UNITED ARAB REPUBLIC

THE INSTITUTE OF NATIONAL PLANNING

Memo. No. 760

METHODOLOGICAL REVIEW OF MAJOR AGRICULTURAL SUPPLY STUDIES

By
Dr.Mohamed Galal Abou El Dahab

April, 1967

CAIRO
3, MOHAMED MAZHAR - ZAMALEK

"Opinions Expressed and Positions Taken by Authors are Entirely their Own and do not Necessarily Reflect the Views of the Institute of National Planning."

OBJECTIVES OF STUDY:

The purpose of this study is to present to researchers in the fields of agricultural economics, agricultural planning, and to econometricians a brief review of some of the major studies that have been done in U.S.A. to estimate and study agricultural supply functions. This review will be from the methodology point of view. That is to present the major procedures and techniques which American economists used in analyzing, studying, and dealing with agricultural supply studies. Beside describing the techniques used, this review, will try to present the steps the researchers have taken to overcome some of the problems they faced in their analyses.

It is also haped that a study of this nature may be helpful to those who are involved in research dealing with analyzing, estimating, and predicting supply for agricultural, industrial, and consumption commodities.

AGRICULTURAL COMMODITY SUPPLY FUNCTIONS

Graphical Methods

This technique, developed by Bean[1] in 1929, is based entirely on the use of graphs. Successive curves for data that represent the relationship between the dependent variable and the independent variables are drawn. By studying these curves researcher can know which one of the independent variables has the greatest effect upon the dependent variable.

---

1) L.H. Bean, "Applications of a Simplified Method of Graphic Curvilinear Correlation," Journal of American Statistical Association, 1929, 24: 386 - 397.

Smith used this technique to study the factors affecting the price of cotton. His dependent variable was the percentage increases or decreases in the harvested cotton acreage of the United States. He used four independent variables. The first independent variable was the New York average price of cotton for delivery in March as quoted during December of the calender Year Preceding the year of harvest divided by the Bureau of Labor Statistical Index of farm product prices at wholesale for the same December.

The second independent variable was the New York average price of cotton taken for one year earlier. The third independent variable was the percentage change that took place in acreage during the year preceding the year of harvest. The fourth independent variable was taken as the last two digits of the year of harvest (period 1902-1926) to represent a trend. By drawing curves to represent the relation between the dependent variable and these independent variables, Smith found that the relative price one year before the the given year will produce more effect upon acreage harvested than the relative price of two years before and the greater the increase the change in the acreage in the preceding year the greater the reaction or decrease in the given year.

Smith pointed out

> To employ these relationship curves for the purpose of forecasting, it is necessary to obtain the values of the independents listed previously for the given year, read from the curves their effects upon acreage, and add together the resulting readings. The sum will represent the estimated or forecasted acreage change.1)

---

1) B.B. Smith, "Factors Affecting the Price of Cotton," U.S. Department of Agriculture, Technical Bulletin 50, 1928, p. 23.

He added:

> If similar estimates are made for all years throughout the period and these estimated changes compared with the changes that actually took place, a very close agreement is observed.1)

The correlation between the estimated changes and actual changes was 0.95.

Bean[2] in 1929 published an article estimating farmer response to price. He used the same technique to analyze changes in the acreage of potatoes in New York, Michigan, Idaho and the United States as a whole, sweet potatoes, cabbage, strawherries, watermelons, rye and cotton in United States, and flax in North Dakota. The dependent variable in his analysis was the absolute increase or decrease in acreage harvested over that of the preceding year. The independent variables were prices received by producers adjusted for changes in the general level of farm prices during the first season and second season preceding the change in acreage. Some of the prices were deflated by the prices of competing crops. The period covered was from 1921-1928.

Bean found that there was a general type of production response to price in all the cases analyzed. The dominant factor in the change in production in any given year was the price received for the production of the preceding year. The price received during the season two years preceding was an important factor particularly if it was low. The nature of the response of production differed by regions and commodities. The range of the indexes of correlation for the twelve cases was from 0.967 to 0.997.

