Proceedings of Workshop on:

AGRICULTURAL AND RURAL DATA

May 4-6, 1977

Jointly Sponsored by:

Economic Statistics Committee, American Agricultural Economics Association

Statistical Reporting Service, USDA

Economic Research Service, USDA

Agricultural Marketing Service, USDA

Series A

PREFACE

To overcome obsolescence of data, a series of papers dealing with the conceptual and operational foundations of major data systems was commissioned by the Economic Statistics Committee of the American Agricultural Economics Association in conjunction with the Statistical Reporting Service, Economic Research Service and Agricultural Marketing Service of the U. S. Department of Agriculture. These papers were presented and discussed extensively at an Agricultural and Rural Data Workshop held in Washington, D. C. May 4-6, 1977.

Papers were subsequently revised and are being published in the two Series in which they were organized. Papers prepared by teams in Series A (W. E. Kibler, leader) on Price Reporting and the Capacity of the Food and Fiber Systems are contained in this publication.1/ Papers prepared by teams in Series B (Gaylord Worden, leader) on Indicators of Economic Well-being of People Engaged in Farming, and Data for Farm and Rural Employment are contained in a separate publication.2/

The papers deserve much study--they were carefully prepared by professionals highly qualified to deal with the conceptual and operational issues in data systems where serious data gaps and obsolescence are promiment. The papers will be little more than an academic exercise unless recommendations are used by administrators and policymakers to improve the respective data systems which they address. Many of the recommendations can be implemented with little or no additional resources. In cases where additional funds are required, it is the teams' judgments that the additional resources required will provide benefits to users in excess of costs.

Luther Tweeten, Chairman
Economic Statistics Committee

1/ Single copies of the Series A papers are available upon request from W. E. Kibler, Administrator, Statistical Reporting Service, USDA, Washington, D. C. 20250, or phone (202) 447-2707.

2/ Single copies of the Series B papers are available upon request from U. S. Department of Agriculture, Economic Research Service, Information Division, Publications Services, Washington, D. C. 20250, or phone (202) 447-7255.

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Series A

CONCEPTS OF PRICE: IMPLICATIONS FOR AGRICULTURAL DATA COLLECTION

by

James P. Houck*

"So the price may be tossed hither and thither like a shuttlecock . . ."

Alfred Marshall

In one way or another, virtually all of economic theory and most of economic life is organized around value, and, hence, prices. We deal with and think about prices so often and so routinely that many of us would be embarrassed if someone wakened us suddenly in the night demanding a definition of the term "price." Probably this is as true of economists and statisticians as of other mortals. So the goal of this paper is to review some of the basic concepts, functions, and roles of price in economic organization. Both theoretical and empirical aspects will be considered. However, this paper is not an excursion into mathematical economic theory or deep analysis. Nor will it be an exhaustive discussion of actual price reporting. The main idea will be to focus on some of the conceptual tools which have a bearing on the collection of agricultural price data and upon the appropriate informational content of these data.

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*Professor, Department of Agricultural and Applied Economics, University of Minnesota. This paper was prepared for the Agricultural and Rural Data Workshop, Washington, D. C., May 4-6, 1977.

Definitions of Price

A rather common definition of a price is, "The exchange value of one unit of a good or service, expressed in terms of money." This is a serviceable statement although some might argue that it is too long, and others might argue that it is too short. In the first instance, prices in a fully barter-economy are not expressed in terms of money (or any other single commodity). So neither the existence of money nor the recognition of a numeraire is essential to having prices but only adds a measure of convenience for economic participants.

While these definitions are useful in the classroom and in general discussion, a broader and more comprehensive view is probably appropriate when we are actually buying and selling things. Such a definition of price might be, "the exchange value of one unit of a clearly-defined good or service, expressed in terms of money at some particular time and place and under specific conditions of transfer."[1/]

Under this definition, exchange transactions need not actually occur for a price to have meaning, but a potential ownership (or use) transfer of the priced item is clearly implied. Each of the conditions needed to define a price under the extended definition becomes important when a real world price-reporting system is designed and operated by a government agency or when price data is gathered for use by a firm or an individual.

[1/] This definition is basically a streamlined version of Alfred Marshall's statement, "the exchange value, of one thing in terms of another at any place and time, is the amount of that second thing which can be got there and then in exchange for the first." (Marshall, p. 51.)

To be complete, we might also consider the more fundamental definition of price as "the terms on which alternatives are offered." This reflects Wicksteed's generic concept of price, and it applies to all situations in which an economic problem involving choice is confronted. (Wicksteed, pp. 21-27.) Prices in this sense arise whether or not formal exchange occurs, whether or not money is in evidence, and whether or not open markets exist. Generic prices can exist in an open market, in a one-person Robinson Crusoe economy, or in a large industrial firm having several operating divisions. The key to whether or not prices develop in this broader context, either as money rates of exchange or as implicit possibilities of choice among alternatives, is the potential of substitution. Thus, prices, broadly defined, develop whenever one production or consumption surface (or set) confronts another and some substitution is possible. (Lange and Taylor, pp. 59-61.) This confrontation can occur across a market where ownership is transferred, it can occur within a single firm, or within a single individual.

The Functions of Prices

Prices may perform some or all of three major functions in any economy or market no matter how it is organized. These functions can be identified in either the abstract setting of economic theory or the reality of actual markets. They can be termed the "allocative," "distributive," and "equilibrating" functions.

Allocative Function

It is somewhat trite to say that prices act as signals in an economy. But this signaling concept lies at the heart of most allocation decisions.

In any economy in which the allocation of productive resources and output utilization are not centrally controlled by a command hierarchy, price ratios (or their equivalent marginal values) play a key role. In both theory and actuality, the changing size of price ratios faced by decision-makers guides rational choice in all but the very long run.

Consider a simple illustration from theory. For a small firm in an open market, the profit-maximizing mix of two productive factors is found by choosing amounts of each such that (1) the ratio of their marginal products is equal to the ratio of their prices and (2) the ratio of each input price to the product price is equal to that input's marginal product. This role of price ratios or relative prices is crucial to allocation when decision-makers are seeking to optimize among various opportunities. To some, this allocative function of prices is more clearly identified as the "optimizing" function.

Since price ratios, or functions of price ratios, perform the allocative function, the actual price levels or monetary units used are not important for this purpose.[2/] Consequently, price indexes, price relatives, or generic prices can perform this allocative role as well as prices expressed in typical monetary terms. For marginal allocative decisions to be signaled, prices need to change relative to each other

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[2/] If monopoly or some other form of imperfect competition is considered, functions of price ratios come into play. Marginal revenues and marginal costs replace prices in the allocative arena. However, these marginal values are functions of prices. For example, consider this well known expression for marginal revenue:

$$MR = P(1 + 1/\varepsilon)$$

where P is the product price and ε is the price elasticity of demand faced by the seller.

either over time, space, or form of product. The political-economic environment in which this occurs can be characterized by free-markets, centralized price controls, socialist control of industry, etc. As long as economic actors are free to make at least some allocative decisions based on two or more prices, this function can occur. Price data whose informational content accurately reflects changes in prices relative to one another over time, space, form, and perhaps other dimensions promote effective allocation decisions among those who use them.

Distributive Function

Although price levels are not central to most short-run allocation decisions, they are crucial in the distributive aspects of economic activity. Once allocative or optimizing decisions are made, then the size of monetary flows within an economic sector is determined by the level of prices and the volume of transactions. Wicksteed's generic notion of price has less relevance in this distributive role. Actual monetary levels and not relative sizes of prices become critical. The distributive function of price is most clearly observed in a monetized economic system with ownership (or use) transfers taking place across open markets or across clearly-defined exchange points within single organizations.[3/] Commodity traders, for example, are most interested in price ratios and the allocative role of prices. Accountants focus their attention on the distributive role of prices.

[3/] Lange and Taylor, in their classic monograph, argue that pure socialist economies would employ prices in their allocative role but rely on centralized decisions for the major distributive aspects of economic organization.

To illustrate the distributive function, imagine an industry with many small firms in profit-maximizing equilibrium subject to known technical constraints. If prices (per unit costs) of all productive resources used double along with the prices of all products sold, the optimal combination of inputs and outputs will not immediately change. But the flow of money profits will double as will the money flow of income to the owners of the resources employed. Depending upon how other prices in this economy change, the distribution of income in the society may be altered.

Naturally, both allocative and distributive processes are influenced by each price change, and it is difficult to isolate them except for discussion. However, price information highly sensitive to geography as well as to marketing or handling levels such as retail, wholesale, farm, dockside, f.o.b., *etc*. permits accurate calculations of how economic costs and rewards are distributed across people, places, functions, and time periods.

Equilibrating Function

Together, the allocative and distributive functions of price may perform a third role, the equilibrating function. In pure theory, an equilibrating set of prices can be viewed as the solution (or solutions) to specific diagrammatic or mathematical problems which embody both allocative and distributive features of economic activity. In the real world, prices perform an equilibrating function if they can change, either *via* market forces or central direction. Price changes in response to disequilibria such as emerging shortages or surpluses stimulate re-allocations of resources and expenditures. In addition, they may alter monetary flows to market participants. Theory and experience strongly demonstrate that these changes usually are in an equilibrating direction.

Where they are an operational part of a society's economic structure, prices will perform at least one of these functions, and possibly all three. Here in the United States, and especially today in the agricultural sector, prices carry the major allocative, distributive, and equilibrating functions.

Perceptions of Prices

Knowing what prices are and how they are perceived in both the abstract and concrete worlds may help to clarify our thoughts about the design and working of a useful price-measuring and price-reporting system. In this section, we try to step beyond their definitions and general functions to examine briefly how prices and price information are embedded in our economic theory and our actual experience.

Static Theory

In static economic theory, prices may be viewed as part of the solution set of specific diagrammatic or mathematical problems. They carry no temporal information. However, comparisons from one solution set to another, known as comparative statics, may suggest temporal adjustments in a "before and after" context. In static theory, prices are equilibrium values because they represent solutions which remain valid until one or more of the underlying functions of the problem changes. Then another solution set generally is implied.

In static general equilibrium theory, both allocative and distributive characteristics of the economic system under study are specified in such detail as warranted by the scope of analysis. The set of prices which brings production, consumption, costs, revenues, trade and incomes into overall balance (with or without a government sector) is the equilibrium solution for a given set of initial conditions. In the Walrasian context, the equilibrium set of prices for the solution of an n-commodity system involves (n-1) price ratios, with one commodity being assigned the role of numeraire. (Samuelson, Henderson and Quandt.)

In the familiar partial equilibrium setting, only a subset of products or markets is studied. Full conditions of economy-wide market-clearing, income-expenditure equality, and price determination are not required. Price solutions in this partial context need only meet the particular market-clearing and distributive constraints established in the problem itself.

In the allocation and optimization problems of economic theory, prices are viewed either as parameters to decision-makers in the firm or household or as outcomes of decisions based on given demand, supply, or cost functions. The prices and price ratios then emerge embedded in the optimization solutions as part of abstract values of Lagrangian multipliers attached to technical and economic constraints.

Dynamic Theory

The essence of dynamic theorizing is to introduce a formal bridge from one time period to another. Thus, the economic activity being studied in any one period can influence the theoretical system in one or more succeeding periods. In stochastic dynamic theories, random shocks occurring in any period also can produce ripples down through succeeding periods. Although analytical and mathematical complexities are vastly increased when dynamic elements are added to a static theory or when fully dynamic systems are constructed, the fidelity between the actual and the abstract worlds is increased if the dynamic components are sensible. Prices and price adjustments are specified in two main ways in dynamic theories most relevant to agriculture.

In the first case, markets are generally assumed to clear, one way or another, in each period. Each period's prices adjust to facilitate this clearing solution, and the system achieves equilibrium in a narrow sense. However, these prices, and possibly other variables, influence demand and supply responses in succeeding periods. This influence occurs directly or through adjustments in formally-specified "expectations" variables. These temporal adjustments in demand and supply plus any external changes or shocks that occur require prices to change so that market equilibrium in later periods can occur. In this way, the system moves through time and is dynamic.

In agricultural economics literature, the basic cobweb models are good examples of this kind of dynamics as are the various Nerlove lagged adjustment models. In this particular class of dynamic models, prices achieve equilibrium levels within each period.

A further elaboration of dynamic theory abandons period-to-period price equilibrium. Instead another formal statement is introduced into the theory to specify the nature and extent of feasible price adjustment from one period to the next. In commodity models, these "price-disequilibrium" systems generally do not achieve a market-clearing price equilibrium each period. Prices are continually out of equilibrium with someone either holding undesired inventory or short of desired inventory. (Labys.) The system crawls toward equilibrium from period to period as prices (and perhaps other variables) attain only partial adjustment to the conditions at hand.[4/] As the external conditions change or if random shocks occur, a new underlying equilibrium is generated toward which a dynamic disequilibrium system will move as rapidly as the specified adjustment conditions permit.

Commerce and Trade

In the context of this paper, one of the most important abstractions or simplifications introduced by economic theory is that, in either static or dynamic models, prices are typically analyzed as discrete values which change abruptly from one period to the next.[5/] Another common abstraction is that all prices are fully known and equalized over the relevant market. These simplifications arise because theoretical commodities are homogeneous and clearly-defined and because the introduction of imperfect knowledge seriously undermines the tractability of most theoretical systems. In the actual world of day-to-day commerce, prices of immediate concern to buyers and sellers are continuous entities, often subject to almost instantaneous change and sometimes open to bilateral negotiation. They are usually highly specific because of the special characteristics of location, quality, and terms of sale peculiar to each transaction. In

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[4/] Actually such a model may crawl (or leap) away from equilibrium if the system is inherently unstable. As with cobweb models, stability conditions hinge on the relative sizes of various structural elasticities.

[5/] In generalized dynamic theories, prices or price changes can be stated as continuous variables (Samuelson). Then differential equations are appropriate tools of analysis. However, in adapting dynamic theory for empirical research, discrete units of time typically are introduced to maintain workability and to accommodate available data.

cases of very high specificity, the lack of knowledge about price may be quite high even among sopisticated buyers and sellers.

From the point of view of buyers and sellers in the real world, prices discovered and faced in trading situations are highly particular and continuous in their existence even if they do not change frequently. They represent immediate financial opportunities rather than solutions to analytical problems. Actual prices faced by traders can be grasped and turned into revenue and cost experiences, or they can be noted and passed by. Either way, their very existence and perception provide perspective for decision-makers.

It is beyond the scope of this paper to deal fully with the perceptions of price in a variety of actual market settings. The literature on this subject is wide and deep, and other papers in this series will surely emphasize current issues in this area of study. Of special interest are the fragmented perceptions of price that seem to be occurring in markets where changes in technology and institutional structure are unraveling the traditional marketing and price-making networks. This fragmentation of price perception is consistent with the notions of "implicit" and "explicit" prices. (Paul, et al., 1967, Paul 1976, Houck 1967.) These ideas help to explain pricing problems with products and services under negotiated production contracts, vertical integration, and special forward delivery agreements.

For example, let A be a commodity of specific form, place, and time. Let B be a commodity of different form, place, or time which results from the application of additional resources to A. These resources (X) may be devoted to processing, transportation, storage, etc. Then the implicit price (P*) for any of these entities can be expressed as the difference between the explicit (or market) prices of the other two (Paul et al 1967).

$$P^*_X = P_A - P_B$$

$$P^*_A = P_B + P_X$$

$$P^*_B = P_A - P_X$$

If a market exists for all goods and services under consideration, then arbitrage and potential arbitrage would keep implicit and explicit prices in line with each other. Market prices would serve as guides to all implicit prices. No fragmentation of price perception would exist. Even in the situation where open market prices exist for two of the three prices in any of the above equations, the third can be priced implicitly with no real problem.

Fragmentation of price perception occurs when open market prices do not exist for two or more of the elements in an equation and yet their per unit values are of interest. Implicit pricing breaks down. This pricing phenomen occurs most readily in production projects when time lags are important (forward contracts may emerge) or when spot markets for particular commodities do not exist or are no longer active (vertical integration may be in evidence).

Economic Description, Planning, and Policy

If prices are perceived in theory as solutions to abstract problems and in daily commerce as expressions of immediate financial opportunity, how are prices perceived by those who describe the economy or those who conduct economic and social policy? Here, one might argue, prices are perceived as indicators of performance or measures of change in performance.

