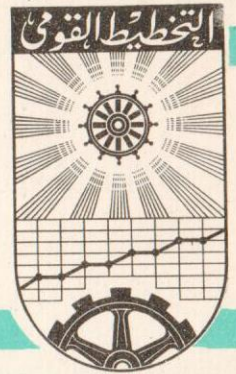


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TECHNIQUES AND PROBLEMS IN ESTIMATING
AGRICULTURAL SUPPLY FUNCTIONS

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Under the Heading "Static Supply Function".

Line No.	Incorrect	Correct
11	$c = aX_2$	$c = aX_2^{b2}$
14	$X_1 = c^{-n}$	$X_1 = c^{-n} Y^n$
17	$C = K + p_1 c_1^{-n} Y^n$	$C = K + p_1 c^{-n} Y^n$

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MAJOR OBJECTIVES OF SUPPLY STUDIES

Some of the greatest problems prevailing now over all the world center around food surpluses or deficits. Nations, faced with either food surpluses or deficits, try to overcome these problems by changing the present supply structure into another which will provide a desired level of production, stability of agricultural product prices and incomes for farmers. A nation will not be able to alter its supply structure unless it has a wide and sufficient knowledge of supply phenomena. The United States, which is one of the most developed countries, faces the problem of food surpluses. If any one looks at American agricultural data now and for the period of 1930's, he will find that the U.S. still has the same problem of a surplus of agricultural products. In the 1930's the surplus was result in part of the decrease in demand for agricultural products. Many of the economists in the earlier period devoted their time and efforts to analyze and study the demand for agricultural products. They thought that they could solve the surplus problem through understanding of demand phenomena. The main governmental device used, to off-set this surplus and restore the price relationships of agricultural and non-agricultural products, was the control of land under cultivation. But a surplus of agricultural products still exists in the United States. A possible reason for this surplus now is the greater relative increase in aggregate supply which is the result of the rapid development in technology.

Less developed countries such as U.A.R., India, and Latin American countries, who now have a food deficit problem, also face a rapid population growth which further complicates the problem. Understanding supply phenomena will aid in developing policies designed to maintain adequate food output for prospective population levels. Understanding supply phenomena may help to solve these problems in both developed and less developed countries.

Knowledge about supply functions will be useful in formulating prediction equations which may be helpful to a nation or a farmer in making decisions concerning their plans for the future. In less developed countries, especially those who have planned economy, these prediction equations will help those who decide and plan for economic development to formulate their agricultural policy on strong foundations. Decision makers in developed countries will be able to predict with greater accuracy the results of their plans concerning farm aids, prices of farm products and incomes in the agricultural sector. Farmers can also predict, with assistance of economists, what the possible effects of future courses of action may be.

PURPOSE OF STUDY

The purpose of this study is to determine if possible answers for each of the following questions:

1. How have economists estimated and analyzed agricultural supply functions?
2. What are the problems that usually face economists in estimating agricultural supply functions?

3. What are the likely directions of future research in supply analysis?

One approach to find answers to these questions is to review some of the literature on supply and response studies for agriculture. This review will be from the methodological point of view. Analytical methods and techniques which economists used in describing, estimating and dealing with supply and response studies in agriculture will be studied.

DEFINITIONS

In studying supply phenomena, different terms such as static supply functions, supply relations, response relations, supply shifters, and structural changes in supply are used. It is useful to give some attention to these terms.

Static Supply Functions:

This is a function which describes the relationship between the quantities offered and prices of output and other variables under the assumption of complete knowledge of all variables.

