Chapter 14

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*Demand Analysis and Data for Regional and Spatial Models of Adjustment**

THE REAL REASON for being concerned here with demand analysis and data for regional and spatial models is that we wish to use these models to predict the interactions of the agricultural production process with the rest of the economic and social web of society. In short, we are concerned with the adjustment process.

ADJUSTMENT DEFINED

What is meant by adjustment? Unfortunately, many vague things. Even more unfortunate in some cases is the fact that analysis said to be adjustment research is designed and executed without explicit recognition of some of the essential elements of any adjustment problem. In the most general sense, to be in adjustment implies that, by some criterion or set of criteria, a satisfactory relationship has been attained between the needs, desires, or goals of the object being adjusted and the nature and organization of that object and its environment. The essentials of this generalized definition are:

1. A criteria for specifying adjustment.
2. The understood object which is "adjusting" or "being adjusted."
3. The nature of the object of adjustment and its environment.
4. The internal organization of the object of adjustment as well as the organization of the environment.

By "nature" is meant those characteristics of the environment and the object of adjustment which do not change during the process of attaining a satisfactory adjustment.[1] By "organization" we mean those

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[1]The facts of nature are of varying order. Elements of the social order can be changed over greater or lesser spans of time: by law, by informal change in social structure, and by technical change. At the other extreme are the more immutable constants of the physical universe.

characteristics which do change or can be changed in attaining a satisfactory adjustment. In economic analysis we usually assume 1 and 2, identify the relevant elements of 3 to be faced as "facts", and operate upon the variables of 4 to determine what constitutes a satisfactory adjustment.

Time is an important dimension of the adjustment process. The chronological period of time involved may vary considerable from one specific adjustment problem to another. The span will depend on the period of time it takes to execute the changes in "organization" (part 4 of the definition above) necessary to attain the optimum equilibrium condition of adjustment.

Usually, in agriculture the criterion of adjustment used is that of optimum income, although social welfare, minimum income, equality of income distribution, market share or dominance, and many other criteria have also been applied.[2] The object of adjustment conceivably could be a firm or group of firms, a region, a conglomerate of subregions, an industry (such as agriculture) or functional sector of an industry (the feed-livestock sector), or an entire national economy. All necessarily have somewhat different organizations and natures. The nature of economic environments will include most of the technical coefficients of production and consumption, particularly in sectors that provide the closest substitutes and necessary complements to the object of the analysis. Important environmental elements often omitted include the asset structure, inventories, and other stocks of the economy. We also tend to overlook the structures in the economic environment which result in action at variance with that conceptualized, such as the deviations from the usually postulated perfectly competitive economic organization of society.

COMMON ERRORS IN CONCEPTUALIZATION

One final important consideration is the question that must be answered in the design of any study: to what end do we do adjustment research, or to what use do we wish to apply our results?

If one wishes his research to provide meaningful adjustment recommendations for national agricultural policy, then he must have as a focus for analysis a socio-economic unit larger than a farm or group of farms. For that matter, even in research which is to provide only farm management recommendations one must consider the aggregative price effects of the sum of individual firm production decisions, if the farm management recommendation is to be reasonably close to an optimum result in any long run adjustment or equilibrium sense.[3]

[2] Some of these other criteria are most often introduced as qualifications to the results of the research.

[3] Also of importance in this problem are the often inconsistent goals of the nation and individual farmer. In a human social structure it is rarely safe to assume that a social aggregate or nation is no more than the sum of its parts. Science must operate with such

In adjustment research, the problem is usually improperly set up to begin with. Often this involves the generally incorrect notion that research formulated at a very low (or micro) level of aggregation can be used directly to illuminate adequately the much higher national or macro level variables of adjustment problems. The reverse also holds. Research done at quite aggregative or macro levels in the economy is rarely ever directly useful in analyses involving micro level variables. Obviously the problems of adjustment are not confined only to one level of aggregation in the agricultural industry. There is a clear need in adjustment problems to design research which functionally relates the micro level analysis to the macro. No doubt it is easier said than done, but it is clearly needed.

