Chapter 16

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Prospective Uses of Estimated Coefficients and Related Stastics

STUDIES of agricultural supply have two broad uses: forecasting and model building. These uses are related, but they are not the same.

FORECASTING

An accurate forecast of future supplies may help a farmer, or a business concern, make a profit. It may help a statesman improve our farm programs and policies.

Such a forecast may cover any period from a few days to several decades. Farmers may try to pick the best day to ship their hogs, or the best month to sell their apples. A dairy concern may need to estimate milk supplies over a decade ahead when designing a new milk plant.

In such cases, forecasts of future supplies are inescapable. The profit or loss of an operation may depend upon the accuracy of the forecast. Therefore, it is natural enough that farmers and businessmen seek the help of the economist and the statistician.

The officer of a farm organization, the administrator, and the congressman must also forecast supplies when considering changes in farm programs. Their aim is not individual profit, but a workable program that will benefit both farmers and the public as a whole.

The effects of farm programs upon the output and supply of farm products is a difficult and controversial subject. But here again, it is impossible to escape forecasts. The only real question is how to make the forecasts more accurate, more timely, and more objective. A poor forecast may wreck a program that is sound in principle.

More and more, the economist is asked to estimate what would happen to agricultural output if price supports were lowered; if the domestic price were maintained at parity and the surplus sold at the world prices; if the market price were unsupported, but the Government paid farmers enough to maintain some income objective; and so on.

The USDA and a committe of land-grant university economists have worked with Senator Ellender's staff on a study of the probable economic results of eliminating production controls, and letting market prices drop to the levels needed to get rid of present surpluses and to balance supplies and demand in the next seven to ten years.

In the future, Congressional committees and Secretaries of Agriculture probably will ask agricultural economists for more forecasts. That is the way to make farm programs less political and more scientific.

MODEL BUILDING

The other main purpose of supply analysis is that of setting up and quantifying an economic model attempting to describe the structure of the economy. Such models may be relatively simple — for example, including only a national aggregate demand function and a national aggregate supply function. On the other hand, there is increasing interest in much more detailed models, breaking down the total economy into dozens or even hundreds of geographical regions or types of farms.

The purpose of these detailed models is not that of forecasting — at least not directly. Such detailed models certainly should help our understanding of micro-economics of agricultural supply. In a general way, this better understanding might well lead to improved forecasts of national aggregates. But the main value of these detailed studies is not forecasting at all.

Their value is similar to the value of the detailed models of demand developed by such men as Walras (13), Pareto (10), and Hicks (7). No practical economist would try to forecast the demand for hogs by first determining the indifference surface of each individual in the economy and trying to compute from these surfaces the national aggregate demand for hogs. Certainly, we all would have much more confidence in a simple analysis relating the national aggregate consumption of hogs to the national average price and the national aggregate income of consumers.

THE DEMAND FOR COEFFICIENTS

Perhaps these remarks are enough to indicate the importance of good quantitative research on agricultural supply. These studies can be of great value to the farmer, the businessman, the congressman, and the theoretical economist. This does not necessarily mean that these people want a number of "coefficients." They may want accurate forecasts of supplies. They may want a more basic understanding of the market mechanism. Statistical coefficients of correlation, regression, standard errors, elasticities, etc., are useful to these people only if these coefficients either help make more accurate forecasts or give a better understanding of the underlying mechanism of the market.

A PLEA FOR GRAPHIC ANALYSIS

Before World War II, Bean (1), Cochrane (3), and others made good use of graphic analysis to study agricultural supplies. Their results helped build a theory of supply, and helped forecast expected changes in supply.

Graphic analysis has been sadly neglected in recent years in favor of more mechanized, routine, conventional methods, based upon computation of coefficients. There seems to be a search for an automatic method, requiring no human thought. The sheer volume of this mass-produced research may at times be awe inspiring. But it probably will not give more accurate predictions of supply than can be obtained much more easily and quickly by simple graphic methods.