Heady stated that

"The production function is the foundation of supply. Under conditions of perfect knowledge in respect to all variables, a firm's static supply function could be derived directly from the production function, given a goal of profit maximization for competitive firms.(1)"

To derive the static supply function from the production function he assumed for simplicity that

$Y = aX_1^{b_1} X_2^{b_2}$ and putting $c = aX_2^{b_2}$ where X_2 is fixed in quantity he obtained the short-run production function.

$$Y = cX_1^{b_1}$$

By expressing inputs as a function of output, he got $X_1 = c^{-n} Y^{1/n}$ where $n = b_1^{-1}$

The total cost equation was $C = p_1 X_1 + p_2 X_2$. The short-run total cost equation was $C = K + p_1 X_1$ where $K = p_2 X_2$. By substituting the value of X_1 into the short-run cost equation he got $C = K + p_1 c_1^{-n} Y^{1/n}$.

By taking the derivative of this equation with respect to Y , he obtained $\frac{dC}{dY} = np_1 c_1^{-n} Y^{1/n-1}$ which is the marginal cost equation.

(1) Earl O. Heady, "Uses and Concepts in Supply Analysis". Agricultural Supply Functions, Chapter I, Edited by Earl O. Heady and Others, Iowa State University Press, Ames Iowa, 1961, P. 11

Equating this marginal cost equation with the price of the product P_y and solving for Y , he obtained the short-run supply function.

$$Y = (b_1 c^n \frac{P_y}{P_1})^{\frac{1}{n-1}}$$

A long-run supply function was derived in a similar way. He stated that

"supply functions should be derived directly from production functions if uncertainty, capital rationing, lack of knowledge, non-monetary goals and lumpiness of fixed factors did not exist.(2)"

But in the real conditions of the agricultural sector these factors mentioned by Heady and others do always exist which makes impossible the derivation of the dynamic supply function from the production function. These factors and others are the cause of most of the problems which face producers when they make their decisions and economists when they study the supply phenomena. They also represent important estimation problems in supply analysis. These factors can be presented as follows:

The Complexity of the Agricultural Production Structure. If we look to the structure of a nation agricultural production, we will find that it is composed of many different products. Each region has her own natural resources, weather, wants, specialization, abilities and skills which made it able to produce a large number of products. Even at the level of individual firm, farmers produce different kinds of products rather than single product. Methods and techniques of production used differ also in one part of the country from that in another part.

Economists, as a result of this complexity, always are faced by many difficulties and problems of aggregation in their analysis.

Fixed Resources. Fixed resources represent an important factor in agricultural production. The production period for the services of these resources differs from one resource to another. These services can be divided into two categories: (1) flow services which will not be available in a later period if they are not used when they are given off such as services from resources like buildings and machines; and (2) stock services which may be entirely used up in the production period or can be stored for other periods; fertilizer is an example.

This fixity is a problem because some of these fixed resources have both flow and stock services. More than that, it is not always easy to distinguish between final products and capital goods. On the other hand, the existence or the absence of fixed resources brings the picture of short-run and long-run periods in the supply analysis.

(2) Ibid., p. 14

Technological Change. Different methods and techniques, new products and inputs were introduced in the agricultural production during the last three decades. Supply relations for both individual commodities and aggregate output move and shift to the right as a result of technological change.

Nerlove stated that, "Changes in technology are to supply analysis what changes in tastes are to demand analysis"(3)

Many problems and difficulties face economists as a result of changes in technology since it is not easy to measure and express them in direct measurements to be used in supply analysis.

Expectations and Uncertainty. Plans in agricultural production must be made at one time for a product which will be forth coming at a future time. This time involved in production does not give us a perfect knowledge of the future, therefore, decision making must take place in an environment of uncertainty.

Perhaps a farmer bases his plans neither on the prevailing prices of outputs and inputs nor on those which he has received in the past but on those which he expects to receive in the future.

These expectations of future prices are generally not subject to any measurement, therefore, they introduce another problem in the picture. This is, how may these prices be estimated and how may their influences on decision-making be determined. More than that, government policies, changes in market structure, and changes in technology have their influence and impact upon farmers' decisions and plans.

