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THE SUBSECTOR AS A CONCEPTUAL FRAMEWORK FOR GUIDING AND CONDUCTING RESEARCH

by

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In 1968, Jim Shaffer produced a set of idea-filled papers on economic research in which he suggested a need for programs of research having a "subsector" orientation /34,35,36/. A subsector was defined as "the vertical set of activities in the production and distribution of a closely related set of commodities" /35, p.3/. It differs from an industry in its inclusion of all vertical components as opposed to only horizontal activities. Shaffer argued that this type of orientation was required in order to evaluate the impacts of what he called the "scientific industrialization" of the food and fiber sector. He felt that the most critical problems and issues of the food industry were associated with this process. Division of the total system into subsectors would provide more manageable units of observation and still permit consideration of the vertical relationships that were essential in evaluating coordination and performance of the industry.[1/]

Shaffer's suggestion was viewed with approval and given further support at the 1968 Nebraska Seminar on Better Economic Research in the U.S. Food and Fiber Industry /51/. The following year subsector studies were recommended as a major area or program of research by the Joint USDA-SAES Task Force on A National Program of Research in Marketing and Competion /50/. Subsequently, there have been several efforts to develop this type of

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research orientation and it has been a much discussed topic at association meetings, seminars and workshops--for example, see /16,21,23,29, 32,52,53,54/.

Our purpose in this session is to review experience in developing subsector studies, to examine the emerging organizational concepts and research approaches and to appraise the future role and promise of this type of research program.

Dimensions of Subsector Research

Subsector studies mean (or have meant) different things to different people. For example, Langham and Polopolus stated that "from a theoretical point-of-view subsector analysis cannot be distinguished from systems analysis and does not therefore represent a new development" /21, p.2/. This view apparently was shared by Manchester who regarded the terms "systems research" and "subsector research" as synonymous /23, p. 1/. Shaffer, on the other hand, took a broader view. He suggested that subsector studies are "more of a departure in research organization than a departure from traditional approaches of agricultural economics research." He went on to say, "Closely tied to my perception of subsector studies is what I call a systems orientation"... "At the same time, I do not perceive subsector studies limited to particular methodologies" /37, p.333,334/.

What emerges is a two dimensional concept: (1) Subsector research systems, a way or organizing research, and (2) subsector systems research, a methodological approach in which a subsector is the unit of observation. We will need to keep these differences clearly in mind in evaluating the merits of subsector analysis.

Subsector Research Systems

Shaffer proposed that subsector studies be done by national consortiums, which in turn would organize special task forces as needed /34, p.4/. So far, actual organizational efforts appear to have fallen well short of the consortium concept. In fact, most published studies which focus on subsector systems (or some significant vertical component) have been developed on a more or less ad hoc basis and are widely dispersed among research agencies and researchers throughout the United States.

Probably the best known "group" effort is the hog-pork study involving ERS, Purdue University and Michigan State University. It will be discussed in a following paper by Candler and Manchester. Another sizable effort centers in the Dairy Group of ERS in cooperation with Pennsylvania State University and with inputs from some other states. Several other ERS subsector systems studies are still largely in the planning stage. They include beef, eggs, coarse grains and cotton /23,43/.

There are two subsector projects organized on a regional basis: SM 46 on vegetables in the South (primarily fresh tomatoes) and NC 104 on grain marketing. I probably should also note the series of special team studies on marketing apples, canning peaches, pork, eggs, and potatoes undertaken in 1972 /41,42,45,47,48/. Although sponsored by the USDA, the teams included representatives from a number of federal and state agencies.

Appraisal Framework

To develop a framework for appraising these and other potential subsector organizational efforts, I drew on the stimulating book by C. West Churchman, The Design of Inquiring Systems /5/. Churchman suggests nine necessary conditions for something to be conceived as a system. Very

briefly, a system must be goal seeking; have a measure of performance; have a client whose interests are served by the system; have components which are goal seeking and coproduce the measure of system performance; have an environment which also coproduces the measure of performance; involve a decision maker who can produce changes in the measure of system performance; and have a designer who conceptualizes the nature of the system and whose intention is to change the system to maximize its value to the client. Churchman notes finally that there must be a built in guarantee that the designer's intention is ultimately realizable /5,p. 43/.

Applying these conditions to subsector research, we obtain the following system specifications.