For this purpose, prices are viewed as per-unit monetary values by which to aggregate the quantity and worth of goods and services in the economy. Then calculations can be made and conclusions can be drawn about the size and distribution of incomes, costs, expenditures, gross output, inventories, taxes, etc. In this work, average or representative prices are needed to match the physical and temporal character of the quantity flows and stocks to be valued. These prices are indicators of the vastly more diverse set of prices generated by the myriad of individual transactions, detail not needed for useful description and planning.

Links between Theoretical Prices and Actual Prices

Price Determination and Price Discovery

A rudimentary but helpful view of the link between theory and practice is that the basic forces of supply and demand (perhaps altered by central authority) interact to determine equilibrium prices for whatever length of run is being considered. Then buyers, sellers, and information interact in ways constrained by law and custom to discover and use the equilibrium prices. The process is imperfect because knowledge is not perfect and, like market power, is unevenly distributed throughout society. Moreover, the equilibrium values determined by basic economic forces are always subject to change.

Economic theory helps us to understand the interaction of forces which form or determine equilibrium prices. It guides us in conducting empirical research to measure and predict these forces. Some elaborations of dynamic theory also provide a bit of insight into the day-to-day processes of price discovery. Yet the human activity of price discovery is much more subtle and complex than a comprehensive theory could hope to capture, except in small pieces. Consequently, actual prices always will reflect the uncertainties and random components of the price discovery process, unless prices are firmly established by central authority or are subject to tight control by monopolistic or oligopolistic forces.

Price Behavior

Although subject to uncertainty and perhaps control, actual prices of related agricultural products tend to move within narrow bands in relation to each other as the price discovery process continually unfolds. The theoretical principles of optimization, choice, substitution, and arbitrage provide powerful insight into the links that bind prices and price movements together across commodities, through marketing and processing levels, and over time.

Naturally the closeness and extent of these economic linkages is subject to change. But unless sudden economic, technological, or social upheavals occur, these linkages change slowly. The prevailing tendency for prices to be fundamentally interconnected has important implications for the number of prices that needs to be observed in actual markets in order to meet the needs of buyers, sellers, economic observers, and policy makers.

Collecting and Reporting Prices in Agriculture

The ideas and concepts sketched in the previous sections of this paper provide background for some further notions about collecting and reporting prices important to agriculture. What follows are largely subjective views, although they are based on these underlying concepts. These viewpoints are general in scope and certainly not exhaustive. Many important specifics are left for further discussion and analysis. This particular set of ideas relates primarily to the specification, collection, and reporting of prices by public agencies--the entire undertaking to be considered as a public good in behalf of society at large.

The Informational Content of Reported Prices

The information to be conveyed by collected and reported prices logically should be related to the major functions of prices--allocation, distribution, and equilibration. However, since the third function is basically a result of the first two, major attention can be focused on price information as it relates to the allocative and distributive functions. One important assumption in all of this is that the expenditure of public money, time, and effort to gather and disseminate accurate price information will promote the functioning of prices and the market system as a major allocative, distributive, and equilibrating force in our society. Another is that it is useful for public and private decision-makers to know about the performance of the economy over a broad spectrum.

Allocative information. Price data designed to promote short-run allocation decisions of buyers and sellers is mainly of the "market news" variety. Since no public or private market news service could hope to report all relevant prices on a regular basis, choices need to be made. The limited public information of this type to be conveyed should necessarily focus less on intricate specifics of place and exact form but more on market tone and the direction of price changes which are occurring. Whatever else it does, a public markets news service should help to alert private decision-makers whether or not markets today are generally stronger or weaker than yesterday or last week, where, and by roughly how much. Other institutions in the private sector can and do find it profitable to gather and distribute their own market news along with data generated by public sources.

Naturally, longer-run allocative decisions are based on information additional to market news. Other kinds of price information with a longer horizon also will affect resource and expenditure allocations. These are monthly, quarterly, and even annual price estimates or averages. Their function as allocative data blends into their function as distributive information.

Distributive information. Prices relating to periods longer than about a week have an important role as measures of economic performance and as indicators for longer-run allocation decisions. Prices reported weekly, monthly, quarterly, or annually are, by their very nature, either averages or representative selections.[6/] Only where centrally controlled by government, by specific contract, or by pervasive market power are these longer-term prices actual transaction opportunities appropriate for the entire period to which they refer.

Public institutions have a major responsibility to develop and report this kind of price information. At least two reasons undergird this view. First, the profit-seeking sector of the economy has much less incentive to accumulate carefully specified longer-run prices for its own benefit or for sale to clients. Secondly, wise public decision-

[6/] Whether or not public price reporting institutions should be committed to interpretive analysis of their data is left as an open question in this paper.

making usually hinges on good measures of current and past economic activity and performance. As with market news, not all possibly relevant prices can be gathered so difficult choices need to be made.

Some Specific Views on Priorities

The following are several specific points deliberately designed to provoke discussion. They are one individual's views and are presented in no special order.

1. The highest priorities for gathering and reporting agricultural price data should be attached to accurate monthly, quarterly, and annual average (or representative) prices. Market news is important but somewhat lower in priority.
2. The public responsibility for daily market news reporting should be focused where possible on the needs of small farmers and businessmen whose primary role is not market trading but production, processing, or physical handling.
3. Where possible, average per-unit returns over specified time periods, sampled with known statistical properties, should be the basis for reported prices--especially for distributive analyses. Highly specific representative prices (mid-month observations) probably are more subject to error and yet require more precise identification.
4. Priority in reporting market news prices should go to products for which daily or short-term allocation decisions are not only possible but customary for many buyers and sellers. Market tone and change should be a central element in market news along with prices for key products at important trading locations.

5. For commodities where the reality and the perception of price becomes highly fragmented because of vertical integration, production contracting, etc., short-run price reporting (daily or weekly) has little relevence and may not even be possible. Effort and priority should go into reasonable estimates of longer-term per unit values consistent with society's broader needs for distributive information.

6. However, decision-makers facing a fragmented price picture may need additional information from disinterested sources. Without attempting to minimize the difficulties involved, it is at least plausible to suggest that public agencies obtain and report regularly on items such as (1) the basic nature of crop production contracts being negotiated (2) the arrangements being used by integrators in the livestock feeding sector, and (3) the use of other special pricing provisions involving non-traditional ownership and use transfers in agriculture.

Conclusion

Mostly ideas in this paper are not new or original. They are presented as a series of reminders and as a possible starting point from which further discussion and elaboration might proceed. Prices are defined as both specific per unit money values and as broader indexes of terms on which alternatives are available. Where individual economic decision-makers have discretion, prices can perform allocative, distributive, and possibly equilibrating functions. Price information provided as a public good can facilitate these functions. It can also promote more accurate discussion about the performance of the economy and more sensible policy decisions by public officials.

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ECONOMIC STRUCTURE, PRICE DISCOVERY MECHANISMS AND THE INFORMATIONAL CONTENT AND NATURE OF USDA PRICES

by
Charles H. Riemenschneider, Research Assistant 1/
Department of Agricultural Economics
Michigan State University

As society changes, its problems and agenda of decisions change. Simultaneously the value of and hence the demand for information changes. During the 1950's and 1960's, farm policy and large surpluses in most U.S. agricultural commodities kept farm prices relatively stable. The consequent elimination of most market price uncertainty simplified price-related agricultural decisions and minimized the perceived need for any serious changes in the data system for agricultural prices. Throughout this period of stable prices and reduced market uncertainty, we underinvested in the agricultural data base while agriculture was undergoing many changes in its structure and in the nature of the public and private policy agenda (4).

In the early 1970's the depletion of commodity stocks and the return of free markets resulted in new variability and uncertainty for agricultural producers and policy-makers. These events of the last five years have catapulted agriculture to a prominence unprecedented in more than three decades. At the same time it has complicated the decision-making within this sector and the rising uncertainty has placed new demands on the information system in agriculture.

This recent sudden increased demand for information, brought on by the changes in U.S. and world agriculture, has disclosed a number of inadequacies of the current agricultural information system. Increased price variability since 1972 has made the price data systems especially subject to closer scrutiny. I hope this paper will provide some insight helpful in improving agricultural price data systems to meet the needs of decision-makers in a time of increased uncertainty.

1/ I am deeply indebted to Dr. James T. Bonnen and Mr. Ralph D. Christy for their assistance throughout the writing of this paper, from its inception to the revisions of this draft. They have provided a critical sounding board for ideas and their valuable intellectual insights have provided a basis for many of the thoughts expressed in this paper. I also wish to thank Dr. Lester V. Manderscheid, Mr. William E. Kibler, Mr. James L. Olson, and Dr. Walter J. Armbruster for their helpful comments on an earlier draft.

Before one can evaluate any government data system, one must answer a prior question. Under what circumstances should government collect any data for a particular economic sector? Differences between economic sectors lead to different demands for information for both public and private use and also affect the incentives for supplying information. However, to date, these differences have not been treated systematically. Despite their obvious influence they appear not to have entered consciously in the decisions which allocate public funds for data collection and analysis between different economic sectors. One of the first tasks of this paper will be to provide some insight into this question.

Two variables or relationships seem to be key in the design or redesign of any data system. The first of these is the configuration of the relevant economic sectors. Economic structure is the thread which ties much of this paper together. It affects the supply and demand for information in both the public and private sectors, has consequences for the distribution of income and information, alters the informational content of agricultural prices, and is related to many of the problems faced in operationalizing USDA price concepts and their measurement.

The second key theoretical relationship to be considered is that between the distribution of information and income distribution. Economists often concentrate on matters related to allocative efficiency while ignoring the important distributional issues. The effects of the distribution of information on the distribution of income are often neglected but in many instances equity concerns lie behind the reason for allocating public funds for data collection and analysis.

Since there has only been a limited amount of theoretical development in this area, a principle task of this paper will be to provide a more coherent theoretical basis for evaluating the economics of information systems in general, and price data systems in particular. Following this development of the theory, a brief review of the two major price data systems of the USDA will be attempted and a few recommendations made.

ECONOMIC STRUCTURE AND THE SUPPLY AND DEMAND FOR INFORMATION

Throughout the development of modern economic theory there has been an overriding tendency to deal with the phenomena of information as one to be managed by assumption rather than explained by formal theory and/or models of resource allocation. The assumption of perfect and instantaneously available information is key in the theory of resource allocation under perfect competition. But when uncertainty is introduced into our models, this assumption begs the question of how much information, what type, and who will supply the information needed to deal with the uncertainty that is inherent in our economy.

Characteristics of Information

Uncertainty has many implications in economics but for our purposes the most important implication is that information acquires the characteristics of an economically valuable commodity (1). Information becomes valuable in the context of uncertainty, in that those firms which possess relevant information can expect to obtain higher profits because of it. If we treat information as an economically valuable commodity, then it is possible to analyze the inherent characteristics of this commodity to determine how these affect the supply and demand for information. Our concern in this section is not so much with the allocative efficiency in the market for information, but rather with the effect of economic structure on the supply and demand for information. While these two issues are certainly connected, we will not concern ourselves with the proof of optimal or suboptimal resource allocation in the production and marketing of information but instead will rely on the arguments of others.

The importance of dealing with information in a systems context has been stressed elsewhere (4), and is the starting point for this paper. The connection between information systems and information as a commodity is closer than one might expect. The major attempt to treat information as a commodity in modern economics was undertaken by Arrow (1). His main concern is with inventive activity which he equates with the production of knowledge or information, using these two terms interchangeably. Arrow's notion of invention is analogous to an information system in that the product in both cases is information. Invention then can be said to be made up of data design and collection along with the interpretation and analysis of data to produce information for a decision-maker.

A partial equilibrium analysis of the supply and demand for information would be quite straightforward if information was a purely private good. Unfortunately this is not the case. As a result, the competitive model is inefficient in allocating resources in the market for information. Arrow (1) delineates three classical characteristics of information that violate the properties of purely private goods and hence affect the allocation of information. These three characteristics are indivisibility, nonappropriability, and uncertainty. As was stated previously, information only becomes valuable in the context of uncertainty so by definition this last property is violated. Information is also by definition indivisible. As Boulding (6) points out, the absence of any unit of information makes the pricing of information difficult and hence even makes it difficult to think of information as a commodity. The electrical engineers and data processors break information down into "bits" and this concept is basic to their theory of information processing.

> "The bit, however, abstracts completely from the content of either information or knowledge, and while it is enormously useful for telephone engineers, who have no interest in what is being said over their telephones, for the purposes of the social system theorist we need a measure which takes account of significance and which would weight, for instance, the gossip of a teenager rather low and the communication over the hot line between Moscow and Washington rather high." (6)

Newman (13) notes two other related problems in defining information in terms of bits. First "bits" may vary with the problems of the decision-makers, and second even if simple factual propositions could be broken down into bits, how can theories based on deduction be broken down into bits since theories do not necessarily have a basis in fact. For our purposes the problem of nonappropriability as a property of information is particularly important because of the implications it has for market structure. Producers cannot normally charge for further uses of information once it is disseminated so the returns to the supplier of information are not fully appropriable. As Boulding (6) asserts, only things clearly appropriable can become property and be exchanged; if something cannot be property, it cannot be a commodity. The problems of appropriability of information make it a pecular kind of property which affect its supply and demand. The question of appropriability cannot be separated from the issue of property rights for information. Copyright and patent laws make the appropriability of returns to information easier for certain types and certain uses of information but the costs of enforcement make this a reasonable alternative only in selected cases. For instance, if one possesses information about a commodity that is traded in a market, one must trade in the market to get a return on the information. However, by completing a transaction in the market at least the nature of the information that one possesses is released to others in the market. Thus no copyright or patent laws could prevent others from using this information. Many cases still remain, though, where the tradeoff exists between changing the mechanisms for supplying information and changing the property rights to information in order to get a more optimal allocation of resources for the production of information. Changing the supply mechanisms is for the most part easier than changing the property rights and hence our later analysis assumes that the structure of the property rights for information is relatively constant.

A further problem encountered when dealing with information is the phenomenon of increasing net returns in the use of information (1). This arises primarily because of the indivisibility of information and the high fixed costs which generally exist in acquiring information relative to the costs of transmitting the information once it is acquired. Thus further users of the same information are able to transmit the information received at a cost lower than that of the original supplier. So information will be subject to increasing net returns in use as long as the value of the information is relatively similar for each subsequent use. The appropriability problem is related to this in that it is difficult for the original supplier to charge for the subsequent uses of the information once it is disseminated. This keeps the costs of obtaining information for additional users lower since the high fixed costs cannot be spread over a large number of users.

There are further characteristics which affect both the supply and demand for information as a commodity. The production of information is a risky process. This arises from the fact that the output of the production process, i.e., the information, cannot be predicted perfectly from the inputs (1). For an information system this problem arises because of the nature of the decisions for which the information is to be used. The same data can be analyzed to produce information that is different depending on the problematic situation.

There is another characteristic of information which Arrow (1) cites that creates a fundamental paradox when trying to determine the demand for information by an individual or firm. Information only acquires value in the context of a decision, i.e., the use of information in economic decisions determines its value. This poses a fundamental paradox. The exact value of the information to the decision-maker or its purchaser is unknown until he has the information, but to make a decision on its value the purchaser in effect must obtain the information without cost. If the seller retained the property rights to the information, then this paradox would not pose a problem but as was shown earlier a major characteristic of information is its incomplete appropriability. This paradox also shows the importance of reliability of sources for obtaining data and information. When a purchaser of information is forced to estimate the value of the information before it is received, the value is usually determined from prior experience with the same supplier. So for the same decision information from unreliable or new sources would tend to be valued less than information from previously reliable sources.

The characteristics outlined above, i.e., the riskiness of information production, the indivisibility of information, its nonappropriability, increasing returns in use all cause the competitive model to lead to a suboptimal allocation of resources from society's point of view for the production of information. Arrow (1) shows that these attributes cause an underinvestment in and an underutilization of information in the free enterprise economy. The same conclusion is reached if one considers that information has many of the attributes of public goods and thus will be underproduced relative to a purely private good in a competitive system.