Weather. Weather is perhaps one of the most important variables influencing the production of the agricultural sector. Some nations have a very wide variety of weather. Weather also fluctuates in each state from one season to another. Farmers cannot obtain, while they are making their decisions concerning production, any accurate information about weather fluctuations in the future periods of production. Moreover, they have by no means control over weather particularly after they have already invested their money and spent their efforts in agricultural products.(4)

(3) Marc Nerlove, "Time Series Analysis of Supply of Agricultural Products", Agricultural supply Functions, Chapter 2, Edited by Earl O. Heady and others Iowa State University Press, Ames, Iowa, 1961, P. 32.

(4) Irrigation and other techniques may be used in some areas to offset unfavorable production effects of weather.

The influence of weather which gives rise to variations in the yield of crops can be classified into:

1. direct weather influences which are the result of changes in weather conditions from one year to another and
2. indirect weather influences which are due to factors affecting the crops yield such as plant diseases, soil moisture levels and insect damage.

Some of the change in the production functions are due to changes in weather. Moreover, it acts as a shifter of the supply function. Therefore, it is an important variable in explaining variations in quantities supplied.

All these previous factors can be considered as limitations in deriving the production function and the static supply function. Heady considered this static supply function as a departure point in supply analysis.

Supply Relations Versus Response Relations:

Cochrane distinguished between the two terms as follows:

"By the term supply relation, or supply function, economists trained in the equilibrium tradition have in mind how the quantity of a product offered for sale varies, as its price varies relative to other product prices, for some given time period and for a given state of arts or technology!"

"By the term response relation, or response curve, economists have in mind or should have in mind it is argued here how the quantity of a commodity offered for sale varies with changes in the price of the commodity. This then is a more general concept; it is, in fact, inclusive of the previous concept of a net supply relation; it is concerned with the output response to price change by whatever means that response takes place" (5)

Supply Shifters:

A supply shift is a parallel movement in the supply curve to the right or to the left. This movement of the entire curve is a result of a change in any one of the independent variables other than the price of the commodity. A movement along the supply curve up or down is a change in quantity offered due to change in commodity price. Learn and Cochrane stated that:

A shift in the supply function for an individual firm is characterized by a change in the planned level of output at a given price without any change in the decision-making environment faced by the firm(6)

(5) Willard W. Cochrane, "Conceptualizing the supply Relations in Agriculture", Journal of Farm Economics, December, 1955, 37: 1161-1176 P. 1162-63.

(6) Elmer W. Learn and Willard W. Cochrane, "Regression Analysis of Supply Functions Undergoing Structural Change, Agricultural Supply Functions. Chapter 3, Edited by Earl O. Heady and others, Iowa State University Press, Ames, Iowa, 1961 P. 64.

The factors which cause a shift in supply curves are presented in the following:

- a- change in the price of factors of production,
- b- change in the price of competing products,
- c- movement of firms in and out of production which is a result of one or both of the above two factors, and
- d- changes in weather.

In their definition Learn and Cochrane wrote:

Shifts in supply result from changes in the values of any of the variables other than price and quantity.(7)

Structural Changes:

Learn and Cochrane defined a structural change as follows:

"Structural change results from some force which brings about a change in one or more of the parameters or a change in "F" (the form of the relationship). (8)

They represented the supply function, involving n variables and described by m parameters, as follows:

$$\text{Supply} = F(x_1 x_2 \dots x_n ; x_1 x_2 \dots x_m)$$

Structural change, therefore, will be a result of one or more of the following factors:

- a- changes in the production function of the product,
- b- changes in the production function of competing products,
- c- movement of firms in and out of production due to changes in product price which is a result of one or both of the above factors,
- d- changes in the institutional conditions,
- e- changes in technology, and
- f- changes in the ability and skill of the manager.

A change in the slope of the supply curve or change in the supply curve position, which is a result of change in any of these factors, is known as a structural change.

APPROACHES TO SUPPLY ESTIMATION

Economists have used two major approaches in estimating supply relationships. These are the positive and normative approaches.