Conditionally normative resource allocation models of farms may be aggregated to help specify production and other boundary limits under differing conditions (of say, technology) but they can be used neither to specify the process of adjustment nor to predict production, price, and other equilibrium adjustment reactions with any reasonable degree of reality.[4] To view the rest of the economy through a fixed set of assumed prices as such models typically do is to throw the adjustment "baby" out before you ever fix the "bath water." How else is one to interpret a model that postulates prices which do not respond to any of the imputed changes in production? This is not to say that such resource models do not have uses. They most certainly do. But these are extremely short run in analytical nature. Such models must be greatly adapted for research that focuses on the basic problems of sector or economy equilibrium adjustment. They also are more limited for farm management purposes than we are often willing to admit.

In such models the production unit will appear to have made satisfactory adjustments to current prices and resource problems. But these adjustments will almost invariably involve an increase in the farm's capacity to produce and in production. Not just one, or a few, but many farmers presumably will make these adjustments and the net aggregative result will have been to increase product output, not just for the farm, but for the industry as a whole. The aggregative production response involved in the adjustments of the original time period have an effect on price and necessitate additional rounds of adjustment in subsequent time periods. The usual resource allocation model does not go beyond analysis of the original time period. This means that the aggregative effect of individual firm actions are never considered as part of the adjustment problem. Where new techniques and organization are involved, the aggregative effect is not just a part but an all important part of the adjustment process. To use price in such a manner is not a failure to include time or aggregation in the model but a failure

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postulates but we should not be misled by "a method of analysis" to exclude from the determination of what constitutes an "optimum" for social policy, all individual or societal outlooks on reality that are not implicit in "the method of science."

[4] This is equally true in budgeting, traditional production function analysis as well as linear programming.

to include the demand structure in the calculus of adjustment. At best it makes the entire demand structure exogenous to the model.

This failure to consider the demand structure is implicit in much of the current discussion of adjustment. Reorganization of input mix and technological change, in fact, practically all structural changes, are often discussed as if such changes, as matters of importance, were limited to the farm production organization. This is obviously not true. The non-farm produced services and physical factors with which farm products are combined account for well over half of the final retail value of food products. Surely if, for example, we were focusing on the impact of technical change on the farmer's adjustment problems, we would have to give some consideration to the technical change taking place in the chain of production organizations that connect the farmer with the consumer. Innovations in the "form of the product" presented to the consumer such as were involved in the precooking and prepackaging of foods and in frozen foods have had considerable influence on the rate of growth in demand for some products. This is certainly true of broilers. Indeed, in the case of broilers and some vegetables the packaging and freezing revolution has probably had significant influence on the location of production as well as on the legal and organizational form of many of the farm units producing broilers and certain vegetables. The freezing of fresh orange juice is another innovation in commodity form that has had profound effects at the farm level.

If and when concentrated sterile milk becomes a major market reality we are likely to see rather significant shifts in comparative advantage between areas of the nation in the production of milk. Any reduction by as much as a third in unit costs such as are potentially involved in this innovation will have very direct effects on enterprise organization, resource mix, and locational advantage of farms and entire production areas (9). The transport and communication developments of the last 20 years have had the effect of breaking down old locational advantages and of greatly shrinking the economic space between markets. In the future such diverse things as the St. Lawrence Seaway and the integrated unit-cartonization of truck, rail, and sea transport will have great location advantage impacts. Any major change in storage or transport costs shifts the locational advantages of different production areas and changes the enterprise and input mix that is optimum for a production area and for types of farms within an area.

New consumer durables have considerably altered consumption behavior and the demand for individual farm products. The refrigerator and the home freezer have had important effects in changing the composition of diets and thus have caused shifts in demand.

One could go on. But all this is only to point out that major changes in consumer tastes or in the costs, organization, and form of products, markets, transport, communication, and storage must inevitably influence the economic facts of life faced by a farm unit and result in changes in the nature of the farm organization itself. No consideration

of the adjustment process or the problems of an equilibrium adjustment in agriculture is likely to be complete or realistic that does not explicitly include in its analysis the relevant structure of demand and the production processes that connect the farm gate and the dinner table. [5]

We have been dealing here with the characteristics that ideally should be associated with research in an adjustment framework. A few final observations need to be made. Limitations of data and analytical tools usually impose partial equilibrium frameworks on our research. If we are to avoid many common errors, such as those noted above, the research problem should be formulated theoretically in a general equilibrium form before it is cut down to workable empirical size. The cutting down of the conceptualization should not only be carefully done, but as much as possible the cuts should be made on the basis of what is least important analytically to the focus of the specific research. Cutting the analytical framework simply to fit a proven tool of research or to avoid data problems quickly leads to sterile research. We stand to gain far more from bold "half failures" than timid "total successes." Failure to conceptualize adequately the research problem is a crippling affliction and one common to much of our research today on adjustment problems.