Information Supply For Private Use

These characteristics of information pose interesting problems in determining a suitable means of organizing to produce information for private sector use. In general, there seem to be three basic methods of organization to supply data. Each individual or firm could collect the information that it needs or purchase it from other firms, firms could work collectively to gather information and make it available to all the firms in the organization, or finally government could collect the information and supply it to all of the firms. Of interest to us is how the economic structure of an industry affects the incentives to organize to collect information. Since there are generally high fixed costs involved in the collection of information, one might expect that a firm will exploit the decreasing costs of producing market information by monopolizing the collection and dissemination of the market information. Williamson (22) argues that even though decreasing costs exist in the collection and dissemination of market information, because of the opportunistic behavior of firms in the market, few firms will specialize in the production of market information. There is a risk that the specialist firm will selectively distort the information it sells. Since the purchaser can only verify the purchased information at great cost, often only by collecting original data itself, exchange between the specialist firms and others in the market usually fails. This argument hinges on the notion that the specialist firm will be opportunistic in its behavior, which Williamson defines as seeking self-interest with guile. If opportunistic behavior is not assumed, then the risk of strategic misrepresentation disappears and specialization in the production of information is possible. This stresses both the need for an unbiased, nonopportunistic firm or organization to collect market information as well as the importance of reliability and accuracy in data collection. The lack of appropriability of returns to and indivisibility of information production makes the possibility for individual firm production of market information less likely except in the case of monopoly. Since there is only one firm in the industry in a monopoly situation, the benefits of any investment in market information for that industry accrue directly to the monopolist. Hence, it can justify its expense and can expect to reap the benefits of any investment in information to manage the industry.

The public good attributes of information lead to an underproduction and underutilization of information when left to a free enterprise economy where individual firms provide information as described earlier. This suggests that in general some type of collective organization would be appropriate to improve production and utilization but this does not give any indication as to whether a voluntarily organized private sector effort is possible rather than a government effort. In making this decision, the theory of groups can be used to give some insight into the more efficient means of organizing to produce information.

Mancur Olson (14) provides a theory of groups and organizations which he relates to the provision of public goods. If one views an industry as a group of firms and information as a public good, then the logic of Olson's argument applies to the effect of economic structure on the provision of information. Olson (14) has shown that some small groups can organize to provide a public good without any benefits other than those provided by the good itself. In cases where groups are very small, i.e., where each member gets a major proportion of the total benefits of the public good simply because the members of the group are few in number, this public good can often be provided by the voluntary action of the individuals in the group purely on the basis of the self-interest of the group members. This suggests that as industry structure moves toward oligopoly that market information is more likely to be provided by an industry association and that government collection of data for private use in the industry is probably not necessary.

While even small groups are not likely to provide an optimal amount of any public good because by definition the good is such that consumption by one member does not preclude consumption by another member, the larger the size of the group the farther short it will fall in providing an optimal amount of any public good (14). As group size gets larger, something more than self-interest seeking behavior may be needed to get the amount of a public good produced closer to the optimum. So as an industry becomes more atomistic some other incentive, such as government subsidy or direct public provision of information, may be needed to get the level of information production necessary to achieve acceptable or desired allocative efficiency.

To summarize the arguments about the relationship of economic structure to the supply of information for private use: First the problems of indivisibility and nonappropriability make private data collection and analysis unlikely under a competitive system. As an industry becomes more and more concentrated, it will be increasingly in the self-interest of the firms in the industry to supply information for their own use and hence government provision of information for private use is less and less necessary. However, as the industry structure moves toward more atomistic competition, then the argument for government provision of data collection and analysis can be made on the grounds of improved efficiency in the allocation of resources because the industry is not likely to provide an amount anywhere near optimum.

Information Supply For Public Use

Up to this point we have discussed the supply of information for private use. Data collection and analysis for public use is by definition a government activity. This is necessary to insure accurate and reliable information for public purposes and to avoid the problems of strategic misrepresentation of information supplied by private individuals for public use. For an example of the difficulties encountered by the reliance on private groups or firms for information needed by the government, the current debate over the level of natural gas reserves is enlightening (12).

The Demand For Information

The demand for information for private use is determined by its value in the decision process of individual firms. The problem in estimating demand for information is that its value is unknown until it is obtained and used. So firms in uncertainty will underinvest in the production of information because they cannot be sure of their level of return. Even in those cases where the firm has a reasonable estimate of the value of certain types of information before it is obtained, the firm or industry may not invest in its production because the gains may never be received by the firm. Thus the demand for information for private use centers on the level of returns to investments in information production and the ability of the firms to capture these returns.

When society begins to industrialize, as production processes become specialized and require extensive coordination, the level of returns to investments in information production to manage these processes increases. As an industry becomes concentrated in the hands of fewer and fewer firms, the returns to investment in data collection and analysis for private use can be captured by these firms. Hence the demand for private use of information increases. At the other extreme of industrial structure where there are thousands and even millions of independent firms, as in agriculture, the amount of private sector investment in information production is likely to approach zero since little of the returns can be garnered by an individual firm. As a matter of fact, the public returns to private investments in data collection and analysis would probably exceed the private returns (3). Thus the demand for information for public use will be high in atomistic markets. Over this same continuum demand for information for public use will at first decline as industrial concentration moves away from atomistic markets then this demand will increase as the need for information to regulate and monitor monopolistic industries increases. This will be particularly true in those cases where society has instituted anti-trust laws or public utility laws to regulate monopolistic industries.

This raises the additional question of public access to data collected by highly concentrated industries and monopolies. There is a public interest in this type of information which should temper any discussion of confidentiality and disclosure. Data on these types of firms are often sensitive because of the concentrated nature of the industry and the immediate effects of any firm's actions on the market. However, this makes this same data extremely critical for public decisions. Thus the benefits to society of the preservation of privacy, particularly among corporations, must be weighed against the information needs of public policy decision-makers (5).

Up to this point we have dealt in terms of the effect of industrial structure on information in a reasonably obvious fashion. There is a more subtle effect which runs in the opposite direction, i.e., the effect of information on industrial structure. Earlier some of the economic characteristics of information were mentioned. These can affect firm size and industrial structure. The riskiness of information production is often such that outside insurance cannot be purchased to offset that risk. Self-insurance in the form of diversification is often used to deal with such risk. This suggests that in order for a firm to be able to produce information through data collection and analysis, it must be large enough to internalize the risk of losses in information gathering. Thus, information production is usually done by large firms and large firm size is generally related to industrial concentration.

The indivisibility of information also can affect industrial concentration, in that it leads to increasing returns in the use of information. Radner notes that "the acquisition of information often involves a 'set-up cost;' i.e., the resources needed to obtain the information may be independent of the scale of the production process in which the information is used" (15). Wilson (23) calls this "informational economies of scale," and notes that this phenomena is self-reinforcing in that a higher scale of operation justifies better information acquisition and increased information acquisition will justify a higher scale of operation. Hence, economies in the acquisition of information can increase firm size to the point of monopoly. Theoretically this will occur as long as information is acquired in an optimal fashion. While Radner and Wilson seem to have horizontal firm structure in mind, as Williamson (22) notes, the same argument can be made for vertical integration in many cases. Thus, indivisibilities in information and the resulting increasing returns in use of information can also affect the vertical structure of a sector by providing an incentive for vertical integration solely to reduce uncertainty.

Hopefully the arguments presented in this section will show that it is not a political or bureaucratic accident that government collects more detailed statistics and does more analysis on highly competitive, atomistic industries, such as agriculture, than it does in more concentrated industries such as steel or autos. Publicly collected data for private management decision-making have played a substantial role in the great increases in agricultural productivity in the United States over the past century. Society has captured the returns to improved resource use in agriculture through lower food costs and the availability of much of the former farm labor force for nonagricultural production. The greater returns through improvement in resource allocation from better public information on competitive industries when compared to concentrated industries provide the primary basis for allocating public monies for statistical systems. Hence, the logical allocation of public resources follows from the industrial structure itself (3).

INCOME DISTRIBUTION AND THE DISTRIBUTION OF INFORMATION

Modern economic theory also has been particularly deficient in dealing with distributional issues while concentrating on problems of allocative efficiency. Just as uncertainty is usually assumed away in models of resource allocation, the distribution of income is often assumed to be optimal to begin with and hence is not treated. The connection between the distribution of information and the distribution of income seems to be a key but often overlooked notion.

As Thurow argues,

> "The factors that cause changes in the distribution of income are themselves distributions. The distribution of education and training affects the distribution of income. Thus, to adequately study the American distribution of income, it is necessary to develop methods of explaining the distribution of income in terms of the distribution of causal factors which influence it." (18)

Information is clearly one of those causal factors to which Thurow refers and thus the study of income distribution requires an understanding of the distribution of information.

The distribution of income can be discussed at two different levels and the types and impacts of information will differ at each of these levels. First, one can consider the overall or size distribution of income in the entire society. Secondly, there is the question of income distribution among given individuals or groups of individuals within society. This distinction may be viewed as a macro-micro delineation of the problem.

Keeping in mind that we are considering information in a systems context, the distinction between data and information has important implications for income distribution. Data require analysis and interpretation in the context of a specific decision to become information (4). In general, a more equal distribution of data among members of society is likely to have quite different effects on income than an equal distribution of information because of the disparity in *analytical capabilities* of those receiving the data. It is this analytical capability that Thurow (18) and others seem to have in mind when discussing the relationship between the distribution of education and training and the distribution of income. Insofar as education provides superior data interpretation capability among members of society, one would expect that the distribution of education and hence information would in turn be related to the distribution of income. This expectation is supported by the literature (18).

This relationship between education and income has been directed primarily at the most general level, i.e., its effect on the size distribution of income in society. As Lamberton (11) notes, the general expectation of improved information is to reduce inequality in power, wealth, and income. However, it is at this most general societal level that improved information is often least likely to cause the desired reduction of inequality because of the different capacities of firms and individuals *to use or act on the* *information* that they receive, even given the same capability to analyze and interpret data.

> Where new information becomes available to small households (buyers) and large firms (sellers), the likely social disadvantage is more obvious--the firms may not only have greater capacity to use the information but also greater capacity to take counteraction. In broad terms, equality of access to information does not insure equality of benefit. Differential capacities to use information may not only preserve but accentuate concentrations of power, wealth, and income. (11)

These insights point out two aspects of information that relate it to income distribution. First, the fact that the value of information derives solely from its use suggests that the capacity to use or act on information will be a major determinant in the distribution of income. The ability of different firms to act on the same information will differ and hence so will the value of the information and the income derived from it. Second, economic structure again seems to be an important variable in analyzing the distributional consequences of information. Insofar as firm size is related to economic structure, e.g., firms in an oligopoly are assumed large enough to influence the market by their decisions, it is likely that large firms not only possess superior analytic capability but also have a greater capacity to use or act on information than do small firms. Thus, one would expect larger firms involved in trades with smaller firms to use their superior information to affect the transactions it undertakes in its favor, so the resulting income distribution would favor larger firms. The distribution of income is primarily determined by the outcome of the market in the private sector (21). So as information affects market structure and behavior, it also affects income distribution.

This reliance on market transactions to determine income distribution highlights the importance of the distribution of information between individuals in an exchange situation. The problems here are at a more micro-level than those discussed earlier and the effects of the distribution of information are on the distribution of income between the individuals involved. This is similar to the market failure brought on by information impactedness which Williamson (22) argues,

> . . . is attributable to the pairing of uncertainty with opportunism. It exists in circumstances in which one of the parties to an exchange is much better informed than is the other regarding the underlying conditions germane to the trade, and the second party cannot achieve parity except at great cost--because he cannot rely on the first party to disclose the information in a fully candid manner.

When trading occurs under the circumstances of asymmetrical information, one can only expect a redistribution of income in favor of those who possess the superior information when compared to the case when information impactedness does not exist.

In the previous section, it was argued that the governmental collection of data and its production of information for agriculture could be justified in terms of improved resource allocation. Weisbrod (21) makes the point that income redistribution can be undertaken in a number of ways including the use of redistributional "side effects" of policies that are usually considered to have efficient resource allocation as their goal and not income redistribution. To the extent that government wishes to redistribute income in favor of agriculture, one can argue that many of the programs to improve the information system for agriculture are achieving this objective, even though many of the programs are aimed at the resource allocation problems caused by uncertainty. However, even those programs which tend to equalize the access of information in trades, such as price and production estimates, might not have desirable income distribution effects because of the market structure in agriculture. The predominance of atomistic producers and concentrated buyers in this sector may prevent any major redistributions of income between buyers and sellers because of the superior analytical capability and ability to use government produced information possessed by the larger firms in the agricultural sector. However, to the extent that government research and data collection tend to equalize the information of individuals involved in exchanges of agricultural commodities, there will be a change in the distribution of income toward greater equality. Many programs have tended to achieve this desired income distributional change. For example, the land grant college system and extension education programs probably have increased the analytical capability of farmers relative to those with which they deal, and the establishment and regulation of futures markets give farmers a greater capacity to use or act on information that did not previously exist for farmers.

PRICE INFORMATION

Up to this point our concern has been with information in general and not with price information per se. In choosing to deal with price information specifically, one raises the questions of how price information differs from other information and why are we concerned with prices. The conventional economic wisdom is that prices are the most efficient means of transmitting the information needed to arrive at a Pareto optimal resource allocation in the market. Hayek (10) has described this as the "marvel" of the price system. The marvel lies in the fact that when price changes reflect the relative scarcity of any resource, adjustments are made in resource use throughout the economy without any knowledge of the cause of the scarcity by many individuals. In general the price system does away with the need for individuals, who are only distantly related to changes in a market, to be made aware of any of the details of changing market conditions. Changes in price are sufficient.

In a competitive system with perfect knowledge price conveys all of the information needed to allocate resources in an optimal fashion. Even when there is less than perfect information, the necessary and sufficient condition for price fully to reflect all of the information available, is that that information is costless (9). If everyone had all the information about the factors affecting supply and demand and hence price, then knowledge about price per se would not necessarily lead to a more optimal resource allocation.

However, there are practical limits on what any individual can retrieve and comprehend. Williamson (22) classifies this as the problem of bounded rationality, so that some means of economizing on the transmission of information about the factors which affect the market are needed. The price of a commodity provides this means for economizing on the transmission of market information.

While price is able to pass on all of the essential information to those concerned in a transaction when there is perfect and costless information, the effect of uncertainty on the informational content of price needs elaboration. When some form of randomness or stochastic elements are involved in a number of variables which determine price, price does not transmit all of the information necessary to allocate resources in an optimal manner (9). Thus, the price of a commodity will not reflect all available information and as uncertainty increases, it will reflect less and less of the relevant information.

Salop (16) notes that as information becomes costly, each small firm is able to obtain some market power. Under these conditions if an equilibrium price exists, it will not be at the competitive level and often there will be significant price dispersion as well. This would seem to imply that as the informational content of price diminishes, those with more information or market power will tend to use this to obtain prices in their favor. If one views market power as another stochastic element that reduces the informational content of prices, then as buyers obtain market power relative to sellers, the prices in the market will decline along with the informational content of the prices.

Government data collection and the production and dissemination of information for agriculture would tend to increase the informational content of agricultural prices. As both traders gain knowledge about production levels, inventory levels, foreign demand, etc., prices will reflect this information. Government provision of information serves to increase the informational content of prices primarily through the reduction of information costs to the individual user.

In an earlier section the relationship between economic structure and the supply and demand for information in general was discussed. Is the demand and supply for information about prices related in the same fashion to economic structure as is information in general? Changes in economic structure may have quite different effects on the demands for price information. The stability of price in oligopolistic markets tends to lessen the need for timely price information for private decision-making. The size of the market itself affects the value of price information. In an atomistic market random shocks may affect the supply of an individual firm but because of the size of the market these shocks will tend to even out and the price estimate will remain representative no matter what any one firm does. In a market with only a few participants the action of any one firm can influence price and a random shock affecting any firm is likely to affect the market price so that a price estimate for the market may not remain representative for very long. This lack of representativeness would tend to reduce the value of any price estimate for that market and hence the demand for price data.

The public demand for price data on an oligopoly is likely to be less than other types of data. For the most part the demand for information by public agencies in concentrated markets is for the purpose of regulation or legislation. Thus the demand is more for information on profits, rate of return, or other performance measures and not so much for information on prices per se except in cases where monopoly leads to price discrimination.

The ability of any one firm to justify expenditures to collect price data is related to the returns it expects to receive from searching for a better price. The returns to investments in price information for any firm are much more easily appropriated by the firm through use in the market than returns for other types of information. The traditional microeconomic theory of information suggests that a firm will search for a higher selling price until the marginal costs of search are equated to the marginal returns of search. Two factors in addition to search costs become important in determining the amount of search that any one firm will undertake: the amount of price dispersion and the number of units that the firm is selling. These factors are important because they determine the expected returns to searching for a better selling (or buying) price for a commodity. Since the number of units that one is selling is a major factor in determining the returns to search, firm size and hence economic structure affect the willingness of any firm to undertake search for price data. Thus, as market structure becomes more concentrated and firm size increases, the individual firm is more likely to undertake price data collection for its own use. The need for governmental action is not as necessary as the number of firms selling in the market is reduced from few to fewer, because the returns to any one of these firms become great enough to justify its own price data collection. As firm size decreases, it is not as obvious that the return to the firm will be great enough to justify its own price data collection to any extent.