(7) Ibid., p. 65

(8) Ibid., p. 65

Positive Analysis:

This sometimes is called a predictive or descriptive approach because it depends solely upon describing the quantitative relationships as they exist. The results obtained presumably can be used in prediction if no structural changes occur. Heady Wrote:

" Positive analysis has come.....to mean prediction of quantitative relationships among variables as they actually do exist at a point of time or have existed over a period of time.(9)

The major procedure that has been used, in dealing with positive analysis, is the regression technique.

Normative Analysis :

This is called sometimes prescriptive analysis because it prescribes what farmers would do if they are to achieve the optimum farm organization.

Heady stated that:

"...Normative analysis refers to what ought to exist, under certain assumptions."(10)

Recently economists have used normative analysis in studying supply relationships. The major two procedures used under normative analysis are budgeting and programming techniques. McKee and Loftsgard stated that:

"The normative supply function is thus an estimate of the optimum supply relation to product price changes in terms of the stated norm, rather than an estimate of actual supply reactions made by producers to change in product price". (11)

9. Earl O. Heady, "Uses and Concepts in Supply Analysis, "Agricultural Supply Functions. Chapter 1, Edited by Earl O. Heady and Others, Iowa State University Press, Ames, Iowa, 1961, P. 16.

10. Loc. Cit.

11. Dean E. McKee and Laurel D. Loftsgard, "Programming Intra-Farm Normative Supply Functions", Agricultural Supply Functions. Chapter 8, Edited by Earl O. Heady and Others, Iowa State University Press, Ames, Iowa, 1961 P. 152.

MEASUREMENT TECHNIQUES

Economists have used many techniques in studying, analyzing, measuring, and estimating supply functions. These techniques represent attempts which economists have made to understand and explain supply phenomena. Each one of these techniques has dealt with supply phenomena from a different point of view. Some use a normative analysis and others use positive analysis. Some depend solely upon graphs while others depend on statistical methods. Some use the available data of previous periods and others depend on data obtained from a representative sample. In some cases results obtained from applying two of these techniques to one problem may be similar. In other cases results differ widely from each other. Each one of these techniques has its advantages and disadvantages. These techniques can be presented as follows.

Graphical Methods:

This technique is based entirely on the use of graphs. Successive curves for data which represent the relationship between the dependent variable and the independent variables are drawn. By studying these curves one can know which one of the independent variables has the greatest effect upon the dependent variable. This method was developed by Bean in 1929. Assuming there is a dependent variable x_1 which depends on three independent variables x_2 , x_3 and x_4 , Beans' methods can be summarized in the following steps:

1. Plot three scatter diagrams x_1 with x_2 , x_1 with x_3 , and x_1 with x_4 to determine by inspection which of the three independent variables is the most important in explaining the variations in x_1 .
2. Determine by inspection a first approximation to the net relation between x_1 and x_2
3. Determine by inspection the first approximation to the net relation between x_4 (or x_3) and the residuals from first x_1 x_2 approximation.
4. Plot the residuals from the curve established in step three against x_3 (or x_4) and determine the relation of x_3 (or x_4) to these final residual values of x_1 .
5. Plot the residuals from the curve established in step four as deviations from the other two first approximation curves and make a second approximation where necessary to reduce the residuals still further. If the first approximation in x_1 x_2 diagram shows the relation between x_2 and x_1 , the residual portions (the vertical deviations from the curve) must be related to the other variables x_3 and x_4 . By plotting the vertical deviations from the x_1 x_2 regression against x_4 we obtain a scatter diagram in which the nature of the relation of x_4 to the residual values of x_1 (that is to x_1 from which the effects of x_2 have already been removed) can be discovered.