The author finds arguments for regionalization or spatialization of the analytical framework convincing. This seems to be one of the first steps necessary to bridge the great void between macro level analysis and the firm-household or micro level. Regions of the United States are, of course, less self-contained economic organizations than the nation so that the analytical framework of regional analysis should extend beyond the confines of the region itself. For instance, a study of adjustment problems of the Lake States dairy industry should take into empirical and analytical consideration the major deficit milk markets to which Lake State surplus milk flows. A complete general equilibrium framework would also include the surplus producing regions that compete with the Lake States.

If the research aims primarily at policy recommendations or general adjustment problems, it is desirable that the results be cast around a series of consecutive time horizons rather than just one. Despite the inherent crudity and hazards involved in projecting a portion of the structural variables of a model, this in some fashion is what must be done. These hazards must be accepted. Adjustment even to past circumstances takes place in unaccomplished, not accomplished, time. Also any consideration of anticipated structural shifts, such as new technical change, must necessarily be given some dated unaccomplished time dimension. Normally this means the construction of more than one model. Approximation of the path of change or process of adjustment will generally provide more valuable information than the

[5] The same is true, of course, of the market structures on the farm input side. The arguments here have been stated quite cogently by D. E. Hathaway, G. L. Johnson, T. W. Schultz, and others.

analysis of the final static equilibrium. Time is the irreducible and strategic dimension of adjustment.[6]

PROBLEMS FACED AND DATA NEEDED

It is one thing to specify the general requirements of adjustment analysis and quite another to know how to go about meeting these requirements in integrated and concrete empirical terms. The author cannot claim much progress in his own struggles with these problems. What follows is still quite eclectric, and in instances tentative.

Notice first the overall context in which we attempt to develop empirical models of integrated demand and supply structures. Most empirical and analytical tools available for demand analysis are macro in form and in variables specified. Most of the applied supply analysis tools are developed for the micro or firm level. Thus there are really two gaps rather than one in our general need for theoretical concepts and analytical tools. An overall prescription can be written in the following form. A major problem of development of supply functions lies in mastering the problems of aggregation of supply functions. A major problem of demand function development lies in mastering the problems of disaggregation. These are not just problems of empirical weights and index numbers but also problems of meaningful empirical specification of intermediate market organization as well as a theoretical explanation of what is happening in the process of aggregation. The author believes the most profitable line of attack on this problem is through direct specification of the structure of production (market firm) and demand that lies between the farm and the consumer. A tall order and not something that we will see done very quickly. However, let us look at some parts of the problem.

National Demand Aggregates

If it pretends to any significant degree of reality, the least an adjustment study can do is to involve an aggregative statement of demand relationships. Only in this fashion can the price effect of net changes in aggregate production be evaluated, even crudely.

Since we are, perforce, limited to comparative statics as a technique of analysis, we must produce a number of macro demand relationships identified in time with the adjustment periods selected for the related supply models. These must be basically synthetic functions but to the extent that it is possible they should be derived from available empirical demand analysis. For dairy, the industry with which the

[6] At least two forms of time are involved, regular chronological time and the more elusive and functional economic time, such as that of Marshall's traditional three periods of "run." One of the great difficulties of time in an adjustment framework is the necessity to relate in a meaningful, quantitative, and theoretical fashion the different forms of time.

author has been concerned at the time of this writing, Anthony Rojko's work (10) could be adapted to this purpose. For many commodities and industries, nothing as developed as Rojko's analysis of demand is available. Even at the level where the most demand work has been done, the macro level, there are gaps in both analysis and data for many commodities.

Basic demand data and demand functions are usually cast at the retail level, supply functions at the farm level. This is the micro-macro problem, but note the integrative problem it causes in developing analytical structures for adjustment purposes. One function must be translated to the other structural level. The point is that this involves some rather complex problems that are not avoided by the oft used technique of applying, as a single constant shifter, farm-to-retail price margins. Our mythologies to the contrary, margins do change with volume. Nor does assuming one function in an entirely synthetic form solve any empirical problems. The nature of demand for a specific commodity at the farm is as much dependent upon the organization, techniques and behavior of processing, transport, storage, and retailing as it is of basic consumer tastes and demand at retail. Farm adjustments to the market are thus as much adjustments to these former factors as to basic consumer demand.

