1920-1984)

Gordon A. King

"New methods of economic research are useful if, and only if, they help us solve real concrete problems." Waugh (1953).

This paper can only sketch some of the important research challenges in Agricultural Economics and the development of analytical approaches to the solution of these problems. The four volume Survey of Agricultural Economics Literature covers in detail the period from 1940 to 1980. The approach here is to distill from the Journal some of the major problems facing agriculture and rural America, and to present illustrations of the research response that led to the development of our present analytical and quantitative methods.

Historically, agricultural economists have been problem-oriented. Contributions to theory and quantitative methods have come through attempts to get analytical or quantitative answers to important problems facing the economy. I trust this emphasis will continue, although one can sense the growing use of complicated theoretical constructs that cannot as yet be quantified. One can see the attraction of such efforts when faced with the grim realities of modeling with poor data sets!

The 1920's

The major challenge of this decade was depressed farm prices and rural incomes. Export markets dried up due to low purchasing power abroad and high

---

Paper presented at the American Agricultural Economics Association Meetings, Cornell University, August 7, 1984.

tariff protectionist policies here and abroad (see for example Benedict, Warren and Pearson, and the American Academy of Political and Social Sciences). During this decade there was a concerted effort to provide better information to farmers facing severe adjustment problems. Also, there was a shift from a basically micro-farm management focus to a broader perspective on supply response, price forecasting, outlook work of the BAE, credit and land use issues, and macro issues such as the effects of devaluation on the farm sector.

The Journal issues of the 1920's provide fascinating reading from the perspective of the 1980's. For example, the effect on exports of tariff policies and weak purchasing power abroad sound like contemporary issues. There are several classic contributions that are noted here: the 1923 article by Spillman on production functions for fertilizer and feed use; Ezekiel's several contributions on correlation analysis that led to his 1930 book on Methods of Correlation Analysis; Waugh's early work on forecasting potato prices in New Jersey (see Waugh (1984), p. 385); and Henry Schultz's analysis of the effects of tariffs on the demand for beef and related studies leading to his 1938 book on The Theory of Measurement of Demand.

Authors such as Erdman and Jesness focused on the role of cooperatives in production and marketing problems. But if it were not for the work of the profession, and the BAE in particular, the data base would not have been available for much of the statistical analyses of that and subsequent periods. Other important contributions include the early quantitative work on prices and his later work on futures markets by Holbrook Working, and the theoretical article on the identification problem by Elmer Working. On policy issues Asher Hobson focused on the effect of European agricultural policies on American agriculture and Wehrwein emphasized land policy as an integral part

of agricultural policy. The list can go on and on. The decade of the 1920's, then, saw the profession broadening its scope from micro analysis of farm problems to market analysis and to the macro impacts of foreign markets and financial markets on the agricultural sector. Not all studies have to be "quantified" to classify as being strong analytical papers in my opinion.

The 1930's

The major challenge of the 1930's was the collapse of the whole economy. The response by the profession was a broad analysis of rural problems and of research methods. A benchmark article by Howard Tolley in 1930 indicates some of the developments of the profession at that time. An impressive series of research bulletins was then prepared on Scope and Method of Research in Agricultural Economics and Rural Sociology sponsored by the Social Sciences Research Council's Advisory Committee on Economics and Social Research in Agriculture. John D. Black was editor of this series to which many of the best researchers of the time contributed.[1] The analytical methods suggested in these bulletins show such diversity that any summary would be pure folly (e.g., from index number construction to price analysis to agricultural policy).

It is not clear to me how quantitative analysis may have been used in the development of farm legislation of the 1930's. However, Cochrane (1984) indicates the contributions of the eager staff of the BAE including among

---

[1]The 21 Scope and Method reports are as follows: (1) public finance, (2) land utilization, (3) credit, (4) rural population, (5) rural social work, (6) agricultural income, (7) marketing, (8) transportation, (9) prices of farm products (edited by Black, Ezekiel and Cassels), (10) index numbers, (11) farm family living, (12) rural organization, (13) farm management, (14) insurance (15) cooperation, (16) farm labor, (17) social psychology of rural life, (18) rural institutions, (19) farm real estate values, (20) land tenure and (21) agricultural policy.

others Tolley and Ezekiel who had contributed much to quantitative developments in the 1920's. Some of the land use planning activities which provided insights as to the nature of American agriculture were to be challenged in the 1940's (see Hardin).

