Chapter I

INTRODUCTION

Ultimate Purposes of Study

The ultimate purposes of studies like the present one are probably sufficiently apparent that little discussion of them is required here. The investigators have tried to obtain quantitative approximations to some of the underlying relations determining quantity and price of livestock products produced and sold in the United States each year. If accurate and reliable approximations to such relations could be obtained, useful applications to both private and public policy would readily suggest themselves. If farmers could more accurately forecast price and cost conditions, they could more efficiently adjust their production.[1] If processors of livestock products had better notions of the amounts of various animals and products that would be forthcoming, savings in processing costs would undoubtedly be possible.[2] If the government were considering sending large amounts of grain or other feedstuffs abroad, a knowledge of the relations considered here would enable one to forecast the effects of such a diversion on domestic prices of feed and livestock and on production of livestock products. Similarly, responses to price supports, taxes, subsidies, or other measures depend on the nature of the underlying economic and technical relations.

As for the application of the results of this study to the kinds of

[1] For the forecast to be useful in this respect it would have to be widely known and seriously considered. This would mean that, to make a good forecast, the forecaster would have to allow for the influence of his forecast on the behavior of various participants in the market. Although learning to take account of the effects of a forecast presents problems that have not been very throughly considered, the recognition that a forecast may influence action does not make good forecasting a logical impossibility.

[2] For many purposes processors of livestock would be interested in forecasting amounts of particular types of livestock to be marketed in a given period rather than the aggregates considered here. They would also be interested in forecasts for periods shorter than a year. The present study is limited to annual variations in aggregate variables, partly because of the complexity of relations among disaggregated variables over shorter time periods and partly because of the nature of the available data.

problems indicated above, the authors must suggest caution. As will be seen in later chapters, sampling variations alone are sufficient to give considerable dispersion of observed variables around the values that can be forecast from our fitted relations. Still more troublesome are the possibilities that some of the assumptions on which statistical analysis is based are unrealistic and that these have led to various kinds of specification error[3] in the results. In the present state of econometrics such difficulties are typical, and economists have generally regarded the results of empirical studies of economic relations with proper reservations.

Intermediate Purposes

Although one ordinarily cannot feel very hopeful that a particular study will yield empirical relations of the accuracy and reliability necessary to answer many of the practical questions that might be posed, there is still, we believe, much to be gained from efforts to obtain the best empirical relations possible. If we are ever to obtain good approximations a certain amount of trial and error may be unavoidable. Frequently something can be conjectured by noting the circumstances under which a particular fitted relation fails to hold. Preliminary examination of data incidental to such a study is often suggestive, and even implausible results may lead to new and useful hypotheses. Part of the difficulty in a typical study lies in inadequacies of the available data. Attempts to use existing data should provide useful suggestions concerning the kinds of additional data that are needed. Similarly, attempts to apply existing methods should provide better judgments of the kinds of improvements in methodology that are most needed.

[3] For discussions of some types of specification error see the following:

D. Cochrane and G. H. Orcutt, Application of Least Squares Regression to Relationships Containing Autocorrelated Error Terms, *Journal American Statistical Association*, Vol. 44, pp. 32–61, 1949.

G. H. Orcutt and D. Cochrane, A Sampling Study of the Merits of Autoregressive and Reduced Form Transformations in Regression Analysis, *Journal American Statistical Association*, Vol. 44, pp. 356–372, 1949.

S. G. Allen Jr., An Example of Loss of Efficiency in Structural Estimation, and Jean Bronfenbrenner, Sources and Size of Least Squares Bias in a Two-Equation Model, both in *Studies in Econometric Method*, Cowles Commission Monograph 14, William C. Hood and T. C. Koopmans, editors, John Wiley & Sons, New York, 1953.

Leonid Hurwicz, Some Specification Problems and Applications to Econometric Models, *Econometrica* (abstract), Vol. 19, pp. 343–344, 1951.