Regional Aggregates and Data Problems

The very act of regionalization of analysis creates a problem in itself. In some degree regional boundaries are necessarily arbitrary. This is a weakness in any regional model. Until one can specify the boundaries of regions in a systematic fashion from within the model, research results are subject to the qualification that another equally satisfactory (by the criteria of the model), but different equilibrium could be obtained from a different and probably no more arbitrary set of regional boundaries. Aggregation problems make this difficulty more intense. The "most logical" regional structure for one industry is not necessarily the most logical for another. Yet the same regionalization must normally be used for both if they are to be aggregated directly.

Another problem in the eternal tension between computational capacity and the degree of differentiation of the usual spatial model lies in the fact that economic space exists between but not within regions. This drives one toward proliferation of regions in order to obtain greater empirical reality. Heady and Egbert's work (5) with a spatial model of grain production ended with coefficient matrices greater than 100 x 300 in order to obtain 104 regions in their U. S. model. But even at this level of differentiation the problem of an adequate level of empirical reality is obviously far from solved.

Farmers are rarely conscious of adjusting their operations to national conditions. They are conscious of and feel the effect of the

national market for their products through particular (usually local) market alternatives to which they may ship their products. Specification of the adjustment problem of farm firms in any particular production area is probably ideally expressed in terms of major local markets and local market structural interrelationships. One cannot begin to list the data needs involved in specifying local market structure. The complex of interdependence involved in some of these local markets is awing. In recent years in the area east of the Mississippi a significant change in milk prices in one major Federal Order milk market has rippled through the rest like a row of dominoes.

Further, the internal cost structures and organization of particular markets should be specified if the national and regional aggregate changes are to be translated accurately to the farm and into farm management data. Only under these conditions can the economic pressures on location of production be introduced as a dimension of the adjustment problem within a given market area. Adjustments as they take place at the intensive versus extensive margin of nonlabor resource use are of very real importance in forming farm management recommendations. As an enterprise moves away from the market it substitutes transport expenditures for rent expenditures; and at the same time because the price of land usually falls, it tends to substitute rent expenditures for other (excluding transport) expenditures. The costs resulting from many market functions are actually mixtures of discounts for space, time, and form preferences and are complex to handle.

Spatial models to date have stated spatial costs entirely in terms of the location of production directly relative to the location of consumption. This is often not an adequate representation even of spatial costs. The location of the intervening market functions where non-farm inputs are combined with the raw farm product should be specified to obtain an accurate minimum cost spatial equilibria.

General Types of Data Used

It is not difficult to classify the demand data most commonly used in handling analytical problems of the sort discussed above.

Historical price data are easily accessible for the national level and even for states. There are, of course, rarely any price data for regions larger than states although states may be aggregated rather easily to such regions. For areas smaller than states local prices can often be had but they are usually quite varied in quality and costly to obtain. Most local markets of any size will have records, but frequently only in sale lots; thus, much laborious work is needed if one is to obtain market prices for any period of time. Central market prices are usually reported in the Wall Street Journal and in newspapers published close to the market. Federal Order markets will usually have good files on such things as prices and volume.

Commodity data on flows between regions and between production areas and points of consumption are not easily had. Typically we use regional production data (actual) in combination with regional demand functions and data (synthetic) to arrive at imputed flows. The smaller the area of the region the more difficult it is to determine empirically the flows of commodities across regional boundaries. The carlot unload data available from a number of major markets is generally inadequate for this purpose. In a few commodities, trade sources and even trade publications have data of at least some use. Overall, however, it is difficult to visualize much improvement in present spatial flow data without major effort by the federal government to collect such data.

Data on transportation costs and alternatives will have to be obtained from varied sources for the different commodities. Transport cost studies are available for a few commodities and areas and types of transport. Undoubtedly in many instances one will be forced to go to major processors to obtain "estimates" of rate structures. One can go to the transportation companies themselves and to their rate books, but actual rate structures are so complicated that this is likely to be a rather costly and tedious process. However, if one needed only a limited number of rates between a few specific points this could be the best approach.