---

1) Ibid., p. 24.
2) L.H.Bean, "The Farmer's Response to Price," Journal of Farm Economics, July, 1929, 11: 368 - 385.

This technique of graphical curvilinear correlation depends solely on plotting the original observations on corrdinate papers. A continuous smooth curve can then be drawn through them by eye in such a way to pass approximately through the center of the observations. This is a very simple method when nature of the relation is indicated closely by the original observations. In this case, it might yield a satisfactory expression of the relation. In other case, the observations may be more scattered, therefore, determining the relation will be more difficult and different persons may draw different curves.

By taking Smith's and Bean's curves as representatives of this technique, we find that no one of them can be regarded as very accurate, because they fitted complex free-hand curve to a small number of observations. Even though this method is a simple one and takes less time to find the relation between the dependent and independent variables, it will be too difficult to use in finding the true relationship, if it is used for many observations. In this case it is not easy to indicate the curve which fit the data best. Moreover, there will be many successive approximations in handling these many observations.

In their analysis, Smith and Bean used central market prices rather than farm prices. The latter is the price to which response of production takes place. The quantity supplied does not depend solely on prices and change in acreage harvested in preceding seasons but also on many other variables which they assumed to be constant or did not mention. For these reasons one cannot place a great deal of confidence in their results. Moreover, this method cannot be used in predicting or describing the relationship between price and production in the future because all of the results obtained from it depend on the circumstances that prevailed in the period covered.

By looking back to the time in which they published their work, it is found that they did attempt to find and determine the relationship between production and prices. They used central market prices because they were the only available prices which could be obtained for a long series of years. By relating changes in acreage to absolute levels of prices, they introduced a dynamic element in their analysis.

Some of the economists now use this technique primarily to give some idea about the relationship between quantitites supplied and changes in prices.

Time Series Analyses - Single Equations

Simple and Multiple Regressions. Moore in 1917 wrote a book in which he introduced a method to estimate the response of cotton production to prices. He believed that price ought to have something to do with production. He wrote,

> There should .... in normal times, be some relation between the percentage change in the price of cotton last year over the preceding year and the percentage change in the acreage of cotton this year over last year.1)

Using the simple linear regression technique he related the logarithmic first differences of cotton acreage with the lagged logarithmic first differences of cotton prices. His analysis covered the period 1890-1913. He found that the simple correlation between the percentage change in the acreage of cotton and the percentage change in the price per pound of cotton lint for the year before was equal to 0.532.

1) H.L.Moore, Forecasting the Yield and Price of Cotton, New York The Macmillan Company, 1917, p. 87.

Moore's work can be criticized on some points. The cotton acreage does not by any means represent the quantity supplied of cotton and hence the response to price changes. Quantity supplied is the product of acreage harvested times the average per acre and not all cultivated acres are harvested. But it seems that this was the best available data to Moore at that time. Response of farmers likely will not only be to change in prices of cotton of the preceding year but also to other previous changes and to changes in the prices of other products.

Moore was, in fact, the first economist who introduced this method of relating quantities to previous prices. His work can be considered as the first study ever made of actual supply response in agriculture. Many of the American economists following him used his technique of relating quantities supplied to prices prevailing at some earlier period throughout all the work they have done.

Smith in 1925 published an article in which he related absolute changes in cotton acreage to prices during the November, December, January, February and March preceding planting. Each price was the mean of the average of the daily spot prices in the New York and New Orleans markets and was deflated by the wholesale price index of agricultural commodities for the same month.

He stated that

> Since prediction of future conditions must be based upon analysis of present conditions, the price of cotton during the planting period might conceivably be a prime factor in the formation of the producer's opinion as to future price and hence of his decision with reference to acreage.1)

---

1) B.B. Smith, Forecasting the Acreage of Cotton, Jarnal of American Statistic Association, New Series, March 1925, 20; 31 - 47, p. 32.