The 1940's

World War II brought the challenges of increased production from American agriculture in spite of massive shifts of labor to war related activities. The Journal reflects these concerns early in the decade and, later on, articles concerned with postwar adjustments. However, the decade provided some important breakthroughs in research methods. Nichols reported on his work using an imperfect competition framework in analyzing the meat packing industry. In production economics, Jensen, et al., published the collaborative agricultural economics--dairy scientist research on input-output relationships in milk production. In agricultural policy, Schultz published his basic work on Agriculture in an Unstable Economy and Cochrane provided quantitative evidence in his "Farm Price Gyrations--" article. In the area of interregional competition, Mighell and Black summarized and extended the research on comparative advantage in dairy production. In marketing, Bressler and others demonstrated the usefulness of the synthetic approach to analyzing milk marketing research. These are but a few examples of the research of the 1940's that led to the exciting developments of the 1950's and beyond.

1950 - 1984

Experience has led me to be cautious in listing recent contributions by author since any list can only be partial and egos can justifiably be bruised. Perhaps a general reference to the Association Handbook-Directory will be an

impartial source. Here it will be useful to discuss developments by major area, but there are a few contributions that must be mentioned.

Econometrics and Problem Solving

The 1950's saw econometrics textbooks become available to the profession (e.g., Tintner). Research in commodity modeling became an exciting and rewarding experience as new methods and approaches were used to describe market structures and price determination. The USDA group including Fox, Foote, Waugh, Rojko and Nerlove, for example, provided new ideas. The key element in this arrangement was that in general the econometrician-types worked directly with skilled commodity analysts so that the tie with the real world was maintained. There were some "real concrete problems" to be solved or, at least, the models allowed evaluation of alternative program actions.

The decades since 1950 have resulted in a mountain of research approaches and econometric techniques (see Judge, et al.). Agricultural economists contributed to this development but more in the application sense than in the theoretical aspects. The development of computers has changed the nature and scope of research. And one should note that even the sophisticated tools still do not allow accurate predictions when events such as an oil crisis or an unusual wheat sale upset past "stable" relationships.

Time series analysis is probably the major data used in econometric modeling. Yet there is increased use of panel and cross section data. One notes that the basic statistical theory of econometrics would appear to require much more refined data, experimental design and sampling than is used in most of our analyses. Perhaps it is not unexpected that predictions, based on time series, particularly outside the sample period observations, do not give precise estimates!

The past 30 years has seen the development of much more sophisticated economic and statistical modeling. But where are we in terms of Fred Waugh's dictum concerning their usefulness in helping to solve real concrete problems? The record is mixed but there is evidence of solid progress. One of the difficulties is that the farm economy currently is tied to domestic policy and is dependent on export markets. The econometric modeling of international trade is a notoriously difficult area as Thompson has pointed out in his appraisal of alternative techniques of empirical trade research. Further work on the effect of exchange rates and international markets is needed for the 1980's.

Recent emphasis has been given to dynamic specifications of economic relationships (see Rausser). Many of our colleagues are intrigued by control theory and the potential of this specification for commodity modeling as well as for production and resource problems. Dynamic specifications are appealing theoretically, but the data demands and the nature of the problems require careful modeling to avoid nonstable outcomes in predictions.

Mathematical Programming and Problem Solving

The early 1950's saw agricultural economists emphasizing the usefulness of linear programming in feed mix problems and of activity analysis in general for a broad range of problems (e.g. Heady, King). These included production and marketing problems as well as numerous interregional competition studies. Professor Heady has 35 years of continuous contribution to such studies as well as in other areas, as is well-known to the profession.

Developments include consideration of risk and multiperiod analysis. Dynamic programming models developed by the profession have shown imaginative applications to production and resource use questions. The current high

speed computers provide the potential for further advances if the data are available. However, there still are problems with solution techniques for nonlinear objective functions and restraints.