Some may argue that government price data collection is not necessary because all firms will supply enough price data to meet their own demand, i.e., equate their marginal cost of search to their marginal return and thus some sort of equilibrium will be reached. This argument neglects two important aspects. First, it ignores a fundamental characteristic in determining the demand for any type of information, that being that the demanders do not know the value of the search until after it is over. This makes search a risky venture which will tend to lead to an underinvestment in information gathering relative to an optimal amount. Of more importance for our argument is the fact that as the amount of search increases in a market, *ceteris paribus*, the amount of price dispersion will decrease (17). This means that in a market with large firms which undertake search on their own, the amount of price dispersion will decrease. However, in an atomistic market with smaller firms the amount of search undertaken by each firm is likely to be less in aggregate and hence price dispersion in the market will probably be greater.

This has important income distributional implications. Since the gross income of producers depends in part on their selling price, greater dispersion of income to sellers will occur as the dispersion of selling prices increases, all else equal. So that one might justify government price collection in markets made up of many small firms because of the greater price dispersion and the resulting income distribution consequences.

The availability of price and its informational content also affects market structure in a more direct way. Williamson (22) argues that because prices do not often qualify as "sufficient statistics," i.e., do not convey all the information about market conditions, in such cases a substitution of internal organization, such as vertical integration, will tend to occur in place of market mediated exchange. Arrow (2) further argues that in cases where production lags and information leads occur (e.g., where a processing firm needs to determine its production before it purchases its inputs and when the input producing firm knows in advance its approximate level of production) that there is an incentive to integrate. However, "the incentive is *not* to insure in advance a quantity of raw materials, but rather to acquire information relevant to its market price" (2). This suggests that the lack of good price data can lead to vertical integration.

Government price reporting can be justified on many grounds. The effect on income distribution of price dispersion may be inconsistent with the goals of society so that the redistributional side effects of price reporting might along provide a rationale for government price reporting. One rarely hears this point being made. Accurate government price reporting can also enhance competition in a given market. By reducing the costs of search for small firms they are helping to alleviate problems of asymmetrical price information that arises since larger firms have a lower cost per unit of volume in obtaining price information where the costs of obtaining such information are relatively fixed. The relationship between insufficient price information and vertical integration suggests that improved price reporting by government might be needed to prevent further concentration and its subsequent detrimental effects on competition and consumer prices. Competition is also enhanced in the capital markets by providing outsiders with information relevant to the evaluation of the potential entry into a certain type of business. Insofar as the government can remain as an objective reporter of prices, it provides a useful function in the resolution of disputes about the value of certain commodities. Finally the need for price information to conduct public programs also justifies its collection by government, the importance of which cannot be overemphasized with regard to agricultural price data.

PRICE DISCOVERY AND THE NATURE OF USDA PRICES 2/

In the previous sections, the economic basis of the demand for and supply of government price data collection has been developed. How well the government is actually doing its job of price data collection is a separate question. This is a continuing primary concern of statisticians. Any evaluation of the agricultural price data system must go beyond the usual tests of statistical sampling accuracy of the prices collected. One must also evaluate the concepts of price involved and how effectively these concepts are operationalized. The determination of the accuracy of the measurement techniques in price collection is only a meaningful performance test *after* the conceptual and definitional accuracy is determined. This study is not so much concerned with quantitative measures of statistical accuracy, but will be more of a first effort in an evaluation of selected price data systems of the U.S.

2/ In addition to the cited material, this section is based on personal interviews with SRS and AMS personnel.

Department of Agriculture.

The Nature of AMS and SRS Prices

Collection of prices received by farmers for agricultural commodities is done primarily within two agencies of the USDA, the Market News Branch of the Agricultural Marketing Service (AMS) and the Prices and Labor Branch of the Statistical Reporting Service (SRS). At first glance it may seem to be organizational duplication and a waste of the taxpayers' money for two organizations to collect agricultural price data. Arguments for the consolidation of data gathering agencies within the federal government have been made for years, in part to eliminate any problems of overlap in data collection. President Ford's 1978 budget report addressed this very subject. However, in the case of the USDA, these appearances of redundancy are deceiving.

AMS and SRS have quite different purposes for collecting price data. The Market News Service was established primarily to provide data which is useful at the micro-level for basic decision-making by firms in the market place. The Statistical Reporting Service approaches its price collection with a more macro view and purpose. AMS price reporting reflects the demand for price data for private use while SRS prices are more for public decision-making. This is not to say that both the AMS and SRS prices are not used for both public and private decisions, but the difference in emphasis within these multiple use data systems is of importance.

Besides this micro-macro distinction there is also an important time dimension involved in the use of prices in decision-making. The timeliness of price data and its specificity affect its usefulness. For most short-run decisions very specific price data of the most recent nature is needed in determining answers to such questions as when and where to market commodities of known specifications. While for long-run decisions, the timeliness is not as important nor is the need for prices on specific classes or grades of a commodity. For example, a livestock producer knows the weight and grade of the livestock that he will sell this week, while the next year's production he might only have an idea of his normal or average weight and grade of cattle. Thus the price data for short-run decisions usually must be more specific and current than that for long-run decisions. A useful way to view these different types of decisions and their resulting information needs might be to characterize the decisions as involving tactics versus strategies instead of short-run versus long-run decisions. AMS prices more closely reflect the tactical needs of decision-makers while SRS prices are better suited for strategic decisions.

Given the teleological nature of any information system, the goals of the decision-maker must be reflected in the concepts used by the data system in order to insure that the information produced will be of any value. The concepts of price used by AMS and SRS differ as a result of the different uses and users of their price data. The AMS price concept derives from the micro-level tactical decisions which farmers must make in marketing their commodities. This price concept is not explicitly detailed in the literature but it seems to be based on the exchange value of a commodity with specific characteristics in a particular market or market area.

The SRS price concept also can be related back to the types of decisions for which it is used. The macro and/or strategic decisions for which the SRS price is used in private and public settings lead to a price concept which is more of a measure of performance of the market rather than an aid in the coordination of the market in the short-run. The concept used in the SRS estimates of prices received by farmers is "that of a price which, if multiplied by the total quantity of the commodity sold, would give the total amount received by all farmers for that commodity" (20). This income-related price concept arises out of the need for SRS to provide decision-makers with estimates of farm income and the gross national product of the farming sector for the national income accounts. Thus the SRS price concept is more a measure of farm or commodity sector welfare, i.e., the value of an average transaction or a unit value concept.

The unit value or average price concept of SRS is quite different than the detailed specification price used by AMS. These concepts are not often substitutable in various decision-making circumstances. Changes in market structure can cause the demand for the data based on these concepts to change. As industry structure becomes more concentrated, the justification for public investment in data collection for private use declines. This suggests that the emphasis in USDA price collection could shift away from AMS to SRS to the extent that the economic structure of agricultural production becomes concentrated in the future. Since AMS prices are market specific, the level of concentration of producers within a given market gives an indication of the necessity for government price collection within that market. Conversely, the availability and quality of AMS prices are a substantial deterrent to further concentration.

These concepts of price are also related to the income distribution questions raised earlier. The micro-level of income distribution, i.e., between individuals or groups involved in an exchange, should become more equal since the availability of AMS type price data tends to equalize access to information of relevance to individuals involved in trades. On the other hand, the SRS price data are important for government decisions which have an impact on the size distribution of income in the U.S.

In terms of conceptual accuracy, both the AMS and SRS price concepts appear to have maintained their usefulness for most commodities through time. The increasing amount of vertical integration and contract production in certain commodities, such as broilers, has tended to make the AMS broiler price concept somewhat obsolete since price no longer provides as much of a coordination function at the farm level as in the past. Thus the need for broiler price information for short-run decisions by farmers is reduced. AMS has responded to this phenomenon by reducing the amount of farm level price reporting for broilers. However, the need for SRS price-based income estimates still remains even in these types of commodities.

Perhaps of more importance is the effect of market structure on the operationalization of these concepts and the measurement of agricultural prices. Changes in economic structure toward greater concentration in and of itself need not cause additional problems in defining and measuring price as long as the same methods for arriving at a price between buyer and seller are used. However, this is not often the case. The price discovery mechanisms in agriculture have changed through time, both with and without changes in the economic structure. Tomek and Robinson (19) describe five basic price discovery mechanisms commonly observed in agriculture: individual negotiation, trading on organized exchanges or auctions, formula pricing, group bargaining by cooperatives or producer associations, and public or private administered pricing. In order to avoid confusion, the distinction between price discovery and price determination should be made. The common usage of these terms classifies price discovery as the actual method by which trading prices are arrived at, while price determination involves the interaction of the forces of supply and demand in achieving a price.

There is a relationship between price discovery and economic structure. For instance, producer group bargaining as a price discovery mechanism is related to economic structure in that the notion of organizing countervailing power for producers is only appropriate when there are non-atomistic traders in the market. Breimyer (7) further argues that administered pricing implies a certain amount of market power. At the other extreme, the futures markets and some terminal auctions are generally characterized by a high degree of competitiveness. However, the relationship between economic structure and price discovery mechanisms is not a mechanical or automatic one.

Price Discovery Mechanisms

Individual negotiations between buyers and sellers are quite common, perhaps the most common method of selling agricultural commodities at the farm level in the world. In terms of price reporting, it poses a number of problems. Contracting, a form of individual negotiations in some cases, makes price collection more difficult because of the dispersed nature of the traders and variability in the non-price terms of trade. The price of apples received by growers from packers and shippers can frequently include the use of packer supplied crates by the grower which get reflected in the price. Since the Market News Service is interested in a price for a commodity of detailed specifications, apples with packer supplied crates differ from apples without the crates. Part of the resulting variation may get reflected in the price range published by AMS for a certain grade and variety of apples but the farmer wishing to use the price data to make decisions will not necessarily be able to determine the value of his apples with and without the packer supplied crates. SRS prices include these types of marketing service charges for the most part. For the determination of net farm income, the inclusion or exclusion of these marketing services in the price should not be important as long as the expenditure survey used to measure farm expenses accounts for the costs of these services in a consistent manner so that the price reported is for a reasonably homogeneous product.

Call *contracts* on grain present another set of problems. These types of contracts set price after delivery, with the seller able to accept a market reported price some time after delivery. For the most part, these sales were not reported prior to January, 1977, when SRS was using the composite estimating system for grains. Now with the use of probability surveys, which collect total expenditures of grain buyers for grain purchases and total bushels received to determine unit value, grain prices will include call contracts. A problem arises when delivery of the grain is made in one month and price set in a later month. This could lead to inaccuracies in the reported price, even when probability surveys are used. For AMS the demand for contract price information is not as great because of the nature of the decision involved in entering into a contract. In contracting non-price terms are also important, while the timeliness of the price data is not as important because of the longer-run nature of the contracting decision; hence there tends to be less demand for AMS prices in these cases.

The uses of the AMS data also cause few of the problems that arise for SRS concerning price quotes and transaction prices. In grain price surveying particularly, the price obtained by surveys of buyers is often only a price quote for a specific grade and type of grain and not the price of an average transaction. For example, an elevator operator might report the price of #2 corn at 15 1/2 percent moisture, when the average actual transaction is corn of 17 percent moisture. Hence the reported price would not reflect the amount of discount taken from the farmers for the corn actually sold. Since SRS wants a price which yields farm income, it is important for them to get an average transaction price. Price quotes are usually as useful as the prices of actual transactions for the tactical decisions for which farmers use AMS prices, since farmers are generally aware of any premiums or discounts. Thus it is not as crucial for AMS to obtain prices for actual transactions as is SRS, even though both AMS and SRS would like to measure actual transaction prices in all cases.

Trading on organized exchanges or auctions makes the collection of price data easier because of the centralization of transactions. The existence of organized futures markets though can affect the accuracy of the price information. Since the SRS price concept is one which is used in arriving at cash receipts from farm marketings and then farm income, any factors which affect cash receipts without affecting prices or quantities will not cause changes in the farm income estimates. The cash receipts of farmers are affected by the price of the commodity in the cash market plus any profit or loss from a futures market hedge. With the increased use of futures markets for hedging by farmers, cash prices for some farmers can vary without varying their farm income. This is not a problem for Market News since they are not concerned with the price which generates farm income.

Formula pricing is being used more and more in the pricing of agricultural commodities, particularly where the commodity moves directly to the processor. Pricing formulas for commodities are often based on some reported price such as the Market News price. In California most government purchases of beef are purchased at a premium or discount from the Market News price. This creates a phenomenon similar to a simultaneity bias for the AMS prices, which will become particularly significant as a larger proportion of the commodity is sold by formula pricing. Taken to the extreme, the entire pricing mechanism will fall apart because there will be no reported price on which to base the formula.

Since timeliness is not as important for SRS, it is possible to obtain the unit value of a commodity sold on a formula price after the price has been established. Probability surveys of buyers' gross purchases in dollars and quantities should account for this. In commodities where these probability surveys are not yet used, particularly livestock, fruits and vegetables, collection of prices by SRS may be more difficult because of the dispersed buyers, but the resulting errors are not likely to be as severe as for AMS because very few pricing formulas are based on SRS price. However, milk is a commodity priced by formula which does create problems for SRS. Since the SRS is interested in determining farm income by states, the point of transaction is not as important as the place of origin of the commodity. The point of transaction is of concern to AMS since their prices are specific to a given market or market area. Federal milk marketing orders cross state lines so SRS often has a problem in determining the state of origin for some milk. A typical market order pricing formula for milk includes such factors as the percentage of fluid milk utilized in the market, price for Minnesota-Wisconsin manufacturing grade milk, distance from the surplus production area, general price level indices, etc. The utilization rates between classes are difficult to determine during the month so the preliminary price is difficult to determine. Each market order operates a little differently which makes it particularly difficult for statisticians to understand the complexity of the market order. So even when the data on utilization rates and the other factors are available the previous month price estimates for milk might not be correct.

Formula pricing of a different sort has become important in grain pricing. Flat cash prices for grains may vary significantly during the day and hence many large buyers and sellers use a transaction price which varies by a fixed amount, the basis, from the futures market price. AMS is now reporting the basis quote for some markets, and because of its stability, the basis provides information which is useful for longer periods of time in contrast to the flat cash price. Since SRS wants a measure of unit value, data on basis movements are of little use. So where collection of data on basis movements might be an important innovation for AMS, it is of little value for most SRS uses without data on the actual futures market price at the time of the sale.

Group bargaining by cooperatives to determine price in some cases makes price collection easier since the price for a large number of producers is the same and can be measured at one point. However, problems arise in defining price since most contracts will also include non-price terms of trade. This does not pose as significant a problem for AMS as for SRS since the uses of AMS price data are primarily for the tactical decisions of producers. Collective organization and bargaining reduces the tactical decisions that any farmer must make so the demand for AMS data on cooperative prices is not as significant. However, it is still necessary to obtain a price or unit value to arrive at farm income. Thus, cooperative sales cause problems for SRS. Besides the problem of uncertain product definition caused by differences in non-price terms of trade there are also problems in obtaining a unit value caused by the time lag between the transfer to a cooperative of title for a commodity and the payments to the farmer for a commodity as well as patronage refunds.

Over one-half of the rice produced in the U.S. is sold through cooperatives. In most of these cases the farmer receives only a portion of his total payment at the time of delivery, with the remainder being paid after the cooperative's supply has been sold. This makes the collection of monthly prices and even yearly prices difficult for SRS. Year end patronage refunds by cooperatives cause similar problems in other commodities. Producer cooperatives that vertically integrate into processing, wholesaling, and/or retailing also cause problems since marketing services normally performed by the farmer in this case are performed by the cooperative. SRS prices usually include the marketing charges incurred by farmers, such as yardage, trucking and commissions, as part of the price received. For livestock, the payment received by farmers in a cooperative might not include these charges. Thus payments per unit sold reported by farmers in a cooperative might not be comparable to prices received by farmers for the same commodity sold in a market. SRS is forced to find ways to adjust the data for comparability.