Smith followed Moore in using the first differences rather than the original values to obviate the necessity of computing trends and to transform the nonlinear relations which are usually associated with the phenomena of diminishing returns into linear relations. The period covered in his analysis was 1907-1923. At first he drew a series of correlation charts between the dependent variable and the respective independent varibales. He found that the relationships were almost perfectly linear. Smith found that the coefficient of correlation = .9502 and that the series of December, January and February were the most important. Secondly, he used another regression in which the independent variables were the three price series and the production and yield-value series per harvested acre lagged one year. The coefficient of correlation was 0.93. This indicates that prices have more to do with determining the producer's mind with reference to acreage than do production and yield-value per harvested acre.

Smith in his analysis used the deflated mean of the average of the daily prices in New York and New Orleans markets. Farmers usually respond not to changes in the prices of the terminal markets but to changes in the prices received by them. But it seems that when he did his work, series on prices received by farmers were not avaialable. He introduced a trend in his regression equation which has no analytical significance here since he used the first difference of acreage which as he mentioned will take care of the trend problem. In his regression he introduced two new variables, the absolute change in production lagged one year and the absolute change in yield-value per harvested acre lagged one year. It is well known now that the use of lagged prices in regression rather than other lagged variables is helpful in identifying the supply curve. He used the acreage of cotton as an approximation to planned output and this may not be a good procedure but it seems that this was the only feasible one at that time.

Walsh[1] in 1944 published an article in which he summarized the results of his study of supply of cotton and cottonseed. The period covered by his analysis was 1910-1933. He used the cotton acreage in cultivation July 1 as the dependent variable. The independent variable was successively the average prices received by growers in the preceding crop year for cotton, cottonseed and composite price of cotton and cottonseed in his regression series. All these prices were lagged one year and deflated by the index number of prices paid by farmers to represent changes in unit cost.

Walsh's work has a great value relative to the time at which it was done. He used in his analysis the prices received by the growers to which farmers actually respond. He introduced a new independent variable in his regressions i.e. the change in cost of production. This was done by deflating all prices used by the index number of prices paid by farmers. This index number consists of prices of all the commodities that the farmer's family used either in production or consumption and, therefore, does not represent accurately cost of production. But it seems that this was the only available index at that time. Using the prices lagged one year has a significant meaning since there is usually a considerable time lag between price changes and production changes.

In 1950 Kohls and Pearlberg published the results of their study of a large number of commodities. They used in their analyses simple and multiple linear regressions. They pointed out that

---

1) R.M. Walsh, "Response to Price in Production of Cotton and Cottonseed," Journal of Farm Economics. May 1944, 26 : 359 - 372.

> This work reports the results of a study of the short time response of agricultural production to price and other factors. The short-run response considers only the year to year changes which are primarily under the control of the producer.1)

The percentage change in acreage from the preceding year was the dependent variable in their analyses. The independent variables were price lagged one, two or three years and other factors.

All prices were deflated by an index of prices received by farmers. They converted all data to percentages of the preceding years. They wrote

> This procedure has the advantage of eliminating all but the most severe trends. It also converts all variables to a common denominator which greatly facilitates later application.2)

Their results show that both low correlations and low elasticities were found. They used the percentage change of acreage as an approximation to the planned otuput. In their regression they used the lagged prices which can help in the identification of the supply curve from the given data. It seems that the reasons for deflating all the prices used by the index of all prices received were that most of these crops were grown over a wide area and the number of relevent alternatives to any of these crops was very large. Their work can be considered the most comprehensive study published to that date.

---

1) R.L. Kohls and Don Paarlberg, The Short-Time Response of Agricultural Production to Price and Other Factors, Purdue University Agricultural Experiment Station Bulletion 555, October 1950, Lafayette, Indiana. P.3.

2) Ibid., Appendix.