Processing costs and structure data are quite crucial to adjustment models. This type of data is not available in any easily accessible form or centralized location. Usually one is dependent upon the cooperation of industry sources, firms, trade associations, and trade publications. In a few instances studies of processing will provide some guides. In recent years increasing numbers of engineering-economic studies have been done in agricultural processing industries.[7] Such studies are usually the only source of processing firm input-output data which is well articulated for economic research.

Per capita consumption data for demand analysis is available for the United States but in general not for states. The 1955 USDA Household Food Consumption Study does provide data on consumption and income by four large regions of the United States.[8] There are also smaller USDA dietary studies for a number of cities and some rural areas which could be used as a basis for estimates of regional per capita consumption levels. This would be pretty much of a patch work empirically, and one might be better off, depending on how extensive the empirical data were, to develop regional demand functions from the traditional variables of disposable income, prices of the product and prices of close substitutes. Even this leaves out variables known to be

[7] These are almost exclusively the product of Bressler and Sammet of the University of California or of their former students. For one of the most highly developed examples see (2).

[8] The "1955 Household Food Consumption Survey" was planned and executed by the Institute of Home Economics in cooperation with other units of the United States Department of Agriculture and is published in a series of reports, fourteen of which have appeared to date.

important in explaining regional differences in consumption; for example, size and composition of families, age and sex composition of regional populations, race, and that inevitable residual, historically conditioned tastes. Harold Goldsmith, Robert Herrmann, and the author are working at Michigan State University with a portion of the original data cards from the USDA 1955 Household Food Consumption Survey. They are developing family compositional classes for the United States and four regions[9] which, along with other data, they hope to use in testing J. A. C. Brown's general hypothesis (1) concerning the relationship between age and sex composition of households, size of household, income, prices, and per capita consumption of specific foods.[10] This may also provide a means of very roughly estimating per capita consumption for states within the four regions using the empirically derived regional demand function and state data.

Snodgrass and French (11, 12) developed an interesting approach to estimating total state milk consumption figures using available income elasticities and disposable income. This is a rough estimate, to be sure, but it has more basis in empirical fact than most efforts so far. The technique could be used for other commodities.

THE USE OF SPATIAL MODELS

Without some comment on the analytical forms in which data are used in regional adjustment analyses, observations on data mean much less than they might. This is particularly so since it has been necessary to cast this paper in terms of farm products generally rather than specific commodities. No one really needs to be told that the analytical and data problems of particular commodities are extremely varied.

There have been a number of interesting empirical efforts to develop spatial models in agriculture in recent years. The earlier efforts of Fox (3, 4) and Judge (7) were with spatial equilibrium models. More recently Snodgrass and French (12) as well as Henry and Bishop (6) applied the transportation model of programming to milk and to broilers. In 1958 Judge and Wallace (8, 13) built a spatial equilibrium model for beef. And in 1959 Heady and Egbert (5) published a general linear programming allocation model analyzing feed and food grain production location.

There should be no need to review these in any detail since C. B. Baker has done so elsewhere in this volume. However, some of the general characteristics of these models as they relate to analysis of adjustment problems should be made clear.

There are three apparent types of models here: the spatial equilibrium models of Samuelson-Enke genesis, the so-called transportation model from linear programming, and the general linear

[9] Northeast, North Central, South, and West.

[10] Brown's formulation seemed to test out fairly well on post World War II English data.

programming allocation model. The differences between these models are more apparent than real. The transportation model is a mathematical subset of the Samuelson-Enke spatial equilibrium model. Both the spatial equilibrium model and the entire linear programming approach were developed from the more general mathematics of activity analysis. And, of course, the transportation model differs from the general resource allocation model of linear programming only in computational procedure, not in the basic mathematical formulation. Thus, these models are more alike than different.

Elegant and logical as these models are, empirically they remain severe abstractions in their present state of development. The Heady-Egbert regional grain production model demonstrates the computational and other difficulties intrinsic in moving toward greater differentiation and empirical content. This model contained 104 producing regions as compared to 48 in the Snodgrass-French model and 21 in the Judge-Wallace model. With 104 regions Heady and Egbert were handling coefficient matrices of over 100 x 300 in order. But despite this admirable and massive effort to improve the empirical capacity of this type of model, Heady and Egbert still end up with results that are too aggregate and of clearly limited empirical value. It is a valiant effort, however, and the result is very instructive, for it seems to demonstrate quite clearly the need for specifying in one's analysis the major functional sections of the intervening market structure.