In describing his method Bean wrote:

"The time required to make the correlation analysis by the usual method by an experienced person is about eight hours. The steps outlined here take less than two hours even when the nature of the curves is not known.(12)

This technique of graphical curvilinear correlation depends solely on plotting the original observations on coordinate 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 cases, the observations may be more scattered, therefore, determining the relation will be more difficult and different persons may draw different curves. Some of the economists now use this technique primarily to give some idea about the relationship between quantities supplied and changes in prices.

Time Series Analysis - Single Equations:

This method consists of obtaining a set of price-quantity observations over a period of time and fitting a curve to them. It is an estimation or prediction of unknown values of one variable from known values of another variable. Regression procedures are positive or predictive type of analysis. Many economists have used the regression procedure in estimating the relationship between the quantity offered and other variables. They have used in their analyses the following approaches.

Simple Regression - Single Equation:

This means that the dependent variable depends on one independent variable and that the relationship between them can be determined by a single equation.

Multiple Regression - Single Equation:

This means that the dependent variable depends on two or more independent variables and the relationship between them can be determined by a single equation.

Canonical Regression:

This means that more than one dependent variable depends as a group on more than one independent variable. As an example; the quantities supplied of a group of products depend together on the prices of the groups as a whole and other factors.

(12) L. H. Bean, "Applications of a Simplified Method of Graphic Curvilinear Correlation," Journal of American Statistical Association. 1929, 24: p. 394

Moore(13) in 1917 wrote a book in which he introduced the method of simple linear regression to estimate the response of cotton production to prices. Moore was, in fact, the first economist who introduced this method. His work can be considered as the first study ever made of actual supply response in agriculture.

Simultaneous Equations:

This method is used when the dependent variable depends on a number of independent variables each one of which depends in turn on other variables. This approach may help in deriving supply functions by allowing the use of more variables which may explain most of the variation in quantities supplied.

Estimation of supply functions and response of output to changes in price by using time series regressions is a positive technique because it describes what does exist in a given time period. Moore was the first one to use the regression analysis to explain farmers response to price change and he was also the first to introduce the concept of using lagged prices. Most of economists following Moore used the same principles with some modifications. Some have measured supply response in acreage planted or harvested, others in physical output. Some presented these acreages as absolute acreage, others as a percentage change from acreage of previous years. Prices were expressed either in absolute terms or based on prices of preceding years. Some deflated prices by the index number of prices paid by farmers to introduce cost of production. Others deflated prices by the index number of prices received to correct for changes in purchasing power. Some introduced prices of competing products, prices of inputs and yield per acre as independent variables.

All these attempts to estimate and analyze the relationship between quantities supplied and prices reflect only historic relationships. They describe something that happened over a previous period. Even though this approach was widely used, many problems still exist with the use of these techniques.

Limitations of Time Series Analysis:

General limitations. Technological change is one of the variables which may result in structural change of the supply function. Change in technology arises as a result of introducing new resources, new inventions, new products and new techniques into the agricultural sector. These new variables cannot be incorporated in regression models, since past observations for them are not available. Some economists assumed unchanging technology in their studies. This may be a good approximation to real conditions only in a relatively short period. But time series analysis refer always to long periods in which this assumption will not hold true. Others in dealing with supply studies of individual farm products introduced a trend variable to take account of technology change.

(13) H. L. Moore, Forecasting the Yield and Price of Cotton, New York, The Macmillan Company, 1917

This may be a good way in case of analyzing some individual commodities but for aggregate products as a whole the problem still exists.

Prediction of the Future. One of the objectives of supply analysis is to provide data useful to policy makers in changing the whole structure of agricultural sector. Future situations can only be estimated by predictive techniques. Time series regression models cannot be used in prediction because future change in variables and new variables cannot be incorporated in these models. Results obtained from this technique may be used only for short time predictions within the period covered by the analysis because these results depend solely on conditions that prevail in the given period.

