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X SURVEYS OF ECONOMIC RESULTS IN AGRICULTURE
Demand and Prices X
by ✓
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Several excellent summaries in this area have been published within the past year. In a paper presented in the summer of 1953 before the American Farm Economic Association, George Kuznets [1] summarized the major statistical and quasi-statistical questions that face research workers in this field and presented results from a number of studies dealing with elasticities of demand for total food, food livestock products, total meat, and beef, pork, and eggs. He included only studies for which results had been obtained by a variety of basic methods and concluded that, with certain minor exceptions, each of the methods gave nearly the same results in terms of coefficients obtained and each appeared to be equally unreliable in making forecasts for the immediate post-World War II years.

Karl Fox [2] in 1953 presented results covering each major farm product or group of products for which he felt that unbiased estimates of coefficients of elasticity could be obtained by the single-equation approach. In addition to the products covered by Kuznets, he gave coefficients of elasticity for poultry meat, feed grains, and a number of fruits and vegetables. Although his analyses were based on data for the 1922-41 period, as were most of those discussed by Kuznets, he concluded that "most of the prewar regression equations stood up well when tested against actual experience in 1947-52." In some cases, however, he made adjustments to allow for the "social factors" which Kuznets considered as important elements in causing forecasting errors for these years. Richard Stone [3] in 1954 published elasticities for a large number of consumer goods in Great Britain and Herman Wold and Lars Jureen [4] in 1953 issued a similar study based on Swedish data. A weakness of these analyses is that a relatively uniform method was applied in all cases, regardless of whether it was directly applicable.

As my time is limited, I propose to cover areas which were not included in the summaries mentioned above and, in a sense, to bring them up to date. I will first consider four fields in which I feel that significant advances are being made and then will discuss briefly the research work being done under my supervision in the Agricultural Marketing Service.

1/ G. M. Kuznets, "Measurement of Market Demand With Particular Reference to Consumer Demand for Food". Jour. Farm Econ. 35:878-895, December 1953.
2/ Karl A. Fox, "The Analysis of Demand for Farm Products". U. S. Dept. Agr. Tech. Bul. 1081, September 1953.
3/ Richard Stone, The Measurement of Consumers' Expenditures and Behavior in the United Kingdom, 1920-1938. Cambridge Univ. Press, 1954.
4/ Herman Wold and Lars Jureen, Demand Analysis: A Study in Econometrics. Wiley, 1953.

Agriculture - Washington   Dec. 29, 1954

Further Experiments With the Stimultaneous-equations Approach

For most of the commodity groups discussed by Kuznets, Fox has given convincing evidence that elasticities of demand can be determined without significant bias by the single-equation approach. Hence, we might expect that results from single or simultaneous-equation methods would be nearly the same. For other commodities, however, simultaneous-equations are clearly needed to adequately represent the basic economic structure. For these, we can expect significantly better results by use of the relatively new simultaneous-equations technique.

Attempts to measure the elasticity of demand for dairy products by use of the single-equation approach have been notoriously poor. In his 1953 bulletin, Fox said: "It is doubtful whether a satisfactory statistical model of the dairy industry could be derived by any means now known. Any detailed analysis of the demand-supply structure for dairy products must be conceived in terms of many simultaneous equations." About a year after this was written, Anthony Rojko 5/ published elasticities with respect to price for dairy products based on some 3-equation just identified models that at least show promising results. Rojko indicates, "Price elasticities estimated from single-equation models were found to be substantially lower than the estimates from the 3-equation model." Further research by Rojko in this area has been completed and will be discussed in a technical bulletin which we hope to finish during the current fiscal year.

Wheat is another agricultural product for which simultaneous equations appear to be needed if elasticities that apply to separate outlets are to be measured. Despite the importance of this commodity, no recent demand studies have been published. Kenneth Meinken of our staff has fitted a 6-equation model for wheat that involves an equation relating to the "world" (Liverpool) price, equations relating to domestic use for food, feed, export, and end-of-season storage, and an identity that states that the sum of these uses must equal the total supply. The limited-information approach based on pre-World War II data was used and the model was applied under postwar conditions with and without an effective price-support program to determine how useful it may be for forecasting. Results, particularly for 1952 and 1953, were surprisingly good. This study is described in detail in a technical bulletin in process.