Egon S. Pearson, The Analysis of Variance in Cases of Non-Normal Variation, *Biometrika*, Vol. 23, pp. 114–133.

M. S. Bartlett, The Effect of Non-normality on the *t* Distribution, *Proceedings Cambridge Philosophical Society*, Vol. 31, pp. 223–231.

In many studies perhaps the most important gains accrue because the investigator is forced to formulate his assumptions about the part of the economy being studied more completely and more precisely than on other occasions. These then become available for general criticism and discussion. Out of such discussion, new hypotheses may arise. Though discussion can and does often proceed without reference to data, we believe the intention to incorporate data into the analysis imposes a discipline that should sharpen theoretical discussion and make it an increasingly useful aid in forming practical judgments.[4]

Emphasis in Present Study

In the course of the study the authors have tried to keep in mind both the ultimate objectives mentioned at the outset (i.e., predicting future values of economic variables and the consequences of economic policies) and the intermediate objectives of formulating ideas about market behavior, testing them as far as possible against empirical data, and making reformulations when these seem necessary. We are interested in the intermediate objectives because we hope that success in pursuing them will eventually make a significant contribution to our ability to predict. However, one can only guess how much work may need to be done before the significant contribution may be realized. Fortunately the ultimate and intermediate objectives cited above are to some extent complementary. A process of trial and error is not likely to be fruitful unless one makes good tries. On the other hand, some choices have to be made. If an investigator wanted to make the best possible forecasts for next month or next year, he would use his resources rather differently than if his main objective were to improve the groundwork on which forecasts might later be based. In particular, if immediate forecasts are the main objective, one is likely to rely more on expert opinion and informal methods of interpreting past experience. If an eventual contribution to forecasting is sought, one may be interested in experimenting with more elaborate and formal methods and one is likely

[4] Of course, theoretical analysis can be compared with data without estimation of parameters in assumed relations or without applying formal statistical inference at all. Examples of such procedure may be found in:

J. S. Duesenberry, *Income, Saving and the Theory of Consumer Behavior*, Harvard University Press, Cambridge, 1949.

A. G. Hart, *Money, Debt and Economic Activity*, Part III, pp. 257-300, Prentice-Hall, New York, 1948.

J. Viner, *Canada's Balance of International Indebtedness* 1900–1913, Harvard University Press, Cambridge, 1924.

Colin Clark, *The Conditions of Economic Progress*, Macmillan & Co., London, 1951.

to spend more time theorizing and trying to understand the fundamentals of the activities one considers. The reader will have no difficulty recognizing that the emphasis here is on intermediate objectives and that much work remains to be done if the results are to be very useful in practical forecasting.

Our decision to investigate livestock products as an aggregate rather than as individual products (such as milk, eggs, beef) is an example of the emphasis on intermediate objectives. For some purposes (e.g., see footnote 2), even good forecasts of aggregate livestock production and an index of livestock prices would have limited usefulness. The greater heterogeneity of aggregates also presents an additional barrier to the attainment of good forecasts.[5] However, to have considered the important food livestock products individually and with any thoroughness would have been beyond the resources of the present study. To have centered attention on a single product would not have eliminated the difficulties. Livestock products are so interrelated both in supply and in demand that any reasonable analysis of one product must take into account the conditions of supply and demand for the others. It is hoped that the results of the present study will be helpful in later treatments of individual commodities or types of livestock.

Products Studied

The individual products included in the livestock products aggregate are cattle, calves, hogs, chickens, turkeys, sheep, milk, and eggs. The basic price and quantity data used to construct aggregate price and quantity indices (construction of the indices and sources of data are discussed in some detail in Chapter III) relate to prices received by farmers and quantities sold by farmers to dealers or processors or consumed on farms. Thus demand in the present study refers to the sum of demand for home consumption plus demand of the commercial sector of the economy for these products. Behavior of final consumers and behavior of dealers and processors are combined in the demand relation studied.[6] Since the individual commodities listed tend to be substitutes in both production and consumption, there should be a tendency for their prices to change proportionally over time. To the extent that this has in fact been the case, some of the disadvantages of aggregating are mitigated. Some notion of the strength of this tendency can be obtained by examining the plotted price series in Figure 1.