1. The goals of subsector research are a subset of the larger set of goals of economic research generally. The particular goals of subsector studies were specified by the 1969 Joint Task Force on Marketing and Competition as: To "improve our understanding of how the subsector is now organized and functioning" and to "increase our knowledge of why and how the system is changing, what the sources of change are, and where such change is taking us" /50, p. 18/. These goals were given a more clinical focus by Shaffer who viewed the objective as "to identify barriers to improved performance and problems of participants in the subsector and attempt to identify the means to remove the barriers or solve the perceived problems" /35, p. 6/.
2. The performance of the inquiring system should be measured by how well it serves the client's interests. Since we always begin with some prior information about the issues of concern, the appropriate

measure of research system performance is the value to the client of the additional imperfect information generated by the research, evaluated in a Bayesian sense.[2/] Because of the great difficulties in developing such measures, performance has been measured in practice by the collective subjective judgment of the community of scientists and research administrators.

3. The client consists of decision makers within the subsector economic system and people charged with making and carrying out public policies with respect to the food and fiber system.
4. The components are the various projects or program areas of research within the subsector framework; subcomponents are the individual researchers or research teams.
5. The research environment consists of the complex of laws and regulations and budgetary and social constraints plus educational and research policies dictated by university trustees, administrators, foundations, government agencies and legislators.
6. The decision maker is a team of economists and possibly other scientists and research administrators.
7. The designer may be the same as 6 or special planning committees, task forces and individuals such as Shaffer.
8. The various study groups plan to develop the organization of the inquiring system to maximize its benefits to the client.
9. Condition 9 is assumed.

Examination of efforts (and non-efforts) to organize subsector inquiring systems in accordance with the above specifications reveals some significant design deficiencies. Of major concern are the client orientation, the delineation of components, the need for better research information systems, and the organization of decision-making teams.

Clients

Identification of clients is very difficult. In designing an inquiring system supported by public funds it is essential that the clients be selected so their goals are consistent with general social goals. Furthermore, to be most effective, the research plan should carefully consider how the information generated fits into the clients' decision system and how it will be used. Judging from published studies, this aspect of system design deserves much greater consideration. We shall return to this point in the discussion of research methodology.

Components

There seems to be general agreement that subsector study components should be specified so they contribute to an overall conceptual model capable of analyzing problems that require consideration of the total subsector. Yet examination of some of the types of subprograms actually proposed (e.g. by the Joint Task Force on Marketing and Competition /50, p. 19-21/), suggests a rather loose collection of studies with no clear indication of how they will tie together. The conceptualization of the whole seems to have been neglected. On the other hand, when we examine efforts to model total systems it is often difficult to see the contributions of building block studies.

One of the reasons for this apparent disparity is the failure to distinguish clearly between subsector systems analysis and the subsector as a focal point for accumulating research results and developing a research information system. The two concepts require different component structures. Subsector systems analysis, in particular, requires that

subprojects fit tightly and contribute directly to the model of the total system. Failure to maintain this distinction may lead to confusion and frustration.

Research Information Systems

I would not argue that all subsector research needs to be carried out by consortiums or task forces, particularly when dealing with minor commodities such as (say) Brussels sprouts. However, there is certainly need for better coordination and information exchange. Even in the subsectors for which ERS has assumed some leadership, the coordination remains informal and does not extend far enough.

One means of improving the performance of the inquiring system would be to have each of the eight commodity program groups of ERS take on the responsibility of becoming national economic research information centers for their particular commodities. This is an extension of the "desk" concept first advocated by Shaffer, but apparently never taken very seriously (see/34, p. 25/). However, at the time Shaffer made his suggestions, ERS was not organized along subsector lines, so it would have been necessary to impose a new structure on top of the existing one, which might have been quite cumbersome to operate. With the new organizational structure of ERS, Shaffer's idea seems much more feasible.

The activities of these Centers would tie in very closely with what goes on now in the related organizational units. What would be added is a formal professional responsibility for each commodity group to be aware of all research and education related activities pertinent to their area. That means knowing about relevant programs and people in all universities (land grant or otherwise), in other branches of government, in various

trade associations and to the extent possible, with private industry. Close ties of the subsector staffs with CSRS would be desirable and would provide a means of making the CRIS system more effective.

The major vehicle for coordination and communication would be a set of annual reports on research in each subsector area. For example, the Dairy Group would publish an annual report on economic research in the dairy industry; the Poultry Group, a similar report on poultry research, and so on. Each report would have an appendix containing information on people, agencies, projects, special information sources and other such data for the subsector. After the initial effort, it should not be difficult to keep the appendices up to date.