Larry Boger and William Cromarty of Michigan State College are fitting a somewhat similar model for apples, except that they are using data by quarters instead of those relating to an entire marketing year. The model is described in a publication issued in 1953. 6/ Results have

5/ Anthony S. Rojko, "An Application of the Use of Economic Models to the Dairy Industry". Jour. Farm Econ. 35:834-849, December, 1953.
6/ "An Experiment in Designing an Econometric Model to Explain Short Term Demand Fluctuations for Apples", Excerpts from a M.S. Thesis by W.A. Cromarty, 1953, under supervision of L. L. Boger, Department of Agricultural Economics, Michigan State College. (Processed.)

been obtained for 2 quarters. The analysis is based on data for the years 1929-51 and the equations are being fitted by the limited-information method. Results have been generally satisfactory, whereas a number of "wrong" signs were obtained when similar equations were fitted by the method of least-squares. This study is significant in that meaningful estimates of the parameters were gained using aggregate data in the short run. There are indications that several other farm products can be analyzed in a similar fashion and that relations can be established that will be extremely helpful to producers and to others in the trade who are interested in particular commodities.

Although lumber is not an agricultural product, it is perhaps closely enough related to be included in this survey. Irving Holland of the Forest Service in an unpublished study 7/ has fitted a 2-equation model relating to the demand and supply for construction lumber. In the model used, the demand equation is just identified and the supply equation is over-identified, so that a combination of the reduced-form and the limited-information approaches was required in fitting. Price appears to have a significant effect on shipments from the supply side but not from the demand side. Hence, the equations were refitted using the recursive approach. Only the coefficients for the supply equation are directly comparable. These were about twice as large for the limited-information method as for the recursive approach and the standard errors were somewhat smaller. Klein 8/ indicates that the recursive approach will yield estimates of the coefficients that are statistically "consistent" (or unbiased when based on extremely large samples) in situations of this sort, but that the standard errors may be larger than they would be if the coefficients were estimated by a simultaneous-equations approach. This was true for this example.

One more study in the simultaneous-equations area should be mentioned here because it was not included in the Kuznets summary. This is the one by Glenn Johnson 9/ on burley tobacco, published in 1952. The endogenous variables were the season average price received by farmers at auctions and pledges of tobacco under the price-support program. This example is of particular interest because it was used to analyze the effect of a support program. Our study on wheat can be used in a similar way.

One problem when working with simultaneously-determined variables is that the estimates of the coefficients and their standard errors are unbiased only when based on extremely large samples. Mathematical problems in obtaining methods that apply to small samples have proved insurmountable. An approach which is being considered and now is underway on a small scale is the drawing of samples and analysis of the resulting data for a large number of small samples by a programmed approach using large-scale computors. This general approach may well provide answers to many of the questions that now face research workers. Such questions include the effects of serial correlation in the residuals or of errors in the data on results, as well as those relating to the necessity of working with small samples.

7/ I. Irving Holland, "Some Factors Affecting Consumption of Lumber, With Emphasis on Demand". September 1954.
8/ Lawrence R. Klein, A Textbook of Econometrics, Row, Peterson and Co., 1953, pp. 90-92.
9/ Glenn L. Johnson, "Burley Tobacco Control Programs: Their Over-all Effect on Production and Prices, 1933-50", Ky. Agr. Expt. Sta. Bul. 580, 1952.

Introduction of Dynamic Elements into Least-square Analyses

For many years lagged values of economic variables have been used in equations relating to demand in order to introduce dynamic elements into the analysis. As this method is well known, references to cases in which it has been used will not be discussed here. However, several novel approaches in this area have been made within the past few years, and those that have come to the author's attention will be mentioned.