Graphic analysis dispenses with most computations of most coefficients. Sometimes, to make the study look impressive and "scientific," the analyst may compute a correlation coefficient. But this is not essential. A good graphic analyst draws a diagram that shows his estimate of the basic relationship. The degree of relationship is shown visually by the closeness of the scatter of dots around the regression line. The interest centers on the shape and slope of the line itself. Here, graphics has a great advantage over algebraic methods. In graphic analysis, it is unnecessary to make the unrealistic assumption that everything is linear — either in absolute numbers or in logarithms.

The electronic computer has made it possible to work with very large, very complicated models. This can be a great boon to research. But much more graphic analysis should be done before punching the data on a tape and pushing the start button on the electronic computer. Otherwise, forecasts made from routine analyses of linear models may often be less accurate than those that could have been made by easy, inexpensive graphics.

STRUCTURAL EQUATIONS VS. SINGLE EQUATIONS

The economic theorist may picture the market mechanism as a set of simultaneous equations. One or more supply equations may be part of this mechanism. Other equations may explain current demand, storage, and other economic variables. In recent years, econometricians have become much interested in such sets of simultaneous equations or "models."

For example, Gerra's (6) bulletin presented a structural model for the egg industry. Rojko (11) has presented a structural model for the dairy industry. Both models included supply equations. They are intended to show the interactions of supply forces and demand forces, and to investigate the nature of economic equilibrium.

Such models can be of great help to the theorist who is concerned with market mechanisms. Some apparently think the structural models will also provide the best forecasts. This question should be tested more adequately — either by Monte Carlo methods, or with actual economic data. Gerra's bulletin includes a brief report of a test with actual data, but his results were not conclusive.

An old-fashioned single least-squares equation is likely to give a better forecast than can be made from one of the structural equations using the same variables. Success in forecasting is the ultimate test of good economic method. In spite of all the modern writing about "least-squares bias," a single least-squares equation gives unbiased estimates of the dependent variable. It is biased only if it is misused as an approximation to one of the structural equations. In like manner, a structural equation is biased if it is used to estimate a dependent variable.

CANONICAL REGRESSIONS

The idea of canonical regression is related to that of structural equations. It was invented by Hotelling (8) in 1936. A good discussion of canonical regression can be found in Tintner (12). It appears to have obvious possibilities in research upon the elasticity of agricultural supplies.

Canonical regression is the regression of one set of variables upon another set of variables. In this case there is no single dependent variable. Rather, one group of variables is dependent upon another group. For example, suppose that the acreages of ten vegetables depend upon last year's prices of the same ten vegetables (and perhaps other factors, such as wage rates for farm labor).

One way to study such a problem would be to make index numbers of vegetable acreage and of vegetable prices. These index numbers could be treated as single variables in the analysis. What weights should be used in constructing such index numbers of acreage and of price? The canonical regression is essentially a method of assigning both sets of weights. Assuming that we want to estimate (forecast) the index of acreage, canonical regression lets us assign weights that minimize the standard error of estimates of that index.

Thus, in a general way, canonical regression should be useful in indicating how a group of production items respond to a set of prices. We would not expect such a regression to give the best forecast of the output of a single commodity. But it, like a set of structural equations, might help the theorist understand the basic mechanism of the market. Also, there is great interest in how total agricultural output responds to the average level of farm prices. This can be studied only in terms of some sort of indexes of output and prices. All indexes are arbitrary. There is something to say for the kind of weights implied by canonical regression.

THE "DECAY RATE"

Works of Friedman (5) and Nerlove (9) have revived interest in what Fisher (4) called "distributed lags." Friedman found that the spending pattern of the typical consumer depends not only upon current income, but upon his income for many periods in the past. Nerlove found that farmers, in planning production, were influenced by prices over a period of several past years. In general, they both found that the most effective periods were the most recent ones — that the effect "decayed" over time.