Government *administered pricing* is presently not used to any great extent in agriculture except for the activities of the Commodity Credit Corporation. These present difficulties in determining a unit value for any commodity because the farmer receives the income as much as two years before the transaction is recorded. When the farmer's non-recourse loan comes due, he can either sell the commodity in the open market and pay back the loan in which case the transaction is reflected through normal methods or he can let the CCC keep the commodity and the value of the commodity is determined by the loan rate established by the Secretary. In either case the measurement of a price to determine farm income can occur years after the income is actually received.

Privately administered prices are usually found in vertically integrated firms. The question here arises as to whether the price is merely an accounting measure or an actual measure of value of the product. It is usually the former and may not bear any relation to farm income unless the expense accounting procedures are known. A further question arises of whether the farming activities of vertical integrated firms should even be included in the farm income measures of SRS. If not, then the problems of privately administered prices in vertically integrated firms would disappear.

This limited examination of price discovery mechanisms in agriculture and the nature of AMS and SRS price collection should point out the different kind of operationalization and measurement problems encountered by different price concepts. Since AMS is interested in a price for a commodity of a specified class and grade in a given market for the purpose of tactical decisions by producers it is often easier to define and collect prices using this concept than the unit value concept of SRS. Aggregation problems are not as severe for AMS prices because of the more detailed specifications and the ability and freedom of AMS to report price ranges rather than an average price. AMS collects prices for a particular market so that cross-state movements of commodities do not have to be dealt with as frequently. SRS is expected to develop estimates of state farm income so the state of origin of the commodity in any transaction is of major importance. The failure to report contract prices and similar problems are generally not as significant for AMS since the prices which they collect are often only for organized markets and for short run decisions. SRS in turn is interested in capturing all transactions because of its desire to estimate farm income.

Changing market structures for different commodities in different states have lead to problems in SRS price collection. Two types of problems seem to have arisen because of this, the first can be characterized as a cross-sectional problem, the second as a time series problem. The cross-sectional problem arises because of the lack of consistent and standardized procedures for estimating prices between states. The composite estimating system used for most commodities except grains, allows each state statistical office to use any source of data it deems appropriate to arrive at its estimate of price received by farmers for a commodity. 3/ These sources often include mail surveys, Market News data, enumerations of auctions, privately gathered data, etc. This in and of itself raises problems in how to weight each source in determining the composite estimate. Each of these sources may be based on different price concepts which might not be related to the SRS concept of price. The quality of the data sources and the effort used in obtaining price data for a given commodity seems to be directly related to the importance of that commodity to the agriculture of that state. The flexibility given to the State Statistical Offices may create some problems but it ameliorates other problems of price estimation. Each state needs flexibility in order to deal with the varied market structure and price discovery mechanisms between states and regions and to deal with changes in market structure through time. It does, however, lead to problems in aggregating state data into a national average price and in comparing such prices between states.

This composite estimating method seems to be better suited for measuring price changes from month to month for a commodity in a given state rather than for comparing the level of prices between states. This does not pose a problem for many types of decisions where knowledge of price changes is important. However, for estimating income the level of prices is key.

The time series problem referred to earlier is caused by the fact that SRS usually moves personnel from state to state, and from price estimation to production estimation and vice versa, on a regular basis. Hence, those involved in estimating the prices for a given commodity often do not get a chance to develop a good working knowledge of the market structure and price discovery mechanisms for the commodity in the state in which they are working. So each statistician tends to "do it like it was done last year," with little regard for changes in the method of price discovery that may have occurred over time in that state.

The synergetic effects of these time series and cross sectional problems are probably much greater than the sum of the effects of each problem taken separately. As the economic structure and the price discovery mechanisms within a sector change, the decisions often become more complex. This creates a demand for data that is not only of greater accuracy and detail but also for data and information in a "learning or developmental mode" (8). In this mode the goals of the decision-maker are never completely specified and a purpose of the information system is to aid the decision-maker in the respecification of goals in a progressively more detailed and complete form. This necessarily includes the redesign of the information system. The developmental mode is an adaptive learning process where goals and problems continue to change and may never be specified completely or in full detail. It should be clear that data and information which remain basically static or in what Dunn calls a performance mode cannot be of much value to a decision-maker in this situation. In the learning or developmental mode the information system

3/ For a more detailed explanation of the SRS composite estimating system see (20).

itself is changing in structure and behavior in response to the data it perceives. Thus the information system must not only perceive changes in the environment but also in itself, even in the difficult situation in which these changes themselves become goals (8, 4).

The flexibility allowed each state in estimating SRS prices gives the data system the ability to deal with change and to a certain extent creates the possibility for a price data system which operates in a learning or developmental mode. However, the movement of personnel, while aiding in maintaining unbiased reporting and management training, tends to keep the system from responding and reacting to changes in the market structure and the needs of decision makers. Hence, the data system tends to remain in a performance mode.

These are problems that the statisticians who operate the USDA price data systems must deal with everyday. They are also, as any experienced statistician can tell you, problems which are not easily resolved. Some perceived solutions involve costly "trade offs" with other objectives. Most improvements involving redesign of the conceptual or methodological base threaten significant vested interests and often require substantial additional resources. Thus, a statistical reformer must have the political skill of a Metternich and the patience of Job.

CONCLUSIONS AND RECOMMENDATIONS

While the analysis of the USDA price data systems presented in the previous section is far from complete, it is at least suggestive of many of the problems that will be encountered in any effort to improve or redesign the data base for agricultural prices. Given the limited analysis our recommendations must inevitably be tentative and limited to those of a more general nature. It should also be obvious that there are no easy solutions to many of these difficulties and much work must yet be done before useful concrete suggestions can be made in many cases.

The formal composite estimating system used by SRS is superior to the system it replaced, but it still has many shortcomings. Two of the most important ones arise because of a lack of standardization between states and the personnel practices of SRS. Changing personnel practices by lengthening the time any statistician remains in a state is one possible solution to this latter problem. However, there are other possibilities. If the statisticians who are collecting prices in a given state had a better understanding of the market structure and price discovery mechanisms used for a given commodity in that state, then changes in the price data system would be more likely to reflect changes in the marketing of that commodity. If state statisticians were provided with a brief description of possible market structures and price discovery mechanisms for each commodity this might give their staffs enough information to suggest changes in data sources and measurement techniques at the state level.

A related problem at the national level is the lack of knowledge of the data sources used by each state in the composite estimate of price. A compilation of these data sources and a method of accessing them when the national prices are being estimated would be of value particularly when it is necessary at the national level to adjust a state statistician's estimate of a price for a given month. This list of data sources by commodity could also be circulated among the relevant state statistical offices so that those personnel involved in price estimation might be informed as to possible improvements in their methods. This might allow those states where a given commodity is important, with their generally superior price measurement, to suggest improvements in the methods and sources of data used in other states. Some of this probably goes on informally now and is part of the reason for personnel shifts between states. This compilation of data sources might also tend to reduce the problems brought on by and lessen the need for the personnel movements from state to state.

While it may be useful in the short run to deal with changes in the SRS composite estimating system, in the long run it may be better to replace it with a system which more directly reflects the concept of price which SRS is attempting to measure. The composite estimating system is a method of aggregating prices from various sources within a state to arrive at a price estimate. The weights used in the aggregation process and the sources of the data used in obtaining a composite estimate of price have important effects on the estimate. If this price estimate does not reflect the value of an average transaction then the farm income estimates will be inaccurate.

The composite estimating system by its very nature now often aggregates prices based on different concepts. Many of the limitations of the current SRS price data system can be traced to problems in measuring unit value. The composite estimating system worked far better in an earlier time when certain commodity market structures were less concentrated and exhibited less variation in price discovery mechanisms for the same commodity.

An improved method currently used in measuring cotton and grain prices is a probability survey of purchasers of farm commodities which determines total quantity purchased and dollars received by farmers for a given commodity. This method is more closely related to the price concept which SRS is attempting to use. It is based on the gross receipts of farmers for a commodity divided by the quantity sold to determine unit value. The weights used in the composite estimating system may not be based at all on the actual quantity sold of a given commodity. This probability survey method should help to alleviate problems brought on by price quotes, formula pricing, and call contracts. At the same time it does provide more standardization of methods between states. This should reduce the problems of noncomparability without reducing the flexibility to survey different types of purchasers in each state. To be effective one must insure that this probability survey is measuring actual transactions and not just deliveries, hence a clear definition of a transaction is needed which is consistent with the definition of farm income used by SRS. In general a transaction would seem to involve both price setting and delivery. This point should be made clear to avoid problems in reporting call contracts. Probability surveys are only done for grains and cotton at this time, but this method should probably be extended to other commodities in the future as resources are made available.

However, before probability surveys can be undertaken for all commodities a more complete list frame for purchasers must be developed. SRS has submitted a budget for 1978 which includes funds for a point of sale survey to determine where agricultural producers sell their commodities. The necessity of this cannot be understated for without a complete and up-to-date list frame these probability surveys are likely to do as much harm as good. One has only to look as far as the 1974 Agricultural Census to see the problems of incomplete list frames in sampling. This suggests that the point of sale survey should be designed to obtain as close to a complete list of buyers as possible. This type of information would also be of value to AMS since the decline of organized markets and the decentralization of price discovery for many commodities has necessitated price data collection from more and more points in the market area.

A point of sale survey and probability surveys will not help to solve all of the problems alluded to earlier. Many of the problems arise from changes in price discovery mechanisms and not necessarily only the point of sale. Thus any point of sale survey must also be concerned with obtaining information about the use of various price discovery mechanisms for each commodity. Failure to collect this type of data could prevent USDA price data systems from responding to the changes that have already occurred.

Since SRS is interested in a price which eventually yields farm income, any changes in pricing points, i.e. points of sale, must be coordinated with the expenditure survey used to determine farm expenses in order to arrive at accurate estimates of net farm income. This would tend to mitigate some of the product definition problems caused by differences in the amount of services provided by the producer or purchaser in a transaction.

To consider the specific problems in aggregating and collecting prices on individual commodities would require considerably more in depth analysis than has been undertaken here. For instance, a problem mentioned earlier brought on by formula pricing in milk suggested that preliminary monthly milk prices are potentially inaccurate. However, before one can recommend the elimination of these estimates a study of the uses of this price data and their relative accuracy must be considered. In apple price reporting, a study of the uses and users of apple price data is needed before suggestions can be made as to the relative merit of defining price as a packinghouse door price versus a first delivery price versus an on-tree price versus an as sold price. Each of these four price definitions are used by one or more states in the U.S. to collect apple prices. A list of such examples could go on for pages. Hopefully this paper has at least stimulated an interest in economists to begin to examine some of these more mundane and practical problems which statisticians face in operating the price data systems on which economists rely in their research and policy analysis. Economists must be willing to cooperate with and take the responsibility to join statisticians in the design of data systems. Without this cooperation economists will not have data for their analytical models which has the same conceptual base as that of their models. Without such a common conceptual base the building of analytical models is an exercise in futility.

Economists in cooperation with statisticians can play a key role in reducing one other significant problem that affects USDA data systems. Voluntary reporting is a central feature of USDA data collection. In recent years the percentage of non-respondents to USDA mail surveys has steadily increased, making it more and more difficult to collect accurate prices and other data. Economists must be willing to educate those members of the agricultural community on whom the USDA relies as data sources of the importance of responding to USDA surveys as quickly and accurately as possible. For if the current trend of declining response rates continues, the ability of the USDA to collect any valid raw data will be seriously impaired. Without this data the ability of economists to do meaningful policy analysis and research would be greatly reduced. Both public and private decision making would be impaired.

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PRACTICAL PROBLEMS IN PRICE REPORTING

by
Dr. Walter J. Armbruster
Staff Economist, Agricultural Marketing Service
U.S. Department of Agriculture

and
Dr. Richard J. Crom
Agricultural Economist, Economic Research Service
U.S. Department of Agriculture

Difficult practical problems must be confronted in incorporating the theoretical concepts discussed in the papers by Riemenschneider and Houck into a workable price reporting system. Some of our discussion may sound repetitive of the earlier papers, though most points discussed extend the theoretical concepts into the unglamorous world of operational price reporting. The problems discussed lie at the heart of the agricultural data system, which is only as good as the data collected and disseminated.

A number of the problems are relatively new to the agricultural data system, directly related to recent changes that have occurred in the agricultural marketing system. Changes in market structure have been associated with shifts in sales away from traditional terminal markets and greater reliance on contract sales. These changes have intensified problems associated with gathering and disseminating market price and quantity information.

Other items are becoming a problem and will likely be more critical in future years. Increasing distribution costs for market news, either mailed or electronically distributed, are being faced. Serious questions may arise as more commercial firms become involved in dissemination of market information. What is the proper role of government in data collection and dissemination versus that of private agencies which may develop similar capabilities, at least on the dissemination side? Some potential problems of the future are associated with the possible impact of electronic marketing systems on market news.

And there are old problems that have been discussed a number of times without really being solved. Questions related to apparent lack of scientific rigor in some data-gathering activities, resistance to making changes in markets for which information is reported, and so-called market thinness--a relatively small volume determines the price reported, which in turn affects the price determined for a much greater volume--all remain unsettled.

CHANGING MARKET STRUCTURE

One of the primary purposes of market information provided through government facilities is to facilitate the short-run marketing decisions of buyers and sellers. It is assumed that farmers, given better data, will fare better than otherwise in dealing with the buyers of commodities who generally have much greater bargaining power relative to sellers. The buyers usually have larger operations and can either generate or purchase economic information superior to that of the producer. Individual producers, or producer organizations which may be limited in geographic expanse and number of members, are in a relatively weak position in the pricemaking process. They are generally assumed to be much less capable of funding the data collection and dissemination or market intelligence functions than are the firms to which they sell. It should be recognized that some producer organizations engaged in bargaining have availed themselves of all obtainable data. But that largely means obtaining data from government or commercial sources rather than generating their own data.

Shifts have occurred in transaction location and form which make the individual producers even more subject to disadvantages in bargaining power. They are often dealing with handlers on a one-to-one basis, and generally have less knowledge of the market situation than the buyer. In fact, individual producers are often more interested in production than in marketing. Under the central market or terminal market transaction system, a number of buyers and sellers were brought together to auction the commodities in a situation not conducive to extensive exploitation of market power.

The changing form and location of transactions make more difficult the provision of market information to offset the perceived differences in bargaining power between buyers and sellers.

Transaction Location

Over the past 10 or 15 years, there has been a marked shift in the geographic location and market level at which market transactions occur. For most commodities, this shift can be characterized as a shift from central market sales points to dispersed locations or direct sales through contracts or other arrangements. In many instances, this leads to smaller volumes per transaction. It always increases the number of transaction locations. The net result of these two changes is greater difficulty in identifying what prices to report as representative of the market. With central market locations such as terminal livestock markets or wholesale fruit and vegetable markets, it is possible to observe transactions as they occur in one physical location. If an individual central market transaction does not involve a large volume of commodity, a series of transactions in a short time period establishes a price for a quantity at that location. In decentralized markets, it may be very difficult to obtain data for large volumes, depending on concentration of production in an area. For example, the Texas Panhandle is much easier to report for fed cattle than is Wyoming where there is no large, concentrated feeding area.

The broiler industry provides an illustration of drastic changes in geographic and market level transaction locations, accompanied by changes in market news to accommodate information needs. When poultry market news reports were initiated in the 1930's, they reported terminal market prices for live broilers. In the mid-1940's, reported prices were based on actual sales involving change of ownership in the producing areas. The trend to integration which began in the 1950's saw the advent of an "at the farm" quotation in the early 1960's. It was not the result of an actual transaction, but served as a base for open market sales and intracompany sales. In 1965, USDA market news discontinued reporting live broiler prices and began reporting negotiated prices for ready-to-cook broilers. Prices are now released representing weighted average prices for nine cities to provide a national figure in addition to prices released for 14 pricing points across the country. Those prices represent "iced" broilers; hence, are now open to criticism as the industry starts selling "chill-pack" broilers.

Today, transactions for broilers only occur at two points prior to retail. One is at the transfer point for ready-to-cook broilers between processors and distributors or retailers, where a price is established and is reported by USDA. The other transaction point is the determination of payments to contract growers.