Expectations and Uncertainty. Most of the economist have used observed prices received and paid by farmers or prices of central markets as their independent variables. Farmers in their decisions do not react to changes in these prices but to what they expect to receive or pay. Expectations are always made with uncertainty concerning the future. It is difficult to handle expectations and uncertainty in time series analysis. Results, therefore, obtained by using prices received will have some bias. Nerlove, (14) realizing this situation introduced the concept of using expected prices in his regressions. He introduced also the concept of using distributed lags in his analysis. These attempts may help to solve expectation and uncertainty problems.

Fixed Factors. The fixity of factors is another limitation for time series analysis. This may be a result of the difficulty of distinguishing between final products and capital goods in agriculture. Nerlove and Addison (15) have used a distributed lag model in their analysis. This may be a simple way to take care of effects of fixed factors in supply response.

Weather. This is a factor which is difficult to measure in quantitative terms but it has a great effect on supply of agricultural products. Most of the economists have used a trend variable to take care of changing weather and other variables not presented in their regression models. But this is not a complete solution of weather problems. Stallings (16) in 1960 developed a weather index as a result of the need for some measure of the influence of weather on economic relationships. This index may help economists in the future by taking account of weather fluctuations in regression.

(14) Marc Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities", Journal of Farm Economics, May 1956, 38 - 496 - 509

(15) Marc Nerlove and William Addison, "Statistical Estimation of Long Run Elasticities of Supply and Demand", Journal of Farm Economics, Nov. 1958, 40, : 861 - 880.

(16) James L. Stallings, "Weather Indexes", Journal of Farm Economics, February 1960, 42 : 180 - 186.

Data Limitations. Regression analysis methods depend solely on recorded data observed for past time series. Economists are faced always by the lack of data which they may need to use in their studies. Data available to be used are obtained from complete enumerations or samples which are designed for special purposes such as government, business and other uses. Data for these special purposes may not be sufficient for economic uses. Therefore, economists rarely find measurement information about some economic variables which may be helpful in their studies. Most of the economists used planned or harvested acreage, in studying output response to price change rather than physical output. This acreage may or may not represent actual, and consequently errors will occur in results obtained. Errors may occur also in data obtained either by samples or complete enumerations designed especially for economic studies. These errors may be a result of unresponsiveness of respondents, double counting, and interpretations of results.

Choice of Models. Economists, in analyzing supply functions, by using time series regression analysis, have to choose the proper models to represent accurately the relationships that may exist. Models which can be used in one case may not be applicable to another case. Some of the economists have used the Cobb-Douglas power equations, because it is linear in the logarithms. Others, assuming the relationship between quantities supplied and prices to be linear, used linear algebraic forms. Others used lagged models. Sometimes the models used may represent statistically the data very well, but they may not at the same time give an accurate economic representation and interpretation of the relationships.

Statistical Problems. Number of Independent Variables, In Multiple regression analysis, the number of independent variables incorporated are limited by the number of observations available. The more independent variables to be included, the more observations which will have to be used if accurate results are desired. The complex structure of agricultural production, in both aggregate and individual firm levels, gives rise to many different relations between products and inputs. Therefore many independent variables have to be included in regression models to get the best explanation of supply response. But this usually cannot be done, since time series available cover relatively short periods for these variables. As a result economists include only a few variables and neglect the effects of other variables on supply response.

Multicollinearity Among Variables. This means that there is a close relationship between the independent variables. Sometimes there is a high correlation between two or more of the independent variables. In this case, the results obtained will not indicate the actual relationship and this may lead to misleading conclusions. Moreover, it is not possible to measure the separate effect of the independent variables upon the dependent variable when such a relation exists among them. If perfect positive correlation exists between two independent variables, then either of them can be used to explain the variation in the dependent variable. The problem now is how to choose independent variables to be used in regression rather than to change the model or technique used.

Autocorrelation and Serial Correlation. In using the technique of lagged time series regression, problems may arise if correlation exists between the lagged time series and itself or between lagged time series and a different one. Auto-correlation is used to describe the lag correlation between the lagged series and itself. Serial correlation is used to measure the lag correlation between two different series. This lag correlation may be a result of the existence of secular trend and long-run movement in time series. The existence of lag correlation always face those who use lagged time series. Statistical estimations obtained in the presence of strong lag correlation lack accuracy.