Halvorson[1] used a time series multiple-regression analysis and correlation analysis for the period of 1934 - 1954 for the United States as well as regional data. The study focuses on the short time supply elasticity which works primarily through changes in production per cow. Farmer's response to price (milk-feed ratio) was measured by the changes in their rates of feeding as represented by the pounds of grain fed per pound of milk produced.

Bowlen in 1955 published an article using a simple regression model to study farmer's response to changes in the price of wheat. The period covered by his study was 1926 to 1952, omitting the controlled years 1938-1943 and 1950. First he used lagged adjusted price as the independent variable and acreage planted as the dependent variable for the United States as a whole. The regression coefficient was 1.05 and a standard error of (b) some three times as large. Then he used the first differences of planted acreage and first differences of adjusted price ratios for the preceding season. But the results were only slightly different.

He stated that,

> It would be incorrect to conclude that price was not an important consideration in farmer's decision making process, but rather the direction and extent to which farmers respond is influenced by a most diverse set of conditions among areas, among farms within an area and over time. 2)

---

1) H.W. Halvorson, "The Supply Elasticity for Milk in the Short Run". Journal of Farm Economics. December 1955, 37: 1186-1197.

2) B.J. Bowlen, "The Wheat Supply Function," Journal of Farm Economics, December 1955, 37: 1177-1185, p. 1177.

Therefore, he subdivided the state of Kansas into three areas on the basis of climatic and other conditions, including possible substitution of other crops. By using a simple regression model, Bowlen found no significant relationships when be used lagged adjusted prices of wheat and acreage planted or when be used first differences of these two variables.

He thought that by dividing the state of Kansas into more homogeneous areas, he could get important results, but these, results were also unsatisfactory. This was a result of using a simple regression model with one independent variable. Wheat production is influenced even in small homogeneous areas by many other variables such as availability of other alternatives for resource use, weather conditions and farmer's income. It seems that using a multiple rather than a simple regression model would be more appropriate. His work can be considered as a guide for other economists to prevent them from over simplifying the problems which face them.

Nerlove in 1956 published an article estimating the elasticities of supply of cotton, wheat and corn for the period 1909-1932. In his regression model he used the expected price rather than last year's price. He stated that, "Farmers react, not to last year's price, but rather to the price they expect, and this expected price depends only to a limited extent on what last year's price was."[1] The expected prices of the past years could not be obtained. To estimate them he put the hypothesis that, "Each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period."[2] This hypothesis is equivalent to

1) Marc Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities, "Journal of Farm Economics, May 1956, 38:496-509.p.498.

2) Ibid., p. 500.

one in which expected price is represented as a weighted moving average of past prices. This can be expressed mathematically as follows:

$$P_t^* = \beta P_{t-1} + (1-\beta)\beta P_{t-2} + (1-\beta)^2 \beta P_{t-3} + \dots \quad 1$$

where P_t^* = the price expected in t years,

P_{t-1} = the actual price in t-1 year,

β = the coefficient of expectation.

By substituting this expected price equation in the acreage response function which is $X_t = a_o + a_1 P_t^* + u_t$, he found that there is a relationship between this year's acreage and last year's actual price and last year's acreage. He estimated the elasticities, multiple correlation coefficients and the trend for the three crops assuming that $\beta = 1$ which he called a special method. Then he compared his result with estimates that have been obtained by other workers in the field of supply response with the unrestricted β which he called the general method. He found that the coefficients of determination, and the elasticities of acreage to expected price are higher using the general method than they were by using the special method.

Nerlove in his paper inctoduced the concept that farmers react not to the last year's price but to the price they expect. But farmers, in fact, not only react to the expected price of the commodity they produce but also to the expected prices of competing products, the expected prices of factors of production, and to the alternative uses of their resources that will be available. He used in his regression deflated prices but it is not certain that farmers use this method at all and even if they do deflate their prices there is no evidence that they use the same deflator.

---

1) Ibid., p. 501