Over 90 percent of broilers are grown on production contracts. However, contract payments to growers are not reported, largely because of strong broiler processor opposition, though USDA reports first transaction point information for most commodities. That first transaction generally represents a price which amounts to payment to the grower for production inputs, management efforts and return on investment. For contract production of processing vegetables, the amount of production inputs paid for in the grower contract price rather than being furnished by the contractor differs from that in broilers. Deserving attention are two questions:

1. Whose interests should be most heavily weighed by USDA in deciding what should be reported?

2. Should USDA report payments to growers for production contracts which do not involve actual exchange of ownership?

A related problem lies in determining for which geographic locations prices should be reported. For some commodities, observed or recorded prices can be adjusted to a central location for reporting purposes. This requires taking into account transportation costs and any differences in product form or quality. It may be preferable to report sales f.o.b. the area or market where the sale is transacted due to variations in freight rates or other costs which confound the determination of how much to add or subtract from a base price.

Determining desirable reporting points is important in determining how many locations are necessary to adequately report true market pricing decisions. One difficulty encountered in changing the reporting system to accommodate changing geographic transaction locations arises from industry opposition. It may be very difficult to close a market reporting location or discontinue a report in which certain parties have a strong interest. An example of this was experienced within the past year upon announcement of intended elimination of regional grain market reports. Pressure was brought through Congress to continue the reports, even though a national report covering the regional markets in less detail would have been available.

An additional difficulty in changing the market reporting system to accommodate change in transaction locations arises from the operating system of price reporting and budget limitations on that system. One person can cover a centrally located market. If those transactions switch to scattered points outside the terminal, more than one person may be needed to obtain information on the same amount of product sales and travel costs increase dramatically.

Recent developments have made the world market impact more important to U.S. producers. This calls for more reporting of data on import and export sales. In some cases, notably grain, transactions may involve one or a few major trading companies who may be reluctant to disclose price data. The importance of such transactions to U.S. prices makes it imperative for USDA to report them.

Market reporting traditionally has been funded through appropriations which must be obtained in Agriculture's budget each year, but difficulties have been encountered. Some of the difficulties arise from mandated programs which also require appropriations. Thus, market information reporting must compete with regulatory and other programs monitoring the marketing system which often have more support or visibility. The result is difficulty in obtaining funding to expand the market information program or even maintain its relative size.

Form of Transaction

In addition to changes in transaction locations, there have been major changes in the form of transactions. One such change has led to the producers signing a contract with a handler or sales firm to purchase his production at a predetermined or formally specified price. One problem in price reporting under this arrangement concerns the possibility of disclosing individual operations. On the other hand, not reporting such prices to avoid individual disclosure could eliminate all sources of information on prices in a market that went almost entirely to contract sales--the "market thinness" dilemma.

Another difficult problem involves contracts which specify the price in terms of some formula or prescribed indicator tied to time of delivery or other date. The prices may not even be known by the buyer or seller until or after the time of delivery which could occur months after the sales agreement was signed. What is the appropriate time to consider as the reportable sale--time of agreement, delivery, pricing, or all three?

Contract sales reporting requires determining the terms of trade and a proper description of the commodities being traded. If each contract differs, it may be extremely difficult to undertake standardization of terms reported; perhaps, it is better to report the terms for the individual transaction. But this brings us full circle to the individual disclosure problem.

As alluded to in the preceding paragraphs, obtaining reportable information is a major problem in timely reporting of contract sales. The problem arises both from reluctance of market participants to divulge information and from difficulty in specifying terms to be meaningfully reported.

In addition to complexities associated with the growth of contract sales, difficulties are attributable to changes in the type of commodity being sold. Raw commodity sales must be reported separately from sales of a partially or completely processed commodity. For example, the recent growth in sales of boxed primal and subprimal cuts of beef have made it necessary to report these sales to accurately reflect the beef market. And USDA market news has started reporting a computed carcass price to provide the producer information related to his interests. An important element of information influencing this market is the inventory of boxed beef, which is currently not reported. Concern about the proper point of transaction for reporting is related, since pricing can be assumed to occur at the point where inventory changes occur.

Transaction Technology

Electronic marketing systems are in various stages of development for some commodities. Such electronic technology as used in telephone auctions, teletype auctions, and computerized trading systems makes possible centralized price negotiation without physical proximity of market participants or products. These markets provide competitive marketing opportunities previously afforded by terminal markets, but require accurate product grading to permit transactions to be entered confidently. One requirement for a competitive market is availability of information. The electronic exchanges generate instantaneously updated information on price, quantity, and terms of trade--the information provided in traditional market news reports. But information on these markets needs to be reported, probably by the government, unless the electronic market is the entire market for the commodity.

Examples of operational electronic marketing systems can be cited; some have operated since the early 1960's. Proposals for computerized trading systems similar to the TELCOT trading system for cotton have been developed. Whether these will be developed into major marketing systems for other commodities in the near future is open to speculation. Where they do develop, the traditional methods for price reporting may become obsolete. Price information could be recorded for historical use directly from computerized systems.

MARKET NEWS DATA COLLECTION

Some of the market structure changes discussed above are directly associated with problems of data collection. A few difficulties encountered in collecting data have existed from the beginning of market news reporting. A number of items may be identified as concerns related to the data-gathering side of the market news system.

Lack of Scientific Rigor

Criticism is occasionally leveled at data collection procedures used for market news by those concerned with statistical accuracy and rigor. Market news data collection is not a science; it is more an art of acquiring what might be called market insight. This makes possible the reporting of prices deemed representative of the transactions occurring. Some of the arguments which seem to favor such an "art" approach over a more scientific approach involving well-designed statistical sampling plans are discussed in the next few paragraphs. However, that doesn't mean that we should discontinue examining possible ways to improve the rigor of data collection procedures.

Ascertaining the exact quality associated with a given price complicates market news reporting. It may be difficult to obtain a cross section of like quality and associated prices to provide a reportable amount in a given class. It may also be difficult to determine exact terms of sale, since differences in quality, form, or time are presumably built into the sales terms--but may be less than readily apparent. Further, there may be additional factors in a transaction which are hidden. For example, if a producer had a relatively small amount to sell but needed the money quickly, he might take a discount relative to a similar lot held by another producer. Such a distress sale complicates accurate price reporting.

Another concern in price reporting involves verification of prices and terms reported. Ideally, one might check with the buyer and the seller on the same transaction. Practically, this may be unworkable because it would greatly increase the workload or in some cases be impossible. However, if there is any doubt about the information obtained, every effort is made to verify that information either for the individual transaction or by comparing it with similar transactions before reporting it as a fact. This is especially true for prices which are on the extreme ends of the range being reported.

In some cases, sellers may be interested in determining the value of their product to the buyer. For instance, if a processor is buying potatoes to process into french fries, they may be of less value to him than to a fresh market buyer, even though of the same quality. Presumably, the competitive market system would bring the prices into alignment. Perhaps the producer should only be concerned with the price he can expect at time of sale rather than how his product is eventually used. Many slaugther cattle are bought for a specific customer's needs. If quality of the carcass does not meet those needs, it may be of very little value rather than worth some discount from a base quality. Prices reported should thus be related to use if the purchases for different uses carry price premiums or discounts. Special circumstances associated with purchases must be accounted for in reporting.

The problems discussed above--quality, terms of sale, verification, and product use--all contribute to the difficulty of imparting strict statistical rigor to the price reporting process.

In contrast, tobacco market news reporting provides an example of a situation in which none of these problems are found. A government regulated sales system is closely associated with the price support program. All sales are made by scheduled auctions at public warehouses, and numerous grades for different qualities make possible detailed relation of price, quality and quantity data. These features of the tobacco market greatly ease the burden of collecting thorough, accurate data. While the system simplifies the reporting burden, producers of many commodities would not likely favor such a controlled market, nor would economic efficiency lead to such a marketing system. Therefore, the tobacco market news system is an interesting but isolated example.

Number of Reporting Points

It is impossible to cover all places where trades occur in a decentralized sales system. Therefore, it is necessary to determine how many market points need to be reported to adequately reflect the market and number of characteristics need to be considered. Among those characteristics are geography, relative volume represented, impact of the market, number of markets reported from the area, and quality available at a given market. More importantly, how closely are price changes correlated at the different locations? Do prices differ only by transportation costs between market locations and thus not result in additional information if included in reports? Currently, we do not have a scientific or even a generally rigorous system for determining how many reporting points are needed to accurately reflect the market situation. But this problem appears to lend itself to such rigor.

Since it is impossible to cover all places where trades occur, perhaps emphasis should be placed on national or regional reports rather than local reports. This would require identification of reporting points that could be eliminated and focusing on major pricing or trading points. It would also call for examining market levels reported. For example, what level of price to report is an especially important question for grains. Should it be purchases from farmers, purchases from first handlers, or prices at export and processing points? Of course, economic factors are not the sole criteria for deciding location of reporting points.

Small-Volume Transactions

Another problem faced in collecting market news is the relatively small volume represented by sales at some major pricing points. Can criteria be developed to determine what is a significant volume of a commodity to report? Is volume alone a determinant or is number of participants a more important factor in describing the importance of a market? Should some minimum percent of total volume be traded at a pricing point before it is reported? Or do other factors override both the volume and number of participants in determining appropriateness for reporting? These are questions faced for almost all commodities. The problem is especially difficult in some markets. Some examples will highlight specific problems.

The Urner Barry price quotes for eggs represent cartoned egg sales in the Northeast. Though based on a very small sales volume in the New York market, the price established by Urner Barry then becomes the basis upon which prices are set for eggs in much of the U.S. For butter and cheese, relatively small volumes traded on the Chicago Mercantile Exchange and the National Cheese Exchange at Green Bay, Wisconsin, are the price indicators for most butter and cheese traded in the U.S.

For grains, the terminal market cash sales transactions reported may represent a small proportion of actual grain volume. The percent of railcars arriving in the Kansas City switching district which are sold on the Kansas City Board of Trade cash market is small and declining. It was 10 percent in 1970 and is about 6-7 percent now.

Raw sugar markets are characterized by infrequent, large-volume transactions. U.S. raw cane sugar prices are announced every business day by a committee of the New York Coffee and Sugar Exchange. The five-member committee of refiners (buyers) and merchants (buyers and sellers) has information on actual transactions on approximately 13 percent of the days. The prices put out by the committee were used by USDA under the old Sugar Act; are widely used as the basis of prices on forward contracts; and provide the basis for payments to cane growers. World raw cane sugar prices are also announced every business day by another committee of the New York Coffee and Sugar Exchange. This committee has actual transaction information on about 11 percent of the days.

Though these committee-determined prices are nominal prices most days, they represent the judgment of trading representatives. While this pricing method does not fit our generally accepted approach, it closely follows the price discovery process carried on in the sugar futures market. And it can be shown that the committee prices add information related to the value of raw cane sugar.

Voluntary Cooperation

Aside from questions discussed above relative to representativeness of data collected, the market news price reporting system is predicated on voluntary cooperation which can also lead to problems. For instance, a buyer or seller could report only the sales most favorable from his viewpoint; that is, the lowest price paid for the highest quality bought, and vice versa for a seller. This is a criticism of the National Provisioner's Yellow Sheet prices for meat and other commodity reports for which information is gathered in a similar manner by telephone from a limited number of sources.

An additional problem of reliance on a voluntary system is that information may be obtained mostly from "cooperative" buyers or sellers, even though they may not be the most important pricemakers in the system. Indeed, it could be hypothesized that the most important pricemakers would have no incentive to cooperate. Their relative strength in the market would likely discourage disclosure of information relative to their transactions, since it weakens their advantage by making others more competitive. It may be possible to check with enough buyers to obtain information on prices paid by sellers who are uncooperative, but it is more difficult to similarly obtain data on volume.

Closely related to this problem and the changing market structure is decreasing cooperation in some market systems as they become more closely tied to individual transactions or in a sense "closed." Such closing of the market transaction system occurs through contracting, integration, and other forms of marketing which tie buyers and sellers together.

Finally, we may find large operators arguing that they are not willing to furnish information voluntarily because of antitrust implications. This is not a valid argument. Providing information about completed transactions does not constitute price fixing, as would discussions in advance of transactions.

All these issues related to price reporting under constraints imposed by the reliance on voluntary cooperation raise a question about the content of market price reports. What is the proper role of USDA in determining what types of information will be reported? Some changes, such as to start reporting contract prices for all commodities, are violently opposed by those buying on contracts. Experience in some states indicates little problem in getting sufficient cooperation to report contracts meaningfully, once the program is initiated. Perhaps USDA should adopt a more positive stance in initiating reporting especially when backed by research or consensus of analysts not directly involved in the industry that such reporting would benefit producers.

It may be necessary, as some of the changes we've been discussing continue, to pass legislation making the provision of market information mandatory. That should be considered a last resort, but may be the only way to assure continuation of a market news system as we now know it. One concern involves possible provision of less reliable data than obtained under a voluntary system.

In addition to the issues that are of direct concern to market participants, some data collecting questions are of greater concern to market analysts. The analysts may provide input used directly in trading decisions, or they may write market reports for use by all market participants. Two areas of concern appear to merit particular attention--data to reflect commodity utilization and world market data.

Commodity Utilization

In many cases, prices are reported for certain specific grades and sizes of product. However, statistical series reporting prices and quantities utilized often do not provide any information about the area of production or the potential end use of that production. These aggregate data may be sufficient to indicate the price being quoted, but not sufficient to allow detailed analysis. Statistical Reporting Service utilization data for potatoes is illustrative.

Potato production comes from three regions, and production from each region has several potential end uses. To make the data of more use to market analysts, data are needed for each producing region indicating whether the product is destined for table consumption, chip making, freezing, or dehydration. Currently, average prices received by farmers are reported by states. For most commodities, no prices are reported by use nor are utilization data reported by production area, but only for the total U.S. Such aggregation makes the available data much less useful for analysis than that collected in deriving the published series. Arguments concerning disclosure of individual operation should be carefully evaluated rather than allowed to foreclose publishing valuable data.

Market analysts also need to know how much of a particular product is in storage as well as the quantity being moved. Lack of data on processed product inventories makes it impossible to accurately analyze market implications of an estimated production. Unfortunately, in the case of many commodities we do not know current inventories. Lack of adequate data on potato inventories has presented a problem for the Commodity Futures Trading Commission in its recent investigation of alleged abuses in the Maine potato futures market.

The beef industry is facing new uncertainty related to stocks of boxed beef, which is stored for several weeks. It is not included in the ending stocks report for beef because most boxed beef is not kept in public warehouses. And it is often stored less than the 30 days needed to cause it to be reported by public warehouses.

World Market Considerations

Another major problem faces the market analyst; the world market is becoming increasingly important. This complicates market analysis because of uncertain world demand, not to mention the added hazard of potential government intervention. Further difficulties are related to lack of accurate price, production or stocks data. The foreign demand for many domestic commodities may shift abruptly because of weather influences, foreign exchange rates or explicit government policy. We became well aware of the drastic implications this has for domestic markets when grains became short in the Soviet Union in the early part of this decade. We found that price changes of 100 percent are indeed possible.

Faced with the uncertainty of world market demand, but nonetheless subject to it, U.S. market participants need the best possible information and analysis of the world market. It is no longer sufficient to report domestic prices and quantities, particularly for some commodities. Current data available for foreign markets should probably be incorporated into market news reports for those commodities influenced by the world market. Agricultural attaches and USDA's Foreign Agricultural Service are possible sources of current market data.

MARKET NEWS DISSEMINATION

The marketing structure changes, changes in form and location of transactions, and associated problems in obtaining representative market information complicate data collection. Practical problems are also faced in disseminating the information in a timely and efficient manner. Though of concern since the inception of market news programs, some problems are especially pressing in the current price reporting system.

Timeliness

Depending on the user, market information may be relevant and useful for a matter of weeks, days, hours or minutes. Market news reports for the individual commodities are focused on the short-term data, while Statistical Reporting Service and Economic Research Service data series provide historical information and projections. Government price reports traditionally have been mailed to interested users. While much of the current market news is now transmitted by electronic processes, mail delivery is still important. Mailed reports may provide more detail and provide a cross-check for radio and other electronic means of dissemination. Some users are interested in receiving the data in printed form which can be used to update records. This includes USDA agencies such as the Economic Research Service and university researchers in addition to market participants or their representatives.

The mail delivery system may also be appropriate to keep producers informed during periods when they are not directly engaged in marketing. For example, the Iowa hog farmer who farrows on a two litter system and markets two times during the year, or the Ohio cattle feeder who feeds one or two lots of cattle per year, may be interested in keeping up during the year. They only need up-to-the-minute information for a very short time when they are ready to sell. The mail system is quite adequate for them during most of the year. Some markets which change gradually may be adequately covered through mailed reports. However, for some other users of the information, mailed reports may be totally useless. They are active in the market which is changing constantly, and their profits or losses may hinge on being currently informed.