Eventually, I think this effort to develop an improved research information system would evolve into Centers which would offer substantial guidance and catalytic influence on the development of subsector study programs. This would be a useful development regardless of the conclusions we might reach about subsector studies as such. Moreover, the information center concept appears to have merit for functional areas as well, such as market development, distribution analysis or farm inputs and finance.[3/]

Teams

Another meritorious development would be the establishment of some subsector research teams (as has been previously advocated by many others), perhaps along the lines of the new NC 117 proposal on "Organization and Control of the U.S. Food Production and Distribution System." They would be interregional rather than regional in nature. A key factor would be to have most of the research team located at one place and given a reasonable

period of time--perhaps 2 or 3 years--to develop the study, with provision for continuation of successful efforts. The greatest potential payoff seems likely to be in the more institutionalized subsectors. Again, this type of effort is likely to have merit regardless of our conclusions about subsector systems analysis as such.[4/]

Subsector Systems Research

We turn now to the methodology of subsector studies. To provide a frame of reference, we need first to determine the kinds of questions or problems pertinent to subsector analysis. By confronting the set of problem areas with the relevant set of available modeling techniques, we may be better able to evaluate the advantages and limitations of various research approaches or mixes of approaches.

Problem Definition

In an address to the Southern Agricultural Economics Association a few years ago, Bill Manley expressed concern about "the vagueness and lack of coordination in recognizing, identifying and defining research problems" /24, p. 3/. Although we may have made some progress in this regard during the past several years, it remains a point of concern. What often seems to be lacking is a clear specification of the instruments of change to be considered, the range of choice open to decision makers and the performance measures that can be generated by the research process. Bearing this in mind, it seems to me that most researchable issues pertaining to subsectors involve determining how various measures of system performance are affected by instruments of change falling in one or another of six classes, as shown in Table 1.

In the examples column, groups 1, 2, 4 and 5 list things about which decisions are made within the system and groups 3 and 6, things which act on the system. This is the familiar distinction between endogenous and exogenous variables and is subject to some change, depending on the specification of the system. Classes 1 and 2 may overlap. The main difference is that 1 is concerned with conscious efforts to redesign the subsector system while class 2 traces (or projects) the impacts of evolving changes in the system.

The column of performance measures lists the kinds of information our economic research seems capable of generating. For decision purposes, these measures need to be related to broader social goals such as efficiency, progressiveness, equity and other values. Success in quantifying these relationships has so far been limited.[5/]

Research Approaches

Although Shaffer indicated that he did not perceive subsector studies limited to particular methodologies, it is possible to identify a particular set of models or approaches that have been used or advocated for subsector analysis. I have grouped these into four qualitative and four quantitative classes.[6/] Brief descriptions and examples follow.

A. Qualitative or descriptive studies.

1. Base studies: Include efforts to identify problems, describe subsector activities and pull together what is known about the parameters of the system. Examples: Southern rice industry /11/; pork industry /32/; dairy industry /44/; beef industry /39/.

2. Analagous experience: Proposed by Hildreth, Krause and Nelson /16/. The idea is to generalize for one subsector from an in-depth appraisal to another. Previous applications unknown.

Table 1. A Classification of Research Issues for Subsector Analysis

Instrument of Change		Primary performance measures
General class	Examples	
1. System design	Size, number, location of plants at different vertical levels; scheduling and coordination systems for flows of activities and materials.	Costs, output, concentration.
2. Technology, business practice	Innovations, ownership patterns, corporate or cooperative structures.	Costs, prices, plant locations, plant size, employment, output, firm growth, stability of outputs and returns.
3. Regulations	Taxes, pollution, use of chemicals, insecticides, drugs, anti-trust, safety, property rules.	Costs, prices, output, plant size, locations of activities.
4. Production and marketing controls	Market order provisions, supply controls, grades and standards, administered pricing programs.	Prices, output, costs, distribution of returns, price and return variability, concentration.
5. Tranfer arrangements	Contracts, bargaining, information systems, other transaction systems.	Prices to participant groups, costs, market concentration, profits stability of prices and returns.
6. Demand parmeters and input markets	Shifts in tastes, substitutes, export markets, socio-economic factors, input prices and availability, transportation costs.	Prices, outputs.

3. Delphi approach: Also suggested by Hildreth, Krause and Nelson /16/. It involves bringing a range of expert opinion to bear on the issues of concern. Examples: Marketing team studies on apples /41/; canning peaches /42/; eggs /45/; pork /47/; potatoes /48/.