The most detailed study of which I know is that by Jerry Foytik [10] for California plums, published in 1951. In his final equation, which deals with factors that affect price in a specific week, he uses as independent variables quantities in the current and preceding week, week of season, and consumer income, and allows for systematic changes in the regression coefficient on income as the season progresses. Major conclusions that relate to this phase of the study are as follows:

1. "Temporal markets are definitely interrelated-- that is, current prices are affected by sales made earlier in the season as well as by sales made currently."

2. "The net price-income relation becomes materially less steep as the season advances."

3. "Price is more responsive to changes in sales during the peak of the season than earlier or later--thus demand is less elastic during mid-season than for either earlier or later sales.

Frank Lowenstein and Martin Simon [11] use a very different approach to introduce dynamic elements into a study of factors that affect mill consumption of cotton. They allow for imbalances in mill inventories of cotton cloth by including as a variable the ratio of stocks to unfilled orders expressed in terms of deviations from a "normal" ratio. When the ratio is relatively high, a downward adjustment in output to reduce stocks is indicated. Conversely, a relatively low ratio suggests the likelihood of a higher output rate in the near future. They found that this variable, along with current and lagged consumer income, consumption of synthetic fibers, and deflated prices of cotton, explained 95 percent of the variation in cotton consumption during the years 1927-32, 1935-40, and 1948-52. These were the only years for which the stock-order ratio was available. All of the regression coefficients differed significantly from zero. An analysis for the same years but for which the stock-order ratio was omitted explained only 84 percent of the variation in cotton consumption.

[10] Jerry Foytik, "Characteristics of Demand for California Plums". Hilgardia, 20:407-527, April 1951.
[11] Frank Lowenstein and Martin S. Simon, "Analyses of Factors That Affect Mill Consumption of Cotton in the United States". Agr. Econ. Research, 6:101-110, October 1954.

Ben Pubols 12/ has recently published an article which makes use of standard methods of regression analysis but it is of interest because he uses successive estimates of the size of crop in forecasting prices. For example, grower prices for apples in September, October, and November, in turn, were correlated with August estimates of production and fourth-quarter disposable income. Similarly, prices in November, December, and January were correlated with October estimates of production and the same income variable. These analyses suggest that prices in September are only moderately influenced by the size of the fall crop and that by January, as would be expected, the effect of the October estimate on prices is reduced as it is replaced as a market influence by the December estimate. Results for November are nearly as good based on the August production estimate as on the October estimate. Similar analyses were run for the spring months using successive monthly stocks and income as independent variables. The percentage of variation in price explained by these factors is highest in March and then declines through May, the last month included in the study.

Analyses Based on Data from Consumer Panels or Sales from Retail Stores

Standard time series analyses that make use of conventional sources of data are not feasible in a number of areas either because of a lack of data or because of their basic complexity. Three principal types of studies for which this is true are those dealing with competition between a large number of separate products, those which attempt to analyze demand for separate grades or qualities of a product, and those dealing with the demand for newly introduced commodities. A number of studies are underway in these areas that make use of data from consumer panels or daily or weekly sales from retail stores.

Published results so far chiefly consist of a discussion of the problems involved in the use of such data and some preliminary findings. Brief summaries of 3 papers presented at the December 1953 meetings of the combined social science societies were published in 1954. 13/ Charles Zwick of Harvard University presented a paper dealing with results from a study on meat, fish, and poultry using consumer panel data at the September 1954 meeting of the Econometric Society. And I gave a brief discussion of a study dealing with competition among deciduous fruits and effect of quality on sales based on daily sales in a group of supermarkets in Denver at the August 1954 meeting of the American Farm Economic Association. 14/ This study is being made by the Technical Committee of the Western Regional Deciduous Fruit Project. George Kuznets has done a great deal of work on competition among citrus products, with emphasis on frozen orange juice, using monthly consumer panel data. Results of this study, which was conducted by the University of California in cooperation with the

12/ Ben H. Pubols, "Factors Affecting Prices of Apples". Agr. Econ. Research, 6:77-83, July 1954.
13/ Jour. Amer. Statis. Assoc., 49:361-362, June, 1954. The papers were "The Demand for Citrus Products" by George M. Kuznets and Richard J. Foote; "An Analysis of the Demand for Meat" by Ayers Brinser, Harry Allison, and Charles Zwick; and "Demand Analysis from the M.S.C. Consumer Panel" by G.G. Quackenbush.
14/ Richard J. Foote, "Discussion". Jour. Farm Econ. 36: December, 1954.