Data on orange advertising over a period of 50 years suggest that consumers respond not only to current advertising, but also to the advertising of several years in the past. In many cases, the effectiveness seems to decrease by a "decay rate" similar to that of the radio-active material. That is, it loses a constant percentage of its effectiveness in each unit of time. If it loses, say, 40 percent the first year (leaving it 60 percent effective), it will lose 0.40 x 60 percent the second year (leaving it 36 percent effective), 0.40 x 36 = 14.4 percent the third year (leaving it 21.6 percent effective), etc. Of course, this particular pattern of distributed lag (or decay) is not necessary in all cases. But it does seem plausible theoretically, and it does seem to fit several economic series very well.

So the decay rate is one coefficient the researcher is likely to find useful in studying the supply of farm products. Brandow (2) and others have questioned some of the methods used to derive such a coefficient. Probably it is well to try different methods.

TWO-PRICE DEALS

In the past few years, there have been several proposals for farm programs that would result in two different rates of return to the farmer — a higher return for his "domestic quota" of wheat, rice, milk, or turkeys, and a lower return for "extra-quota" amounts.

One of the unsettled questions about such proposals is whether farmers would react to the "blend price" in planning production, or whether they would react to the lower price received for extra-quota production. Theoretically, we might expect farmers to react only to the lower price on extra-quota production, <u>if</u> they were convinced that their future quota was fixed and did not depend on current production, and <u>if</u> the farmer computed his economic interests correctly and reacted strictly as an economic man.

These are big ifs. We need to know much more about how farmers actually do react to two-price deals. Some work has been done in base-rating plans for milk, but more research is needed in this area.

NON-PRICE FACTORS

Finally, economists tend to limit their interest too narrowly to the response of production to prices. There are certain other factors that warrant consideration. A number of years ago onions and tobacco were the two main crops raised in the Connecticut Valley of Massachusetts. Price was certainly a factor in determining the acreage planted to each. But so was inertia, and the unwillingness of American-born farmers to follow the example of their Polish-born neighbors and have their wives and children weed onions on their hands and knees in the hot sun. Price is probably not the main reason that very few onions are grown in the Valley today. It is rather that the Polish immigrants and their children have adopted American culture patterns.

Farmers' production plans are influenced by anything that makes them more or less optimistic about the future. Advertising and promotion generally might induce farmers to expand their operations — whether or not they reason that future prices will be higher. In any case, the economist does not need to limit his interest to the response of farm production to price alone. Rather, he should look for any sort of influences that could be identified and measured.

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Discussion

IN LISTENING to the papers at this workshop I am reminded of the quotation that appears on the title page of H. Theil's book Economic Forecasts and Policy.[1] This quotation, taken from the book The Napoleon of Notting Hill by G. K. Chesterton, goes as follows:

> The human race, to which so many of my readers belong, has been playing at children's games from the beginning – and one of the games to which it is most attached is called, "Keep Tomorrow Dark" and which is also named "Cheat the Prophet." The players listen very carefully and respectfully to all that the clever men have to say about what is to happen in the next generation. The players then wait until all the clever men are dead and bury them nicely. They then go and do something else. That is all. For a race of simple tastes, however, it is great fun.

In spite of our efforts to capture the parameters of supply relations and to predict, our opponent, the real world, has done a good job of keeping tomorrow dark, or at least dim. This is not surprising when one considers that our theories of economic change do not enable us to narrow substantially the class of admissible hypotheses and that by their very nature structural supply relationships are subject to strong random fluctuations. Perhaps if we can, as in the spirit of this workshop, study individual structural equations, we may find bits of order here and there. These can gradually be combined into a systematic picture of the whole, thereby generating a little light along with our heat.

Waugh has discussed the two broad uses of supply functions and has commented on alternative methods of capturing the coefficients of supply relationships. Since many of the other papers and discussions have discussed methods of sampling the coefficient space for desired parameters, I will concern myself mainly with an extension of Waugh's remarks relating to the uses of these studies and how models, methods, and uses interact.