4. Systems analytic description: Close to base models. It examines the subsector in depth within a systems taxonomy. From this an effort is made to identify forces of change and to suggest desirable adjustments (the Harvard Business School approach). See Goldberg /12/, wheat, soybeans, oranges; Arthur, Houck and Beckford /1/, bananas; Marion and Arthur /26/, broilers; Morrissy /29/, fruits and vegetables.

B. Quantitative models.

1. Design models: Show how the subsector system (or some significant part) might be reorganized to reduce costs and increase profits. Linear and non-linear programming are the major tools. They include optimum number, size and location models for plants and activities (overlapping area efficiency and interregional competition models) and coordination models which determine when and in what quantities and qualities products should be procured, produced and sold in an integrated system. Examples: Holder, Shaw and Snyder /17/, rice; Leath and Blakley /22/, grain; Bell et al /4/, fertilizer; Snyder and Candler /38/, hogs; Belden and Schrader /3/, turkeys.

2. Comparative static models: Show equilibrium positions of industries before and after varying one of the instruments of change (see Baumol /2/). Previous subsector applications are unknown.

3. Dynamic econometric models: Market oriented supply-demand models of commodity systems for which parameters are estimated by econometric (stochastic) methods. Examples: Hallberg /13/ (in progress), dairy; French and Matsumoto /9/, Brussels sprouts; Crom /6/, beef and pork; Rausser /31/, oranges; Houck, Ryan, and Subotnik /18/, soybeans. Mann /25/, tobacco. For additional references see Johnson and Rausser, AAEA article /19/.

4. General systems simulation: Distinguished from econometric simulation by its greater detail and flexible approach to estimating parameters of the equations of the system.[7/] There are many variants, including micro-dynamic models (still rare) which may simulate behavior of individual decision units in modeling the total system. For references see Johnson and Rausser AAEA review article /19/. Examples of micro-dynamic models are Duewer and Maki /8/, meat products and Desai /7/, dairy industry.

Evaluation of Approaches

Table 2 suggests the range of applicability of the several research approaches to the six problem areas outlined in Table 1. The exact placement of the X's might be disputed. For example, design models (B1) might show how an optimal system would be affected by instruments of change in classes 2, 3, 4, 5 and 6. However, this has so far not been a primary application of these models. In any case, it is clearly evident that there are several ways to approach most of the economic issues pertaining to subsectors. I shall comment briefly on the strengths and limitations of these alternative methods as they relate to the issue classes in Table 1.

Table 2. Applicability of Research Approaches to Problem Areas

Problem area	Research approach							
	A1	A2	A3	A4	B1	B2	B3	B4
1	X				X			
2	X	X	X	X		X		X
3	X	X	X	X		X	X	X
4	X	X	X	X			X	X
5	X	X	X	X				X
6	X			?		X	X	X

Base studies are applicable to all classes of issues. A thorough understanding of the system is an obvious requisite for further analytical models. This phase of subsector work seems fairly well developed. The problem is that we often have difficulty in moving on into quantitative synthesis.

Delphi and systems analytic approaches may be particularly useful where the time requirement for obtaining results does not permit the development of quantitative models or where we simply are unable to estimate such models. Based on the applications to date, the Delphi approach seems better adapted to problem definition than solutions. The systems analytic approach applies a more rigorous qualitative framework and seems worthy of further development. One of its limitations, at least in the studies cited above, is the difficulty in sorting out the analytical conclusions.

The possible uses of analogous experience seem fairly limited.

The state of design model development is well advanced. We have the capacity to provide generally good measures of potential gains from improved coordination, location, size and number of facilities in centralized marketing systems. The research information may also provide indicators of possible incentives for integration or other organizational changes in the subsector. The problem with many of these studies is that they do not have clearly specified clients with the power to implement the study findings. Such studies cannot have much impact.

With the development of dynamics and simulation, comparative statics seems to have fallen into disuse. However, in view of the problems encountered in measuring many types of behavioral parameters in dynamic models, perhaps we should not bury it yet. In particular, it may be a useful way to evaluate shifts due to new innovations or changes in demand

parameters. In cases where dynamic models yield highly uncertain time paths, comparative statics may still provide an indication of the likely final impact.