Identification Problem. Usually, in estimating supply functions by using regression analysis, economists use recorded data for prices and corresponding quantities for a specific period or over a series of periods. These data can be used to construct a demand curve or a supply curve. By plotting this data as a scatter diagram a problem arises, that is how one can tell that these points are on the supply curve or on a demand curve. This is what econometricians call the identification problem. It is easy to determine whether data represents demand or supply curves under certain conditions. If the prevailing conditions indicate that the demand curve has not changed while supply curve has shifted over time as a result of any change in supply shifters, then the data represents points lying on demand curve. If supply curve has remained unchanged and demand curve has shifted over time as a result of change in demand shifters then the data represents points lying on the supply curve. The problem of identification will still exist if the two curves shift together. This problem can be solved. Brennan stated that:

"...Two important possibilities are open to the econometricians; (a) the use of multiple regression analysis, and (b) the use of lagged regression!"(17)

Using multiple regression analysis will help to introduce in either or both demand and supply equations a variable which does not exist in the other equation. Sometimes it is known that either quantity supplied or demanded depends to a great extent on a lagged variable. These two methods may help in solving the identification problem.

Operating Unit Methods:

Under the operating unit method there are two major techniques, budgeting and linear programming. These two methods are the same in general, in that they use the same assumptions of constant input-output ratio and linearity, and both are based on individual records from selected samples of firms. But there are some differences between them. The budgeting method is used to attempt to find the production problem which gives maximum profits. But in determining

(17) Michael J. Brennan, Preface to Econometrics, Cincinnati, Ohio, South Western Publishing Company, 1960, P. 375.

this unique program much time is consumed. By the linear programming technique, on the other hand, one can determine the optimum program for more complex problems than those studied in budgeting. Heady recommended that, "when the problem is large scale, use linear programming as a time saver. When the problem is small scale use budgeting.(18)

A simple presentation for the method used can be summarized in the following:

1. Selected a sample of farms which represents the farms producing the product and the area or region for which the supply function will be constructed
2. Set up a mathematical model of series of linear equations to represent all possible alternative farm activities with the available resources.
3. Specify fixed resources or other restraints which can limit the program.
4. Determine input-output coefficients.
5. Select a range of prices within which the prices of the products and inputs may vary.
6. Solve these linear equations in the model of (2) above to obtain the maximum profit from the given resource combination.
7. Construct a supply function from the results obtained.

Black(19) in 1932 suggested the budgeting method in discussing methodology for research in interregional competition. Knudtson and Cochrane published a paper to estimate the supply function for flax at the firm level. They stated that, "The purpose of this study was to explore the possibilities of using a linear programming technique to derive a commodity supply function at the firm level"(20)

Economists in using the linear programming technique have to specify some assumptions concerning the goals and actions of farmers, such as specific techniques of production, specific products, specific resource use and the attainment of maximum profits. Supply functions obtained are called normative supply functions. This means what farmers ought to do in their production operations in response to price changes under certain assumptions. The results obtained by this method are optimum only in terms of the assumptions used in the analysis.

(18) Earl O. Heady, "Simplified Presentation and Logical Aspects of Linear Programming Technique," Journal of Farm Economics, Dec. 1954, 36: 1035-1048, P.1035

(19) John D. Blank, "Interregional Competition in Agricultural Production, In Research, In Farm Management-Scope and Method.." Social Science Research Council Bulletin 13, 1932, 87 - 101.

(20) Arvid C., Knudtson and Willard W. Cochrane, "A supply Function for Flax at the Firm Level," Journal of Farm Economics, February 1958 40: 117-123, P.117

Since this method depends upon certain assumptions, it has the advantage of allowing analysis of effects of new variables. Therefore, it is easy to include the effects of possible changes in technology in estimating supply functions.