Other Analytical Approaches to Problem Solving

Analytical tools, or methods of separating any particular problem into its component parts, are much broader than just econometrics and mathematical programming. For example, the plant efficiency studies focused on analysis of component parts and then synthesized these elements into cost functions (French, et. al.). Input-Output studies have focused on the interrelationships among various sectors of the economy (e.g., Carter and Heady). Market structure studies, while perhaps using quantitative methods, focused on the theoretical implications of noncompetitive structures on market outcomes (see Farris). Economic development problems have been skillfully analyzed (e.g., Hayami-Ruttan). World agricultural problems have been appraised (e.g., see Johnson, and Johnson and Quance). Analytical approaches to resource problems have been developed that do not necessarily involve the above mentioned quantitative methods (see Salter and Ciriacy-Wantrup). If data problems are intractable or if there has been no experience with a program such as food stamps, agricultural economists have developed theoretical analyses as to likely outcomes with given "reasonable" assumptions as to supply and demand elasticities. Simulation of alternative outcomes with sets of alternative coefficients may provide reasonable bounds that aid decision-makers in reaching policy conclusions.

Conclusions

How have we fared over the last 65 years in developing new methods to solve real concrete problems? On the positive side, the profession has been

in the forefront in developing and utilizing quantitative methods in analyzing the whole range of problems facing the agricultural economy. Some in the profession have developed the data bases on which others have relied for their analyses. One could be justifiably proud of this record.

But what of the next two decades? Do we really understand the current structure of production, marketing and resource use or do we need a comprehensive study like the National Commission on Food Marketing (Brandow)? Do present data sources provide the key factors that influence changes in productivity and supply and demand? Will we retreat to the confines of theoretical economic models and econometric techniques? Will we identify the real problems facing rural economy, the questions of economic development, the future of trade, the problem of stabilization of stocks, the production adjustments in the continuing "Unstable Economy"? Will the welfare implications of public policy be addressed in our future research efforts? The use of analytical and quantitative methods to help solve these and other "real concrete problems" is the challenge of the future if this profession is to maintain its deserved reputation in applied economics.

References

American Academy of Political and Social Sciences, The Annals, Vol. 142, Philadelphia, March, 1929.

Benedict, Murray. Farm Policies of the United States, 1790-1950, New York, The Twentieth Century Fund, 1953.

Brandow, G. E. (Executive Director) Various Technical Studies, National Commission on Food Marketing, Washington 1966.

Bressler, Raymond G., Jr. City Milk Distribution. Cambridge, Harvard University Press, 1952.

Bressler, Raymond G. Jr. and Richard A. King. Markets, Prices, and Interregional Trade. New York, John Wiley and Sons, Inc., 1970.

Carter, Harold O. and Earl O. Heady. An Input-Output Analysis Emphasizing Regional and Commodity Sectors of Agriculture. Ames: Iowa State Res., Bulletin No. 469,1959.

Ciriacy-Wantrup, Siegfried von. Resource Conservation: Economics and Policies, Berkeley, University of California, Division of Agricultural Sciences (3rd ed.) 1968.

Cochrane, Willard W. "Agricultural Policy in the United States--A Long View", Unpublished paper presented in the Banjamin Hibbard Memorial Lecture Series, University of Wisconsin, Madison, Wisconsin, April 13, 1984.

_____. Farm Price Gyrations--An Aggregative Hypothesis. Journal of Farm Economics, 29(1947):383-408.

Ezekiel, Mordecai, Methods of Correlation Analysis, New York: John Wiley & Sons, Inc., 1930.

Farris, Paul L. (ed.) Future Frontiers in Agricultural Marketing Research Ames: Iowa State University Press, 1983.

Foote, Richard J. Analytical Tools for Studying Demand and Price Structure. United States Department of Agriculture, Agr. Handbook No. 146, August, 1958.

Fox, Karl A. The Analysis of Demand for Farm Products. United States Department of Agriculture, Technical Bulletin No. 1081, 1953.

French, B. C., L. L. Sammet and R. G. Bressler. "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia Vol. 24, No. 19, July 1956.

Gustafson, Robert L. Carryover Levels for Grains. United States Department of Agriculture, Technical Bulletin No. 1178, October, 1958.

Hardin, Charles M. "The Bureau of Agricultural Economics Under Fire: A Study of Valuation Conflicts." Journal of Farm Economics, 28(1946):635-668.