It seems apparent that if we could gain knowledge of domains, such as firm behavior relations, we could make predictions about them, or by understanding the underlying structure or mechanism, control or at least influence them. Therefore, if we could succeed in capturing the relevant variables and their attendant coefficients, this knowledge could be of invaluable use for decision making at the various choice levels. Use of this knowledge as a basis for decision making could run the gamut of providing the necessary information to guide a particular firm in its choice of output level to that of a government that desires to know

[1] Theil, H. Economic Forecasts and Policy. North Holland Publishing Company, Amsterdam, 1958.

in advance the probable consequences of alternative courses of action that may be considered. Therefore, such quantitative knowledge is a prerequisite for intelligent formulation of government policy and for resource allocation by the firm.

Although the estimates have a variety of uses, no particular set of estimated coefficients contains magic numbers that can be used for all purposes. In most cases the definitions and assumptions underlying the model and methods specify the use to which the estimates can be put. For some decisions only changes in the exogenous variables will be relevant. For this situation, knowledge of the reduced forms relation is adequate. However, knowledge of the past structure is necessary if actions under consideration and the expected changes of uncontrolled conditions involve not only changes in exogenous variables but changes in the structure itself, e.g., if we change from a free market situation to that where the price of a commodity is controlled. The important thing about having knowledge of structural relations is that it makes it possible to predict the effect of not only one given structural change but of any well-defined structural change. Of course, for many decision-making purposes knowledge of supply relations is not sufficient. We must also have parameter estimates for other behavior and technical relations.

With tongue in cheek, I will say I have a feeling many of us use estimates for purposes other than for what they are intended. Estimates and analysis from which specific inferences are to be derived should be designed in detail to provide an appropriate base. It is important before "pushing the button" to check directly the appropriateness of the most critical coefficients for the problem at hand.

Thus far we have said that the estimates of supply relations should be useful for decision making on the government and firm level. Given knowledge of these relations it is now in order to consider how to use this information to make the best decisions. Two of the outstanding men who have concerned themselves with this problem are the Dutch economists, J. Tinbergen and H. Theil. Theil considers this problem under the framework of "decision making under uncertainty" and his procedure may be sketched as follows:[2] assume that the variables for which predictions are to be made are connected by a linear model of the type

$$BY + \Gamma Z = U \tag{1}$$

where B and Γ are matrices of structural coefficients, U is a vector of random disturbances, Y a vector of endogenous variables, and Z a vector of predetermined variables. If we then assume the B matrix is nonsingular, we can write the reduced form equation which expresses each Y as a linear function of the Z's. The Z's may then be partitioned in the following categories: (a) instruments or controlled variables,

[2] Ibid., pp. 379-556.

(b) uncontrolled variables, and (c) lagged variables. Since the lagged variables are known at the moment of decision making, they appear in the reduced form as a constant term. It is then necessary to predict the values of the uncontrolled exogenous variables along with that of the disturbances of the reduced form. The reduced form may then be written as follows:

(2) $$Y = \pi_1 \; Z_1 + E$$

where Y is the vector of noncontrolled variables which the policymaker can influence, Z_1 is a vector of the policymakers' instrument or controlled variables, π_1 is a matrix of coefficients and E is a vector of constant terms and is composed of noncontrolled exogenous variables, lagged variables, and reduced form disturbances.

Given the above equation it is possible to make conditional predictions. The decision maker may then proceed to evaluate the alternative values of Y and Z_1 that are available for choice. Assuming that a welfare function exists which describes the ordering of alternative outcomes according to increasing preference, the policymakers' "best" decision is then found by maximizing

(3) $$U = u(Y_1 \; Z_1) \; ,$$

subject to

(4) $$Y = \pi_1 \; Z_1 + E \; .$$

In this sense, a very close formal relationship exists between this type of analysis and the classical theory of consumer demand. In Theil's formulation it is easy to see how imperfections in the coefficient matrix π_1, or in E could bring about imperfect predictions and decisions and thus generate welfare losses.