Problems of Linear Programming:

Linear programming has some disadvantages and problems which always face those who use it. These can be presented in the following.

Linear and Nonlinear Relationships. This method is a simple one, since economists assume that all the models used can be expressed by linear equations. But in fact not all the relationships analyzed are linear. Economists for simplicity have estimated nonlinear relationships such as diminishing marginal productivity or decreasing marginal rate of substitution by a series of linear segments. This will introduce a bias in the results obtained. This disadvantage can be seen in the case of overhead labour when assuming linear input-output relationship, because it is well known that as output increases the quantity of labour per unit of output decreases. Therefore, economics of scale cannot be handled well by using this technique.

Aggregation Problem Individual firm supply functions obtained by using the linear programming technique can be used to construct a regional supply function. if homogeneity of all production conditions and prices exists. But in fact this homogeneity does not exist, because techniques, resources, products and prices received or paid vary between firms within a region and in turn between regions. Economists, in overcoming this problem, may set some restraints concerning techniques, quantities and varieties of products. Therefore results obtained will be similar to those obtained by using past recorded data which cannot be used in future prediction. Moreover, in constructing a regional or national supply function from individual firm supply functions, computational and financial problems face economists.

Subjective Choice of Alternative Enterprises. In constructing the models used in the analysis, one must have a list of all possible alternative uses of available resource and a list of all possible activities that can be carried out by the firm. Choice among activities that may maximize profits will be difficult since complete data of these activities and resource use alternatives are not easy to be obtained. Moreover, one must take into consideration all possible techniques of production that can be used and this in turn will make the analysis more difficult. Since maximum profits is generally the only criterion used in this subjective choice results obtained by one economist may differ largely from others obtained by other economist.

CONCLUSIONS AND RECOMMENDATIONS

Economists have used the positive approach more than the normative approach in studying supply functions. The two approaches have their advantages and limitations. No one can say that either of them is the best in estimating supply relations. Both of them can add to the understanding of supply phenomena.

Much of the work that has been done is in the form of time series regression analysis. The major limitation for time series regression analysis is that new variables and structural change cannot be introduced in the analysis equations. Therefore with a structural change, which may be a result of rapid change in technology or other factors, future prediction is impossible. On the other hand, with linear programming or budgeting, normative supply functions are built up and estimated under certain assumptions. These assumptions may or may not prevail in the future. Therefore, results obtained by using normative approach may not be applicable for future prediction.

Economists, in their studies, have devoted most of their efforts to estimate and study supply relations for individual farm products. This may be helpful, to some extent, to decision makers on either a farm or governmental level. Problems of the agricultural sector can be solved, however, only through knowledge of supply relations at the macro level. Even through this is known by most of the economists little attention has been given to aggregate supply functions.

Changes in price of agricultural products have some effects on the quantity supplied. The results obtained in most of the previous studies indicate that supply price elasticities for agricultural products have a positive sign. This is the opposite of what is believed by many, that agricultural products have zero or negative supply price elasticities. On the macro level, where limited work has been done, results obtained indicate that output of agricultural products as a whole respond, to some extent, to price changes.

To obtain adequate and more accurate estimates of supply functions in the future, many things have to be done. First, more efforts and studies have to be devoted to theoretical aspects of supply phenomena. It is only through more adequate theory and testing that supply relations can be better understood. The more theory we know, the better our empirical research will be.

Second, data has to be given more attention. This will come by collecting information and data either by complete enumerations or sample surveys for the purpose of supply studies. Plans have to be made to collect all data which are not available now.

Third, estimates of supply functions, by using techniques which depend on both normative and positive approaches, may give accurate and adequate estimates.

Fourth, attempts have to be made to try to estimate indices which measure the change in technology.

Fifth, more attention and studies have to be devoted to the aggregate supply relations.

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