These models are highly synthetic, the Judge-Wallace model perhaps most so. This is due only in part to data limitations. It is in the nature of things that some "predetermined" variables of the analysis are not susceptible of empirical predetermination. A major difference in models is to be noted in the fact that problems of production are not a part of the Judge-Wallace or Snodgrass-French models. Thus no analysis of price-supply response is possible. In the Heady-Egbert model the production-resource problem is the central feature of the analysis. Heady and Egbert on the other hand do not handle the transportation problem, although, as they and others have pointed out, transport costs could be included as a production cost in the standard programming model.

In their present stage of development, all of the types of models described above end with rather unreal empirical conclusions. The reasons for this differ with the models but the models share an important limitation that is at least partly responsible. All implicitly assume a perfect or near perfectly competitive economic world. Institutional restraints and imperfect markets explain much of the actual pattern of production location, prices, and interregional commodity flow. Realization of this limitation is particularly important if analysis of adjustment is one's objective. It is instructive to note that the policy proposals of Cochrane and others imply that we are badly off base in using unqualified competitive models in analyzing agriculture's present major policy problems.

Both the transportation and production problem must be a part of

any spatial or regional framework for adjustment analysis. But this cannot be where one stops, for none of these models may be described as adequate for handling the analytical problems of analysis of the adjustment process. Increasingly many of the intellectual and practical problems of science in our generation seem to be those of understanding "process" and the structures associated with "process" (14). Comparative statics and the dating of variables is about as close as one now can get to the analytical dynamics required for any reasonably complete understanding of "process". Even the present tools of comparative statics in many instances are more highly developed than much of the empirical data to which they are applied. This is true both of the production as well as the demand and market structure data used in the spatial models cited above.

Giving up some of the rigor of single system models (such as the spatial models above) for a carefully tailored combination of models which would mesh in one or a few selected common variables or assumptions might be a profitable direction in which to experiment in our empirical research. An integrated sequential system of models should divide the research problem into more manageable pieces and allow one to obtain more sophisticated empirical content and thus probably greater predictive validity. The transportation model can be adapted to handle elements of market structure in addition to transportation costs. Technical change in functions of market structure can probably be handled, at least in a rough manner, within or in conjunction with a transportation model. The demand functions with which we face these models must have a better developed empirical basis than at present. Surely too, we can use the results of the resource allocation model for the product supply dimension of the transportation or spatial equilibrium models. Changes in one model would then be capable of being worked through the other and a price-supply response process of a limited sort would be simulated. It is a common characteristic of applied empirical research that many of the most productive frameworks are less elegant than the theoretical proto-types from which they come. This is not a suggestion that one flee rigor but rather that empirical problems be approached from more of a problem-solving point of view. We are somewhat prone today to be testing tools when we claim to be solving problems.

Any empirical bridging of the structure between the firm-household level and the national economy or macro level must be designed around a particular goal or limited set of research goals. Given the present state of the arts in agricultural economics research, when we say we wish to be able to draw meaningful conclusions adapted for agricultural policy purposes from such a framework, we should recognize that in so designing it we give up some of the potential capacity to draw a very wide range of farm management conclusions from the same model. The reverse is also true. Indeed, in connecting macro and micro levels in the same analysis, some capacity is given up at both levels in order to

make the structural connection. No finite construct or set of constructs has infinite capacity.

It is necessary to note in conclusion that the basic theoretical concepts through which the economist must view an adjustment problem are the major limitation to present research. The most urgent need is to develop such concepts, not the improvement of data or adaptation of analytical tools.