[5] This may to some extent be counterbalanced by the greater stability of aggregates. They may be disturbed relatively less by accidental factors on which the investigator has no data.

[6] For further explanation of this point see pp. 107 and 108.

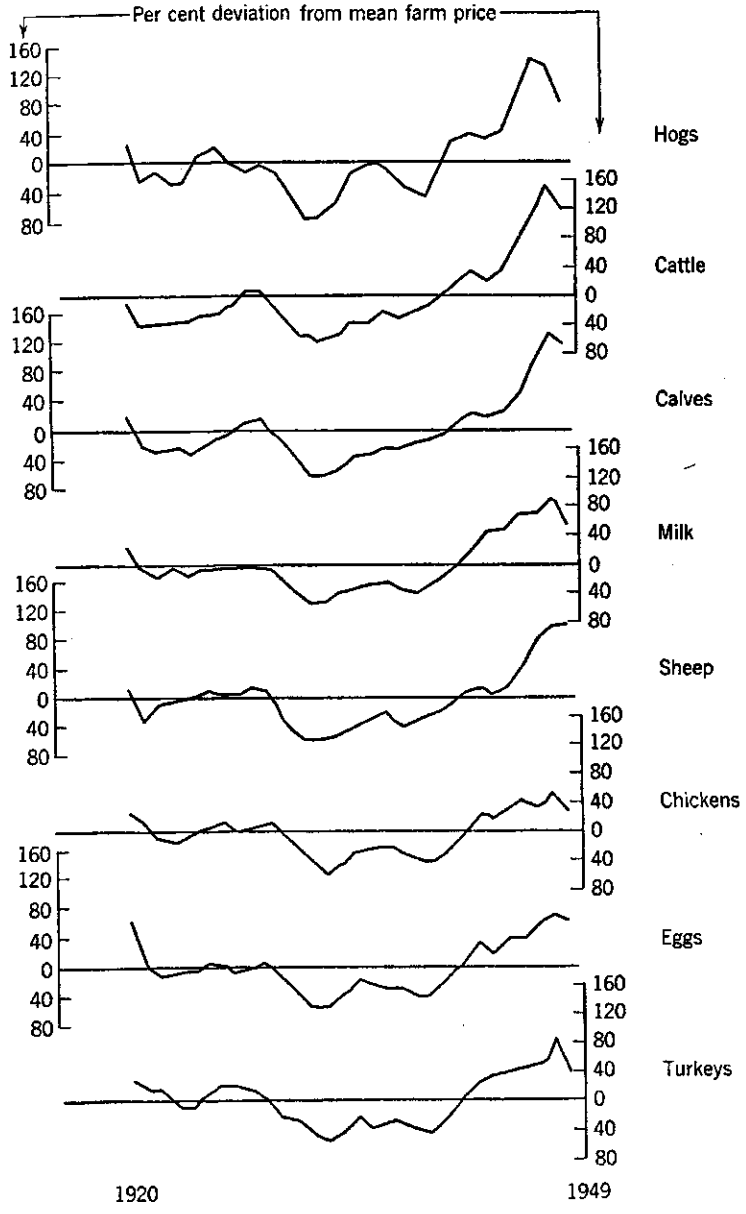

FIG. 1. Price movements for individual products. Based on price data from *Agricultural Statistics*, 1942–50.

The principal livestock omitted from the study are horses and mules. They have been excluded because of their declining importance[7] and because their inclusion in an aggregate would have greatly increased its heterogeneity. Similarly, sheared wool has been excluded since it is a minor product, contributing in recent years about 1 % to the value of livestock products sold, and since its price is strongly influenced by a number of factors that are not present for the other commodities. The other livestock and livestock products omitted—poultry other than chickens and turkeys, goats, mink, foxes, dogs, etc.—are of negligible importance. Chapter III includes some discussion of problems arising from the exclusion of horses and mules. The data used in the study cover operations during the calendar years 1920–49, inclusive.