Agricultural Marketing Service, should be published within the next 6 months or so. Further details on the Denver study and the studies on citrus are included in a handbook dealing with analysis of demand that Fox and I issued early this year. 15/

Zwick found significantly different price elasticities by age groups in his study relating to the demand for beef, after allowing for variation in family income, with demand being relatively elastic for young housewives and highly inelastic for older housewives. This is a finding that could not be obtained from the analysis of either aggregative time series or data from a budget study covering a single time period.

By far the most complete analysis that I have seen in this area is an unpublished study by Harold Riley dealing with the demand for meat, based on weekly data from the Michigan State College consumer panel, for the period July 1951 - June 1953. 16/ Fortunately this was a period of substantial price changes for both beef and pork. Riley expressed the quantity purchased of one kind of meat as a function of the price of that meat group, prices of competing meats, and a temperature variable that was found to have significant effects on the demand for meats in the summer months.

Elasticities and cross-elasticities of demand for kinds of meat, such as beef and pork, from this study were similar to those derived from the analysis of time series data. The major contribution of the study was the measurement of elasticities for retail cuts of meat. The price elasticity of demand for beef steak was found to be highly elastic; for beef roasts, ham, and pork chops, were slightly elastic; and for ground beef and bacon, were slightly inelastic. Further studies along these lines for meats and a number of other commodity groups have been completed or are currently underway at Michigan State College.

Use of Spatial-Equilibrium Analyses to Study Export Demand

Karl Fox in 1953 published a paper dealing with the application of the theory of spatial-equilibrium to the livestock-feed economy. 17/ At the 1954 summer meeting of the American Farm Economic Association, he presented a paper in which he showed how the spatial-equilibrium approach might be used in studying the effect on the pattern and volume of trade of changes in tariffs and export subsidies, or of the introduction of a two-price plan when applied to a single commodity among several countries or groups of countries. 18/

15/ Richard J. Foote and Karl A. Fox, "Analytical Tools for Measuring Demand". U. S. Dept. Agr. Agr. Handbook 64, January, 1954, pp. 68-74. The method of analysis for the data from stores outlined in this handbook has been modified as indicated in my paper referred to in footnote 14.
16/ Harold M. Riley, "Some Measurements of Consumer Demand for Meat", Ph.D. Thesis, Michigan State College, 1954.
17/ Karl A. Fox, "A Spatial Equilibrium Model of the Livestock-Feed Economy in the United States". Econometrica, 21:547-566, October 1953.
18/ Karl A. Fox, "The Use of Economic Models in Appraising International Trade Policies". Jour. Farm Econ. 36:   December 1954.

If exports for a given country appear to be determined chiefly by the spread between the price in major importing countries and the domestic price, as they do for wheat, then a system of simultaneous equations similar to the one described previously can be used to measure the elasticity of demand for exports. This elasticity chiefly reflects the fact that when exports are large, the commodity must be transported over longer internal distances and the price spread must be sufficient to cover the added transportation costs. For other commodities, such as cotton, tobacco, and some fruits, exports come from essentially the same internal geographic areas regardless of whether they are relatively large or small. In such circumstances, a spatial-equilibrium analysis for individual years might more nearly indicate the economic forces that affect the quantities exported from a given country.

In such a study, it would be presumed that each importing country imports from the cheapest available source, that consumption in the importing country depends in part on the price that it has to pay, and that prices in both importing and exporting countries are at such a level that all the available supply is consumed and the aggregate world transportation cost is as low as possible. Effects of bilateral agreements, tariffs, subsidies, and other institutional forces can be built into the analysis. This appears to be a promising avenue for research, and we plan to initiate studies along these lines in the near future for certain export crops.

Undoubtedly there are other areas in the demand and prices field in which new developments with respect to the application of economics to agriculture are taking place, but these are the ones with which I am most familiar.