REFERENCES

1. Brown, J. A. C., "The consumption of food in relation to household composition and income," Econometrica, 22:444-60, 1954.
2. French, B. C., Sammett, L. L., and Bressler, R. G., "Economic efficiency in plant operations with special reference to the marketing of California pears," Hilgardia, 24:543-721, 1956.
3. Fox, Karl A., "A spatial equilibrium model of the livestock-feed economy," Econometrica, 21:547-66, 1953.
4. _____, and Taeuber, R. C., "Spatial equilibrium models of the livestock-feed economy," Amer. Econ. Rev., 45:584-608, 1955.
5. Heady, Earl O., and Egbert, Alvin C., "Programming regional adjustments in grain production to eliminate surpluses," Jour. Farm Econ., 41:718-33, 1959.
6. Henry, W. R., and Bishop, C. E., "North Carolina broilers in interregional competition," N. C. Agr. Exp. Sta., Agr. Econ. Info. Series 56, 1957.
7. Judge, George G., "A spatial equilibrium model for eggs," Conn. Agr. Exp. Sta. Bul. 318, 1956.
8. _____, and Wallace, T. D., "Estimation of spatial price equilibrium models," Jour. Farm Econ., 40:801-20, 1958.
9. Mathis, A. G., "The probable impact of milk concentrates on the fluid milk market," USDA Marketing Res. Rpt. 208, 1958.
10. Rojko, Anthony, "The demand and price structure for dairy products," USDA Tech. Bul. 1168, 1958.
11. Snodgrass, M. M., Linear Programming Approach to Optimum Resource Use in Dairying, unpublished Ph.D. thesis, Purdue Univ., 1956.
12. _____, and French, Charles E., "Linear programming approach to the study of interregional competition in dairying," Ind. Agr. Exp. Sta. Bul. 637, 1958.
13. Wallace, T. D., and Judge, George G., "Econometric analysis of the beef and pork sectors of the economy," Okla. Agr. Exp. Sta. Tech. Bul. 75, 1958.
14. Whitehead, A. N., Process and Reality, Humanities Press, New York, 1929.

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Discussion

IN CONSIDERING Bonnen's paper, I believe it is important to note particularly his characterization of the models discussed. He refers to them as models of the adjustment process. The adjustment process introduces a succession of time periods into the analysis. The succession of time periods extend into the future because he proposes to use

the models to predict "the interactions of the agricultural production process with the rest of the economic and social web of society." They are therefore models of integrated demand and supply structures, and would thus empirically bridge the entire structure between the farm and the household levels in the national economy. Both the production and the intervening market functions would be specified to obtain an accurate minimum cost spatial equilibrium.

He justifies broad scope in the models he proposes with the observation that "no consideration of the adjustment process or the problems of adjustment in agriculture is likely to be complete or realistic that does not explicitly include in its analysis the relevant structure of demand and the production process that connects the farm gate and the dinner table."

He recognizes that he identifies the characteristics that ideally should be associated with research in adjustment. He proposes an ideal model as a basis for a theoretical formulation of the research problem in a general equilibrium form before it is cut down to workable empirical size. I am in full agreement with this complete conceptualization of the research problem. I also agree that the cutting down should be carefully done without undue reference to use of a particular analytical tool or reference to shunning data problems.

When Bonnen turns from the general requirements of the models to how to meet these requirements in integrated analysis with empirical data, he joins most of us in finding progress difficult. Regionalization of the analysis is accepted as a first step in bridging the gap between the national aggregative and the farm-household level. A number of macro demand estimates that are identified in time with the adjustments periods selected for the related supply estimates must be made. These must be basically synthetic functions but they should be derived from available empirical demand analysis. Reference is made to several types of basic demand data, including prices, transportation costs, processing costs and structure data, interregional flows of commodities, and per capita consumption.

As to models, neither of the three in common use — transportation, Enke-Samuelson-Berkman spatial equilibrium, or general linear programming model — are considered to be adequate.

With further respect to models, Bonnen concludes that experiment would be profitable in the direction of giving up some of the completely systematic rigor of these present spatial models for "more eclectic combinations of models which mesh on one or two fronts, but obtain greater empirical content and sophistication and thus greater predictive value." Although I am not sure that I understand the implications of some of the words in this quoted suggestion, I believe we might all join in this proposal for further experimenting with model formulations and combinations. I suspect, however, that successful combinations of models cannot depart very far from a considerable degree of systematic rigor. Several suggestions were offered on how combinations might be made. This is the part of the paper that I hope will be expanded

in a further development of suggestions on how progress may be made in meeting this general problem.

I am going to close my remarks with further observations on Bonnen's final comment concerning the use of linear programming models for normative allocation of resources on representative farm strata for spatial aggregative purposes. The tendency has been, I believe, to overload the programming model with farm management alternatives that might well be decided outside the model from prior and more simple types of analyses. This applies particularly to a wide range in choice of production practices. We need to make more preliminary studies so that more judgments can be made on choices of alternatives and thereby simplify the programming models that are used for spatial aggregative studies.