Statistical Specification, Structure, Model

In any application of statistical analysis, the inferences that can be drawn depend both on the data and on the a priori assumptions the investigator makes about the statistical universe from which the data are drawn. These a priori assumptions are called the statistical specification. Choosing an appropriate statistical specification is a particularly critical and difficult task in most applications of statistics to economics. Most applications to economics involve nonexperimental data so that the investigator cannot make his data conform to a previously selected specification. He cannot design an experiment but must endeavor to choose a specification that will be reasonably consistent with the process by which his data were generated in the real world.

Economic and Statistical Models

In the language that has been developed to consider statistical analysis of economic relations, the process by which a set of economic variables is generated is called a structure. The variables whose values are explained by the structure are called endogenous variables whereas those whose values are determined outside the structure are called exogenous. The set of structures compatible with the investigator's statistical specification is called a model.[8] In the present study we find it

[7] Horses and mules on farms declined from 26 million in 1920 to 8 million in 1949. Data from *Agricultural Statistics, 1942–51*, U. S. Department of Agriculture, Washington, D. C.

[8] For a fuller discussion of the role of structures and model see T. C. Koopmans and William C. Hood, The Estimation of Simultaneous Linear Economic Relations, *Studies in Econometric Method*, Cowles Commission Monograph 14, William C. Hood and T. C. Koopmans, editors, John Wiley & Sons, New York, 1953.

J. Marschak, Statistical Inference in Economics: an Introduction, *Statistical*

useful to distinguish between what we shall call the economic model and the statistical model.

From economic theory and from a priori knowledge of the workings of the sector of the economy being considered, the investigator can usually form some idea of the kinds of relations that are included in the structure under consideration and the variables that are important in each relation. He thus has some guide as to the appropriateness of assumptions he might make about these aspects of his model. If these assumptions are questioned, economic theory or knowledge of institutional arrangements can usually be brought to bear. Economic theory and knowledge of institutional arrangements may also make it possible to specify certain qualitative restrictions on the nature of the relations. We apply the term economic model to the set of structures consistent with the assumptions that the investigator develops from considerations of economic theory and knowledge of existing institutions.

In the present state of economic and statistical theory, the investigator typically finds it necessary to make additional assumptions for which economic and institutional considerations offer little if any guide. He must typically specify the algebraic form of his relations and the way in which the relations are affected by unobserved influences. Although economic considerations may sometimes exclude certain possibilities, they do not usually provide very strong grounds for preferring a particular set of assumptions. The specifications made about these aspects of the structure are often chosen partly to simplify the statistical analysis and are to some extent arbitrary. In our study we refer to the set of structures consistent with all the assumptions of the investigator as the statistical model.

Although the above distinction is not always a sharp one, we believe it has usefulness. If the investigator always makes explicit the basis for the assumptions underlying his economic model, these can be more readily evaluated by economists and by persons well informed about the relevant institutions. There is perhaps more incentive to experiment with alternative sets of assumptions that apply only to the statistical model, and it may be hoped that experience will help in forming preferences among them.

Content of Later Chapters

The development of the economic model used in the present study is described in Chapter II. Results using a particular statistical model and the observations described in Chapter III are given in Chapter IV. In

Inference in Dynamic Economic Models, Cowles Commission Monograph 10, T. C. Koopmans, editor, John Wiley & Sons, New York, 1950.

succeeding chapters, particular relations are discussed in more detail and results obtained from different statistical models (and in a few instances from different economic models) are presented. Chapter VIII contains some comparisons of the estimated relations with data for 1950, designed to give a preliminary notion of the possible predictive value of the relations. A sample computation is given in the appendix.