Dynamic econometric models seem most suited to issues in classes 3, 4, 6 and might be a part of the framework of 5. Probably more effort has gone into this type of subsector study than any other. Measured in terms of our ability to predict beyond the range of historical observation, the results have so far been considerably less than spectacular. While there remains much that might be done by imaginative conceptualization and measurement, the potential of this approach is greatly limited by inadequate or non-existent data. The data situation becomes even more crucial as we focus on higher vertical components of the subsector. With the exception of some highly restricted retail and wholesale price series, no agency collects and tabulates price and quantity data beyond the first handler on a systematic scientific basis. We clearly need to develop new and better data sources for prices, costs and product movements throughout the system.

General systems simulation is probably what most people have in mind when they refer to subsector systems analysis. Yet, I am unaware of any operational applications of general systems simulation to subsectors. By "operational" I mean a model completed, tested, applied and found useful. The most extensive application in agriculture is the Michigan State University sector modeling effort in Nigeria and Korea /20, 27/. This might be viewed as potentially an excellent approach for subsector analysis. There are, however, several points to keep in mind in transferring this experience.

First, this type of study is very costly. The MSU simulation team estimates that with a conceptual framework already available, the cost of

modeling a developing country about the size and complexity of Nigeria would be about $300,000 (in 1970 dollars) plus the cost of continued operation /27, p. 348/. Costs for modeling a major U.S. subsector could be higher.

Second, the MSU studies were developed for a clearly defined client (government planners) to fulfill a felt need for information to aid in making specific policy decisions. They were able to interact with their clients and to obtain their support (or at least avoid barriers) in seeking needed information. These conditions obtain to a much lesser degree in most U.S. subsectors.

Finally, although the MSU studies are very well conceptualized, many parameter estimates are subject to considerable uncertainty, a problem not likely to be avoided in similar studies of U.S. subsectors. The behavioral and competitive parameters which Shaffer felt were so important have proved especially difficult to quantify and to test. At this point our capacity to conceptualize and computerize greatly exceeds our capacity to measure.

In view of the variety of issues pertaining to subsectors and the limitations and special characteristics of the possible research methods and approaches, it is clear that there is no such thing as "subsector methodology." Furthermore, although all of the approaches described focus on total systems, it does not seem appropriate to regard subsector analysis as identical with systems analysis, except under an extremely broad and aggregative definition of systems analysis. The research method must be selected in accordance with the demands of the problem (or expected set of problems), the time available, the prior information and data available, and the special interests and talents of the researchers.

Future Role and Promise

Most of the previous discussion has been an elaboration and systems specification of Shaffer's concept of subsector studies. Although several weaknesses were noted in the design characteristics and the methodology of actual subsector research efforts, nothing has been said that would invalidate the concept itself. The issue for the future is not whether subsector studies may be needed, but the importance and place of such studies among other research programs pertaining to the food and fiber sector and how we organize to conduct them.

Many problems associated with subsectors, perhaps most, do not require that we deal with the full array of vertical subsystems. And as we move higher in the vertical system, it becomes increasingly difficult to maintain a meaningful commodity separation. Moreover, the 50 or so subsectors into which the food and fiber sector might be partitioned vary widely in importance, in institutional structures, and in their potential as objects of useful economic research. The result is that although much of our research needs to be systems oriented, to include vertical structures and to relate to particular commodities, the dominant focus seems likely to be on issues rather than commodity subsectors as such.

The major benefits of a subsector framework seem likely to derive from its role as a focal point for the accumulation of research results and the structuring of research information systems. This type of coordinating orientation may reveal holes and duplication of effort, lead to improve planning and have a general synergistic effect on research pertaining to the subsector.

As a final point, I would stress the fact that I am not suggesting we abandon efforts to develop useful models of total subsectors. However, we should recognize that much of the quantitative analysis in this area is still in a pioneering stage that might best be viewed partially in the context of basic or perhaps "intermediate" research. Judging future performance in terms only of the past record or some expectation of early accomplishment may prove disappointing and lead to premature rejection of some potentially useful approaches.

Footnotes

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1/ For further development of the reasons for increasing concern with vertical structures and subsectors, see Hildreth, Krause and Nelson /16/.

2/ There is a large body of literature dealing with decision making under uncertainty and the Bayesian approach to the problem of inference and decision. For illustrations relating to agriculture see Halter and Dean /14/.

3/ For additional development of these ideas see French /10/.

4. For further discussion of the benefits of group research, see Henderson, Bell, and Perkins /15/.

5/ For discussion of such measures, see Marion and Handy /27/.

6/ This distinction is not strictly accurate since qualitative models may rely on various kinds of data. However, the qualitative approaches do not use formal systems models.

7/ For a comparison of econometric and general simulation approaches, see /28, p.17-37/.

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