Ordinary radio, side-band radio, commercial teletype or video (Reutters, Commodity News Service), and newspapers are all important means of disseminating market news. The teletype has been in use by market news for many years for speedy dissemination of market prices. The leased wire is available for a fee to those so desiring. Customers for this service are large buyers, market traders, large-volume producers, and media who further distribute the information. The farm radio and TV shows are a free promulgation device for market news. Usually, the programs are sponsored by commercial firms seeking to advertise their products and appear two to three times per day.

They are usually sufficient to inform the producer who is making marketing decisions over the next few days. The public media probably provides sufficient timeliness to anyone who does not do a sufficient volume of business to afford a leased wire unit.

The small short-wave radio is a recent innovation in electronic price exchange mechanisms, which may further enhance buyers' bargaining positions compared to producers. Packer buyers on terminal markets have used walkie talkie devices for several years in maintaining contact with head buyers assessing the total supply, and keeping up on current market developments. This may give them a substantial bargaining advantage even over the terminal commission agent. The current "C-B" radio available to country buyers enables them to buy cattle from large feedlots such as those in the Texas Panhandle, while maintaining constant contact with the head buyer for market information. When packers realize that the day's kill is bought, prices may fall substantially. On the other hand, widespread knowledge of producer difficulty in delivery, such as caused by impassible rural roads, can increase prices sharply in a matter of minutes.

Such rapid flows of information can cause rapid changes in market situations. Instant knowledge of supplies at other markets, even in other states, also has a direct bearing on price quotations for the day. Particularly, price quotations in the western time zones may alter after eastern markets have closed. Clearly, mailed market news reports don't fulfill the information needs in such situations.

Funding

While the mail still represents a low cost form of market news dissemination to individuals, the cost of the mails has gone up considerably in recent years. Costs estimated for reports vary by commodity, depending on frequency of release and content. If they arrive too late for intended use, mailed reports are of no value. They should be reviewed regularly to assure that the content is useful at the time of receipt. Regular review of mailing lists to determine characteristics of recipients is a prerequisite for meaningful evaluation of content usefulness.

Alternative forms of disseminating individual reports are not cheap relative to mailed reports, though mass media dissemination generally is the cheapest per person reached. Daily "Yellow Sheet" subscriptions cost $120 per year. Electronic equipment is quite expensive; the annual cost for a leased wire hookup is about $1,500, and line charges are additional. Two-way radio service is an individual cost consideration within firms; however, they must invest several hundred dollars for useful communication devices.

One question that has been receiving increased attention is whether government market information should be distributed to users for a fee. If so, should the fee cover only the cost of distribution, or should it cover the cost of collecting market news as well? The question has largely been raised in connection with mailed reports as postage costs increase. Undoubtedly, the number of subscribers to government statistics will drop considerably if a charge is made. Based on experiences of the National Marine Fisheries Service, Department of Commerce, it would be mostly small subscribers who quit. However, the Economic Research Service has put a rather substantial fee on a publication which summarizes the Agricultural Outlook and has maintained a large subscription list. Most commercial market news services, which have been growing in size, charge substantial fees.

Market news was initiated as a government service to aid many small producers. It has evolved to be of considerable service to large commercial agri-business firms as well. Is it equitable for such firms to receive market news provided at public expense on the same basis as individual producers? Or should a user charge be made to such firms? If so, what should the private party's share be? If charges are instituted for mailed reports, should they also be instituted for receipt of other regular releases on alternate dissemination devices?

Another question concerns the resale of public information by private firms. Public market news data is often the primary base of private market news services, who resell it for a profit. Should some graduated fee schedule set higher charges to such users than those to individual recipients not reselling the data? The farm news media argue that they provide a free vehicle for disseminating government market information. Could an argument be made that public market news agencies could afford to pay a fee to radio and TV for disseminating their information?

One problem likely to be faced if user fees are instituted is whether free data could still be obtained. The National Marine Fisheries Service found resistance from market participants to providing free data for inclusion in a publication for which they had to pay. They attempted to deal with the situation by furnishing free reports to cooperators. Questions developed about how direct the input must be to qualify one as a cooperator. So the issue of free data acquisition may be faced in conjunction with initiating user fees.

Costs continue to increase for traditional forms of market news dissemination. New technology makes possible additional methods of dissemination, but usually at relatively high costs. Funding of market news increasingly is a problem. Calls for new reports, expansion of reporting points, or additional content create new demands for what has been rather static appropriated funds. User fees are generally discussed in the context of covering the costs of printing, handling, and mailing printed reports. Those costs represent approximately 10 percent of the current market news expenditures. Attempts to reallocate funds from declining to expanding markets are met by pleas to maintain the status quo, or at least expand without cutting established programs.

Requests for funds to expand market news services are increasingly countered with demands to demonstrate the economic value of market news. Economists have long espoused the need for information to provide a competitive market environment. Attempts to measure the value of market news have not been particularly successful, probably for the very good reason that it is difficult to develop criteria for measuring its value. But we will probably continue to see increasing interest in comparing the benefits of market news with its cost. Perhaps the most important research contribution to market news would be development of a satisfactory measure of its value. It is an area generally neglected by agricultural economists, though general theories of the value of market information are becoming more widespread. Efforts are needed to evaluate the contribution of market news to increased incomes or economic welfare. Only when its value is adequately measured can we determine if such programs are about the right size or should be doubled or halved.

ROLE OF MARKET NEWS

The goal of the market news service is to collect, analyze, and disseminate market information to help coordinate the production and utilization of agricultural products. Historically, market news reporters have reported prices for a narrowly defined product usually described by grade and weight. They have varying attitudes toward indicating reasons for any price changes or conditions of sale. Such interpretation is viewed by many as a necessary addendum to the prices reported.

Interpretation of Data

Earlier, we alluded to the need of decisionmakers for analyses rather than just data. The general philosophy underlying market news has been to provide raw data to the user for his analysis. The degree to which interpretation of reasons behind observed prices was presented varied by commodity and reporter. Today's decisionmaker is more sophisticated. He needs to know about changes in supply and demand conditions, supplies of competing products or markets, and shifts in nonmarket factors such as weather. If the user knows the factors affecting a price change, he can likely react better in making his own marketing decision.

Price data are often reported as if all transactions took place under similar conditions, which was more nearly true under the terminal market system. It may be as important to know what conditions surrounded the sale as to know the price itself, since decentralized sales complicate reporting a homogeneous sales unit. For example, in the case of direct sales of livestock, one is interested in knowing where and when the livestock will be weighed, how quality will be determined (perhaps carcasses graded after slaughter), who pays transportation costs, the day of delivery, and how allowance will be made for weight loss (shrink) during transit and/or any damage to the animal such as bruises incurred in transit. Many of these conditions are currently reported along with price data, but the burden of dissemination may be greater than the value of such information as the amount of such information increases.

It may also be useful to know the bargaining situation surrounding the pricing process. Did the buyer and seller have equal information and strength, or did the buyer have superior information? This is often the case in many commodities where there are relatively few buyers compared to the number of sellers. But if a bargaining unit represents producers in establishing the sales price, a different outcome would be expected. The size of production unit may also have a bearing; for example, livestock producers having several thousand head of livestock for sale per month are usually much better informed than those selling an occasional small lot.

Finally, USDA rules forbid disclosure of information unless at least three individual firms have provided information which is then aggregated. It may be more difficult to avoid disclosure of individual confidential transactions when quoting direct sales, particularly if individual terms of trade are analyzed. The market news reporter interpreting data would be faced with getting enough coverage so that the disclosure rule is not violated.

If the interpretative role is added to market news, the market news staff may need to be augmented with some analysts. In addition, the Department would need to know the level of economic knowledge of the audience receiving the information. For example, small producers will require a less sophisticated analysis than the large market trader or agricultural processing firm.

The need for timeliness cannot be relaxed; yet interpretation takes time. The analysts would need to be housed in the areas where the information is being assembled to provide immediate access to preliminary and successive stages of data as it develops. These additional services will require more sources; only the user can evaluate the added costs and whether they are justified in public or private support.

Adapting to Changes

It is sometimes argued that more reporting of retail prices would be a desirable change in market news. The current system and associated expertise could thus serve a wider audience by expanding its role. Such information would serve the needs of others than producers and traditional marketing firms. It would also better serve the interests of producers by giving data related to the question of how accurately or quickly farm price changes are reflected through the marketing system to those who purchase the products. It would serve well the needs of economic analysts, policy makers, and the marketing system generally.

We can probably assume a wider audience for market information in the face of recent experiences with more volatile food and agricultural commodity prices. If so, should more attention be given the level of understanding of the audience and the terminology of price reports? Are we bound unnecessarily by technical definitions, or is the terminology used understandable to those not directly involved in the trade? Are there inconsistencies in terminology between reports issued by different agencies of USDA?

Finally, is better coordination between USDA agencies involved in disseminating price reports called for? A meaningful data system attuned to the current agricultural market structure is needed. Can it be maintained in top condition when responsibilities for various segments of that system lie with different agencies, even reporting to different USDA policy makers? What actions may be taken to assure proper coordination among the agencies?

The issues or questions raised throughout this paper have all been discussed in terms of possible changes needed to assure the continuing relevance of the agricultural data system. Our system has been better than that of any other country. It will remain so only if we deal satisfactorily with some of the problems faced. Research on some of the topics may be needed. In other cases, solutions may be derived from the collective thinking of groups such as this one.

Rapporteur's Report on Price Reporting

M. C. Hallberg

The session on price reporting was concerned exclusively with AMS market news and SRS prices. Participants of the session, following the lead of the authors and discussants, reviewed the conceptual base having a bearing on these price series, and discussed several operational problems associated with the collection and dissemination of these data. The intent of this focus was to help in the identification of weak links in the price reporting systems and to suggest needed changes or, at least, establish some priority areas.

Professor Houck reviewed the role prices play in an economic system. In theory prices serve three major functions--allocation of scarce resources in the production and distribution of goods and services; distribution of economic rewards among people, places, functions, and time; and equilibration of supply and demand. Prices also serve as an aid to the understanding of the marketing system and in judging how well the system performs.

Houck also discussed how prices are perceived and used in both the abstract and real worlds. He noted that perceptions of price have become quite "fragmented" particularly in markets where pricing takes place under negotiated production contracts, forward delivery agreements, vertical integration, bargaining, etc.--a theme which permeated the entire session.

Mr. Riemenschneider, among other things, outlined the essentials of a theoretical framework for evaluating the economics of information systems in general, and price data systems in particular. Two key elements of this framework were (1) the relationship between the economic structure of the sector and the demand and supply for information relevant to decision-making in the sector, and (2) the relationship between the distribution of information and the distribution of income in the sector. Collectively, these elements relate to how much and what type of information is needed and who will or should supply it. Riemenschneider then attempted an evaluation of the AMS and SRS price data systems based on the previously developed framework.

By the first two authors we were reminded that supply and demand forces interact to determine equilibrium prices. They went on to point out, however, that economic agents must discover these prices before they can be used in the allocative process, and that prices are discovered through the interaction of buyers and sellers and the information they possess. This interactive process is often quite subtle and complex, reflects uncertainty and randomness, and is subject to an uneven distribution of knowledge and/or capability to analyze knowledge. Hence, the process of price discovery is imperfect, subject to rigidities, and can and does take a variety of different forms depending on the structural characteristics of the market. This, in turn, reflects on the quality and usefulness of the data available for collection by USDA as well as on the need for price data of the type considered.

Riemenschneider deals at some length with the relationship between price discovery and market structure as to Armbruster and Crom. A variety of considerations are relevant here which Armbruster and Crom handle under the headings: transaction location, form of transaction, and transaction technology. But Armbruster and Crom went substantially beyond the previous authors by discussing several practical problems associated with the process of price data collection and dissemination brought about by structural, institutional, and technological changes in the market.

Thus, the major concern of the session was on problems related to price data collection resulting from the variety of and changing nature of the economic structure and institutional character of the agricultural industries. There seemed to be general concensus that AMS market news prices are most useful as a guide to the short-run allocative decisions of firms, while SRS prices help firms make long-run allocative decisions and, perhaps more importantly, aid in the analysis of a market's performance where information on money flows is required. Since tracking a market's performance is of obvious importance, so too are SRS prices. The nature of the institutional and structural characteristics of most agricultural industries led to the general suggestion that priority be given to SRS prices at the expense of AMS market news prices. Another suggestion was to report information on the terms on which the reported prices are based--e.g., number of transactions, contract terms, etc.--so the user can assess the adequacy of the reported prices for his purposes.

A vast array of problems having a direct bearing on prices collected by USDA were identified here. Some of these problems have been with us for a long time; some are of recent origin. I doubt, however, that any caught the participants by surprise! While identification of problems is a necessary first step, the real question, left unanswered by this group, is what to do about them. The answer to this question will come from future workshops directed to this issue and from additional research. Research needs suggested include (1) studies designed to determine the value of information to different groups so that realistic priorities can be established, and (2) studies designed to isolate or clarify the structural characteristics of the various agricultural industries so we can not only identify data needs but the appropriate level at which price data should be collected.

Series A Price Team Recommendations that might be useful to USDA in improving the Price Data Systems.

1. The Statistical Reporting Service should provide more detail in a supplement to its SCOPE AND METHODS publication. Detailed documentation on how price data are generated is needed by agricultural economists. Compiling this detailed documentation would also help statisticians think through the system of setting estimates and would standardize collection, etc. of price data. Agriculture Handbook #365, "Major Statistical Series of the U. S. Department of Agriculture--How They Are Constructed and Used" should be updated.

2. Reevaluate the entire AMS Market News Pricing System. Past attempts to close individual markets of decreasing importance have not been well received. The total Market News System for the country should be evaluated instead of concentrating on individual markets. One approach would be to examine the utility of wholesale price reporting and the desirability of Market News competing with such reports as the "Yellow Sheet". The timeliness of mailed publications relative to their purpose should be evaluated.

3. Develop a USDA policy for reporting contract sales, particularly for commodities where contract pricing is important (fruits and vegetables, broilers, etc.). In the development of this policy consideration must be given to the impact the policy could have on current price series published.

4. SRS should develop information on alternative price discovery mechanisms, composite estimating system, and alternate sources of data used in various geographic locations. This information should be transmitted to all of SRS's field offices.

5. SRS should consider expanding probability sampling concepts for other price series. Probability concepts are currently being used for pricing grain and cotton. Look closely at commodities that will cause problems when developing changes in price data collection methods.

6. Develop a clear definition of what constitutes a transaction for reporting prices. This needs to be standardized among commodities.

7. Improve education for farmers and agribusinesses on the need to report to USDA price data for the farm sector.

PERSPECTIVES ON CAPACITY CONCEPTS, MEASURES, AND USES FOR THE FOOD AND FIBER SYSTEM

by J. B. Penn*

Introduction

The convergence of a series of natural and economic events in the past few years has once again raised the Malthusian specter that warns that the world has a limited ability to feed its growing population. Although there are differences of opinion about the implications of the 1972-74 food crisis, and although we enjoy a respite from that acute situation, events during those years have underscored the ever-present question about the longrun food-population balance. U.S. consumers were insulated from critical food shortages, but the situation again prompted questions about the capacity of the U.S. food system and brought a renewed emphasis to monitoring its efficiency and performance.

Considerable literature is available on the subject of capacity, both specific to the agricultural sector and even more so for the general economy. For agriculture, there is an imprecision of language on this subject, with terms such as production capacity, potential, ability, and productivity used loosely and interchangeably. This creates confusion not only for economists, but also for policymakers, planners, and the public. This vagueness also suggests a needed examination of the appropriateness of our concepts, their measures, their uses, and ultimately the data that we collect and use. The problem of definitively treating production capacity is especially acute within the agricultural production sector because of the length and segmentation of the production process, the biological processes of production, and the vulnerability to weather variability.

This paper provides an overall perspective on the various capacity concepts in the farm and nonfarm sectors, their measures and uses, the relationship of productivity to capacity, and the potential linkage of the

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*J. B. Penn is Senior Staff Economist with the Council of Economic Advisors. At the time this paper was delivered, he was leader of the Agricultural Policy Analysis Program Area, Economic Research Service, U.S. Department of Agriculture. The helpful comments of W.E. Kibler, Eldon Weeks, and colleagues in ERS are acknowledged with thanks.

agricultural and nonagricultural sectors of the food and fiber system. This overview is intended to provide a context for the two subsequent papers which take up the issues in detail. As such, no original contributions are advanced--this is only an arrangement of "flowers from the gardens of others," and I have freely picked.