Hayami, Yujiro and Vernon W. Ruttan. Agricultural Development: An International Perspective. Baltimore: Johns Hopkins Press, 1971.

Heady, Earl O. and Wilfred Candler. Linear Programming Methods. Ames: Iowa State College Press 1958.

Hobson, Asher. "Some Agricultural Tendencies in European Countries." Journal of Farm Economics, (1926):

Jensen, Einar, John W. Klein, Emil Ranchenstein, T. E. Woodward, and Ray H. Smith. Input-Output Relationships in Milk Production, United States Department of Agriculture, Technical Bulletin No. 815, May, 1942.

Johnson, D. Gale. World Agriculture in Disarray. New York: St. Martin's Press (for the Trade Policy Research Centre), 1973.

Johnson, Glenn L. and C. Leroy Quance (eds.) The Overproduction Trap in U.S. Agriculture: A Study of Resource Allocation from World War I to the Late 1960's. Baltimore: Johns Hopkins Press, 1972.

Judge, George G., William E. Griffiths, R. Carter Hill and Tsoung-Chao Lee. The Theory and Practice of Econometrics. New York: John Wiley and Sons, 1980.

King, Richard A. "Some Applications of Activity Analysis in Agricultural Economics." Jour. Farm Econ., 35(1953):823-833.

Martin, Lee R. (Editor). A Survey of Agricultural Economics Literature, Vols. I-IV, Minneapolis: University of Minnesota Press, 1977.

Nerlove, Marc. Distributed Lags and Demand Analysis for Agricultural and Other Commodities, U.S. Dept. Agr., Agr. Handbook, No. 141, June 1958.

Nichols, William H. "Market-Sharing in the Packing Industry." Jour. Farm Econ., 22(1940):225-240.

Mighell, Ronald and John D. Black. Interregional Competition in Agriculture with Special Reference to Dairy Farming in the Lake States and New England, Cambridge. Harvard University Press, 1951.

Rausser, Gordon C. (ed.) New Directions in Econometric Modeling and Forecasting in U.S. Agriculture, New York: North-Holland, 1982.

Rojko, Anthony S. The Demand and Price Structure for Dairy Products. U.S. Agr. Mkting Serv. Tech. Bul. No. 1168, Wash. 1957.

Salter, Leonard A. A Critical Review of Research in Land Economics. Minneapolis, University of Minnesota Press, 1948.

Schultz, T. W. Agriculture in an Unstable Economy. New York: McGraw-Hill Book Co. Inc., 1945.

_____. "Production and Welfare Objectives for American Agriculture." Jour. Farm Econ., 28(1946):444-457.

Social Science Research Council, Advisory Committee on Economics and Social Research in Agriculture. Scope and Method of Research in Agricultural Economics and Rural Sociology.

Spillman, W. J. "Applications of the Law of Diminishing Returns to Some Fertilizer and Feed Data." Jour. Farm Econ., 5(1923):36-52.

Tintner, G. Econometrics. New York, John Wiley, 1952.

Thompson, Robert L. A Survey of Recent U.S. Developments in International Trade Models. U.S. Econ. Res. Service Bibliographics and Literature of Agriculture No. 21, Washington, Sept. 1981.

Tolley, Howard R. "Recent Developments in Research Method and Procedure." Jour. Farm Econ., 12(1930):213-230.

Warren, George F. and Frank A. Pearson. The Agricultural Situation. John Wiley and Sons, Inc., 1924.

Waugh, F. V. "Programs for Using Agricultural Surpluses to Reduce Malnutrition and to Benefit Farmers." Jour. Farm Econ., 22(1940):324-330.

_____. Selected Writings on Agricultural Policy and Economic Analysis, James P. Houck and Martin E. Abel, Editors, Minneapolis: University of Minnesota Press, 1984.

_____. "Applicability of Recent Developments in Methodology to Agricultural Economics," Jour. Farm Econ. 35(1953):692-726.

Working, Elmer J. "What Do Statistical Demand Curves Show?" Quart. J. Econ., 41(1926):212-235.

Working, Holbrook. Selected Writings, Compiled by Anne E. Peck, Chicago Board of Trade, 1977.