Demand and Price Structure Research in AMS

We have under way a research project which was initiated in 1947 under the Agricultural Marketing Act of 1946 in which we plan to study the demand and price structure for each of the major agricultural products or groups of products. These studies are fairly uniform in the sense that in each case we develop descriptions and diagrams of the principal economic forces that affect the commodity, together with appropriate background information, and identify and measure to the extent possible with available data the influence of major factors by the use of statistical analyses. However, the detailed approach differs materially from commodity to commodity depending on the nature of its economic structure. The regression analyses frequently apply to season average prices for the entire country, but discussions are included of price differentials or patterns by months and between grades and geographic areas.

The results generally are published in technical bulletins in our "Demand and Price Structure" series. So far we have published

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bulletins of this sort dealing with wool, 19/ feed grains, 20/ food fats
and oils, 21/ vegetables, 22/ and peanuts; 23/ we hope to complete within
the current fiscal year bulletins on wheat and dairy products; and we
have additional projects underway that relate to cotton and other fibers,
tobacco, high protein feeds, cattle, all meat, poultry and eggs, and
milk. Preliminary results from some of these have been referred to
previously. Additional projects will be started as funds permit. In
addition, we have published or have in progress certain statistical bul-
letins that furnish required background material, 24/ several agricul-
tural handbooks that discuss research procedures, 25/ and numerous
journal articles and other publications that relate to procedures or
findings.

This work is designed to give a sounder basis for the price,
production, and consumption forecasts made by commodity specialists
in the Agricultural Marketing Service and by Extension staffs at State
colleges; to aid Government administrators and others in evaluating
the probable effects of various types of price support programs, in
determining the probable incidence of changes in tariffs, freight rates,
processing taxes, and export and import subsidies, and in measuring
probable effects on total farm income of programs that tend to increase
total production; and to furnish background information and analyses to
Extension workers and research staffs at colleges, trade associations,
and processing industries who may be involved in economic research re-
lating to the particular commodity field.

Many colleges and other research institutions have similar
projects that relate to specific commodity fields or deal with aspects
that cut across commodity lines but, so far as I know, this is the only
project in the price and demand area that plans to systematically cover
each major agricultural commodity group.

19/ Albert M. Hennie, "Prices of Apparel Wool". U. S. Dept. Agr. Tech.
Bul. 1041, 1951.
20/ Richard J. Foote, John W. Klein, and Malcolm Clough, "The Demand and
Price Structure for Corn and Total Feed Concentrates", U. S. Dept. Agr.
Tech. Bul. 1061, 1952; Richard J. Foote, "Statistical Analyses Relating
to the Feed-Livestock Economy", U. S. Dept. Agr. Tech. Bul. 1070, 1953;
Kenneth W. Meinken, "The Demand and Price Structure for Oats, Barley,
and Sorghum Grains", U. S. Dept. Agr. Tech. Bul. 1080, 1953.
21/ Sidney J. Armore, "The Demand and Price Structure for Food Fats and
Oils". U. S. Dept. Agr. Tech. Bul. 1068, 1953.
22/ D. Milton Shuffett, "The Demand and Price Structure for Selected
Vegetables". U. S. Dept. Agr. Tech. Bul. 1105, 1954.
23/ Antoine Banna, Sidney J. Armore, and Richard J. Foote, "Peanuts and
Their Uses for Food". U. S. Dept. Agr. Marketing Research Rept. 16, 1952.
24/ "Statistics on Cotton and Related Data", U. S. Dept. Agr. Statis.
Bul. 99, 1951, and Antoine Banna, "Oilseeds, Fats and Oils, and Their
Products, 1909-53", U. S. Dept. Agr. Statis. Bul. 147, 1954.
25/ Foote and Fox, Op. Cit., and R. J. Foote and Karl A. Fox, "Seasonal
Variation: Methods of Measurement and Tests of Significance", U. S.
Dept. Agr., Agr. Handbook 48, 1952. We have in process 2 more handbooks
that we hope to complete within the current fiscal year, one on graphic
analysis in economic research and one on computational procedures when
working with systems of simultaneous equations.