Although the approach by Theil is similar to that of Tinbergen in that it uses econometric models for policy purposes it differs in how decisions are made. Also, Tinbergen[3] neglects disturbances in the equations.

Tinbergen fixes certain desirable target values for the noncontrolled variables on an <u>a priori</u> basis. He then tries to find the instrument values necessary to reach the target or targets. His approach would be to start with a system of linear equations of type 1 and assume that the number of controlled and noncontrolled variables are equal. Therefore, the Γ matrix of coefficients is square. If we also assume that it is nonsingular, we can express each Z in terms of all Y's, i.e., just the reverse of the reduced form equations. If we ignore the disturbances, we can generate for each set of target values the

[3] Tinbergen, J., On the Theory of Economic Policy, North Holland Publishing Company, Amsterdam, 1952, and H. Theil, <u>op. cit.</u>, p. 392.

necessary instrument values. In this sense it is similar to structural analyses in input-output models. Of course, in this approach we have the problem of how to handle exogenous variables which are not instruments and how to proceed in decision making when the number of target and instrument variables are not equal.

I have attempted to sketch two approaches to the use of econometric results in decision making. Obviously my brief sketch has not done justice to the penetrating and refreshing approaches of Theil and Tinbergen. Many problems, of course, remain in real world applications. However, I believe it is safe to say our ability for using the estimates greatly exceeds our ability to capture the relevant coefficients.

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Discussion, Chapters 15 and 16

THE PAPERS by Waugh and Swanson demonstrate that many useful ideas can still be stated simply and briefly. It was good to have persons of their stature make this point.

Swanson's paper will be considered first. It could be criticized, perhaps, for deviating from the topic assigned. This is excusable, but it means we were denied his views on alternative models for analyzing the feed-grain economy and their appropriateness. He did, however, have some worthwhile things to say about supply response studies.

The estimates of the effects of changes in certain variables in the feed-livestock economy and their interrelationships are of interest.

The discussion of yield variation due to weather points out an important difficulty in trying to explain production changes. The caution against economists trying to be meteorologists seems well founded. It would probably have been expecting too much to have looked for an alternative way of getting around this problem.

Some of the other ideas presented in the paper that seemed particularly interesting were: (1) the effect of changes in feed supply in a given year on later livestock production via the build up or depletion of breeding livestock inventories, (2) the apparently changing role of the feed-livestock economy as an equilibrator to absorb shock of fluctuation in feed-grain production, and (3) the apparent increase in stability in hog production associated with increased size of operation. Some of these and other relationships mentioned support the viewpoint that data from individual farms can supply us with insights on supply response not obtainable from time series data alone.

We turn now to Waugh's paper. Several times during the conference the question has been raised as to what use we are to put the supply response coefficients. From the title of Waugh's paper, we would expect to find the answers here. The paper does have something to say about this. But largely it is dismissed by saying that farmers and policy makers are not directly concerned with coefficients. We must agree with him that they are of value only if they help us forecast or understand the market. He really does not tell us whether or not he thinks the coefficients forthcoming will do either of these things. He does make a plea for using much simpler methods —particularly graphic analysis. He states, however, the major weakness of this method when he says we can visualize only three dimensions at once. This seems a serious enough limitation in dealing with the complex of variables involved in the supply response function and seems to confine its use largely to preliminary analysis.

Waugh favors "old fashioned" single least squares equations over the structural equations. It may be that, as he states, a structural equation will give a biased estimate of a dependent variable. It was not made clear why this may be so.

One of the principal values of the paper is its emphasis on the use of good common sense as far as it will carry us and his warning that we should not let ourselves get so entangled in the complications of methodology that we lose sight of the problems and the real objectives of our studies.