Uses of Capacity Measures

Measures of production capacity, capacity utilization, and changes in capacity over time are essential ingredients to economic analysis in a wide variety of areas. They relate centrally to many problems of current public concern--the rate of economic growth, the unemployment level, general price inflation, the distribution of income, the competitiveness of the United States in international trade, the cost of providing governmental and other essential services, and others.

Capacity is a key factor in many of the questions being asked of agriculture and the food system today. A keen interest in the capacity of U.S. agriculture is shared by nations around the world, now more concerned than ever about food availability, and by domestic producers, processors, and consumers concerned about farm product prices, farm incomes, and food costs. The increasing economic interdependence of agriculture and the nonfarm economy is drawing the attention of economic planners and policymakers concerned with the role of agriculture and food in domestic and international policy dimensions. Capacity of the food and fiber system is a fundamental component to inquiries in all these areas.

The importance of agricultural capacity measures is now widely acknowledged, and such measures will likely assume even greater importance in the future. Measures of the capacity of agriculture and the food system 2/ will increasingly be needed to respond to questions emanating from a variety of sources. These questions will address our ability to feed ourselves and provide contingency food assistance throughout the world; our ability to sustain a vigorous international commerce in agricultural products; the constraints on capacity of adopting alternative systems of meeting our food requirements in view of energy and environmental considerations; and the capacity implications of changing climate and weather patterns.

It has been observed that it would be difficult to identify any industry "...that has more facets more profoundly anointed or afflicted...by public policy" than agriculture (15). This means that decisions affecting capacity utilization and growth are jointly taken by the public and private sectors. The capacity implications of this pervasive "regulation" of the food system have not been deeply explored and merit careful research consideration.

2/ While perhaps not rigorously employed, the distinction in mind throughout this paper is that the food and fiber system is composed of input supplying, production (agriculture), and processing and distribution sectors. The term "agriculture" is generally used in reference to the production sector.

Additionally, the domestic agricultural and food policy focus over the next decade may well shift from the traditional preoccupation with prices and incomes to a concern for the structure of the food and fiber system. The implications for capacity and capacity utilization are such that precise measures will be required. The resolution of many future policy issues in a number of areas may well depend upon the impacts that proposed solutions have on capacity. As agriculture has become more integrally linked to world markets, other sectors of the food system, and the general economy, it would seem that a conceptually consistent and efffectively measured concept of production capacity across all sectors of the food system is warranted.

As important and as widely used as it is, capacity is, nevertheless, an elusive concept and a number of alternative definitions and measures exist (discussed in the next section). While this is often a source of confusion, it is not necessarily undesirable, as many of the concepts and corresponding measures are really of different things. Capacity figures in and of themselves are not very meaningful--to be useful they must be related to a particular context.

A primary reason for studying and determining capacity is to derive capacity utilization rates. Estimating both actual and preferred utilization rates is important in evaluating economic activity, helping to explain the behavior of investment, inflation, productivity, profits, and output, in assessing current economic conditions, and in forecasting future activity.

Unfortunately, alternative measures of capacity utilization, varying widely as to their levels and in their movements, do not always tell the same story. The usefulness of any particular concept or measure depends in considerable part on the purpose to be made of it. Any shortcomings or restrictions on the definitions, measurement procedures, or underlying data should ideally be limited to the purpose for which they are being used. While different purposes may be amenable to one or more of the concepts and measures, a uniformity across sectors or systems is needed.

One of the shortcomings in measures used to study the domestic food and fiber system is not necessarily that several concepts exist, but that there is not at least one concept and related measure applicable across all sectors. Currently, several concepts are used for the production sector and several are available for the inputs and the processing and distribution sectors; there is not one applicable to all sectors in the food system. For many of the uses for capacity measures, a uniform concept applicable to the entire food and fiber system and consistent with the general economy has much merit.

In making a case for this, Spielmann and Weeks (15) have stated:

> The estimation of similar measures (compatible with those of other economic sectors) in the farm sector would provide a vehicle for direct observation of the size, growth, and utilization of the industry for private and public purposes; provide assistance in assessing the performance of the industry for private and public purposes; provide assistance in assessing the performance of the industry with respect to general economic

goals of growth, stability, equity, and efficiency; permit the analyses and early detection of imbalance among trading industries in multi-industry commodity flow systems; permit analytical placement of measures of output in a perspective to allow refinements in productivity and efficiency measures for the industry and analysis of investment behavior; and permit analysis of the trade-offs between developing new capacity and using existing capacity more intensely.

Alternative Concepts, Definitions, and Measures

Capacity generally refers to the quantity of output that can be produced in a given period of time with the existing stock of capital. In this general definition, the phrase "can be produced" is open to a variety of interpretations.

The engineering interpretation relates to the amount of physical output under a normal organization of production and with an uninterrupted and unlimited flow of inputs, and yet accounting for required maintenance. 3/ Even here there is ambiguity in the meaning of "normal organization" of production, yet it would seem to be based on the notion of average or typical conditions. Also, implicit in any estimate of output from this interpretation is some notion of the product specification and mix. This is definitionally important because the rate and duration of machine downtime may depend on what is being produced. Obviously, the greater the machine downtime, the less production possible. Difficulties with this interpretation are that the "normal organization" changes over the course of the business cycle--one shift may be normal in periods of economic contraction but two shifts may be considered normal in expansionary periods (9).

A second interpretation of capacity is based on a cost perspective, generally seem as the level of output where average cost is at a minimum, with resource prices and the production function given. However, it is sometimes defined as the level beyond which the cost of additional production escalates sharply. This interpretation is also not without its ambiguities. Studies of the relationship between cost and output suggest that for some products there may be no unique minimum cost point, but rather ranges of output over which unit costs are constant. Further, for some products, unit costs do not increase even at very high levels of output (20). As a practical consideration, the cost approach has inherent measurement problems because few firms keep detailed cost data appropriate for capacity measurement.

These basic concepts clearly illustrate the consideration that must be given when selecting one measure of capacity over another. For instance, if an analyst is interested in quantitative analysis of the efficient allocation

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3/ Frequently the engineering interpretation is stated as a maximum possible production operating around the clock 7 days a week. Then, from this maximum, a "practical capacity" or "normal organization" capacity reflecting less than maximum is derived.

of resources, the interest is with the cost concept of capacity. The engineering measure is of little value, unless a precise relation between the engineering and cost estimates has been established.

Four Principal Nonfarm Sector Measures

There are four principal measures of capacity utilization for the nonfarm sectors of the economy (13). These have been developed by the (1) Wharton School, (2) the Federal Reserve System (FRB), (3) the Bureau of Economic Analysis (BEA) of the Department of Commerce, and (4) McGraw Hill. Each has an implicit underlying capacity concept and inherent flaws; none of the four can be singled out as best for all purposes.

There is no explicit definition given for either the McGraw-Hill or BEA measures of capacity. Yet, most firms included in their surveys indicate the "normal organization" interpretation to be the one they have in mind (8, 11). The FRB utilization rate, is constructed using the McGraw-Hill rate so it too is linked to the "normal organization" interpretation.

The Wharton utilization rate is based on a different concept altogether. Their definition of capacity is based on observed production peaks-that is, capacity is assumed equal to output at production peaks, and between peaks, is a linear interpolation. The Wharton capacity concept is also unique in that it is also a function of labor availability, whereas the others are entirely capital-oriented--capital stock is given and labor, raw materials, etc. are assumed available.

The different underlying concepts and construction techniques thus preclude meaningful comparisons of the alternative measures. Also, given values of any of the measures are of little use unless compared with past values of the same measure, especially as they apply to stages of the business cycle. Also, the measures are aggregate, which suggests that thorough examination of conditions in the economy necessitates examining key sectors. Bottlenecks and shortages in key sectors could effectively limit production, even if unused capacity were indicated by the aggregate measure. International conditions are also of increasing importance, as free flow of import material and energy are potential constraints.

Capacity Concepts in Agriculture

Agricultural economists have long been concerned with production capacity, but primarily from a particular vantage. During the the fifties and sixties, many analysts were concerned with the "farm problem." Analyses which treated the capacity of the production sector were primarily oriented toward the causes and cures for the obvious "excess capacity" manifested in low farm prices and low farm incomes. Excess capacity implies, of course, that capacity is known, but these studies seldom, if ever, explicitly defined it.

Most of the studies of this era implicitly used a market equilibrium definition of capacity--that is, capacity was implicitly defined as that level of production which cleared the markets. This definition of capacity allows no distinction between quality and quantity of resources, nor does it reflect any of the sources of capacity.

One of the most widely cited studies of this era was prepared by Heady and Mayer (7) for the National Advisory Commission on Food and Fiber and published in 1967. A benchmark competitive equilibrium (free market) capacity for 1980 was first determined and alternative economic settings under differing assumptions and policy scenarios were then obtained. Excess capacity was defined as production above the benchmark market clearing levels, and specifically in terms of cropland not needed to fill the demand levels.

Another representative study of the era was that by Tweeten and Quance (17), who defined excess capacity as "the volume of farm production capacity diverted from the commercial market by Government programs of acreage diversion, stock accumulation and food aid (21)." Again, the notion of excess capacity implies an underlying market equilibrium capacity concept.

More recently, the vantage of agricultural economists treating capacity has shifted from excess to deficit capacity considerations. Two recent studies, by Brandow (1) and Yeh, et al (21), examine production capacity for a future time period, but the focus has shifted from concern with excess capacity to concern with meeting food needs due to population and economic growth pressures. Brandow examines the "production potential" relative to quantities "likely to be demanded in the future." He employs the market equilibrium concept of capacity noting that "...if it turned out that agriculture would produce more than was demanded at assumed prices, then agriculture would have excess capacity. If it turned out that demands exceeded output, then capacity would be deficient."

The most recent study by Yeh, et al also defines capacity in a market equilibrium context. The authors note that "production capacity is measured within the context of prices and public policies required to realize that capacity and is directly tied to the supply function relating output to price." They reject the concept of "absolute maximum production capacity" in favor of a "more operational concept of feasible supply capacity." Rather than just designating any output above market clearing levels as "excess capacity," they further define a series of capacity related concepts.

In terms of traditional supply-demand schedules, they define "feasible supply capacity" as "...that output at which the supply curve becomes very unresponsive to price because quality land, fertilizers, other conventional inputs and managements are at such limits that additional output comes only at substantial costs." This amount of capacity is then broken into "unutilized capacity" and "excess supply capcity" which has a demand and supply response component, all determined by the price level in relation to the equilibrium price level.

A recent paper by Spielmann (14) surveys the literature of capacity studies in agriculture and notes the lack of precision and diversity in definitions employed. He also found that most studies implicitly or explicitly use capacity defined in terms of both supply and demand in a market equilbrium relation. He further notes that an assumed, continued stream of fixed and variable inputs to producers appears basic to the capacity definitions employed.

Capacity--Productivity Relationships

When we speak of a particular level of production capacity, we are implicitly referring to a point in time--a very shortrun period. As we extend our discussion from a point in time to longer time periods, we move to comparative statics and on to dynamics. Productive capacity changes over time, and closely intertwined with this change is the associated concept of productivity.

Productivity, at its simplest, is a measure relating output to input. Partial productivity measures relate total output to one or only a few inputs. Total productivity measures, of course, relate total output to all factor inputs. Capacity at a point in time implies a fixed investment and technology level. Changes in the underlying structure of the production process may change capacity, and it is desirable to be able to sort out changes due to an increase in inputs or in fixed investment from changes in the quality of those inputs. At the heart of this is the whole subject of the conceptual base and measurement of productivity, and relating this to capacity change (growth). A consistent conceptual base would facilitate attempts to identify sources of capacity change and to distinguish between those due to changes in productivity and those due to changes in the quantity of inputs employed.

As with capacity, the treatment of productivity in agricultural production, other sectors of the food system, and the rest of the economy is a patchwork affair. In a recent critique of productivity concepts and measures in agriculture, Christensen (3) notes the desirability of a total factor productivity concept and measure, and then discusses the disparity among methods of calculation and the inherent limitations in most of the methods now used.

The conventional approach to total factor productivity measurements involves the compilation of an index of total output and an index of all factor inputs, with total productivity being the ratio of the output index to the input index.

Christensen treats the numerous problems of productivity measurement, including:

- -- The choice of an index number procedure for aggregating outputs and inputs and the implicit assumptions one is adopting when choosing a particular method.
- -- The treatment of intermediate inputs--the value-added versus the gross output approach.
- -- The separation of scale economies and diseconomies from technical change.
- -- The allowance for dynamic interaction between technical progress and captial accumulation.

-- The problems with the assumption of all technical progress as being neutral, as opposed to technology being embodied in capital, or labor, or other inputs, or induced by changes in relative prices.

-- The difficulty of reflecting quality changes in inputs.

It should be noted that a large amount of work and much professional debate has centered on measuring productivity growth in the general economy. This is exemplified by the exchange between Denison and Jorgenson and Griliches (2), and in the National Bureau of Economic Research volumes of Studies in Income and Wealth.

The Department of Agriculture has prepared a total productivity measure for the agricultural sector (the only Government agency to do so on a regular basis), as well as a number of partial productivity measures. Work is also underway in the Economic Research Service to develop productivity measures for various industries in the food and fiber system, particularly the food and kindred products sector. I might note that the total productivity measures for the agricultural sector have also been criticized over the years in various studies, including a recent National Academy of Sciences study (12) and one by Griliches (5), who suggests that the USDA input index neglects important quality changes which have occurred in inputs such as farm labor, machinery, and fertilizer.

Considerable work has been done on productivity in the farm sector and other sectors of the system with the exception of the food distribution sector, for which little work on productivity is available. A first approach would seem to suggest a utilization of this existing work in the various industries aggregated to develop a measure for the whole food and fiber system. However, the outlook for this approach appears bleak. Howe and Handy (10) have stated in this regard:

> The sampling of the literature reveals that a large number of individual productivity measures are available for many of the individual segments of the food and fiber sector. Conceptually, individual works might be aggregated industry by industry to develop a sector productivity series. Unfortunately, available measures follow no consistent methodology for measuring outputs or inputs and thus, even if a satisfactory system was found for combining existing industry productivity series, lack of consistency makes any aggregation impracticable.

Conclusions

This paper has attempted to provide an overview of the status of production capacity analysis and related work for the agricultural and the nonfarm economies. A major conclusion is that there is no common conceptual base for measuring capacity, and there is wide diversity in the methods and procedures used in capacity measurement.

Recent changes in the economic relationships between the domestic agricultural sector and the general economy, as well as the increasing importance of U.S. agriculture in world markets, are likely to bring new problems and questions about capacity and productivity. This would suggest that there is considerable merit in having a capacity measure compatible for all sectors of the food and fiber system. Arguements advanced by other authors appear quite persuasive on this point.

A further conclusion is that to achieve development of such a measure, much conceptual and procedural work remains to be done. The problem is aggravated because of the uniqueness of the agricultural sector in relation to the other sectors. The length and segmentation of the production period, the biological process involved, the ability to substitute products, the susceptibility to weather, and other factors pose difficult problems in developing a common conceptual base and consistent procedures.

Some assessment of the problems involved, the procedural difficulties, the data now available and data needed, and appropriate ways of obtaining the data has been done. The work by Weeks and Spielmann is illustrative. However, much work remains to be done. These and other problems are further pursued in the two papers which follow in this session.

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CURRENT PRACTICES RELATED TO CAPACITY AND CAPACITY UTILIZATION MEASUREMENT FOR FOOD AND FIBER PRODUCTION--AN INVENTORY

Eldon E. Weeks*

INTRODUCTION

Except for a few short periods during our Nation's existence, principally during or immediately following wars, the United States has had few occasions for deep concern about the capacity of its agriculture to produce sufficient quantities of characteristic outputs for short-to-intermediate run needs. To the contrary, much of the policy concern over the last 4 or 5 decades has been with symptoms and causes of what many have termed "excess capacity." This led to attempts to manage the phenomena of "low" farm product prices and "large" commodity inventories.

Our experience in the 1973-74 period, however, seems to have led a number of analysts to be concerned with the question of whether we should be measuring the capacity of our food and fiber system and the degree to which that capacity is utilized. The existence of the subject of capacity on this program is taken as at least partial evidence of these concerns.

The Assignment

The author's assignment for this paper is straightforward, and it doesn't include much more than the title implies. The principal part of the assignment is to construct inventories of capacity-related measurement concerns and to remark on them to the extent that we can--just far enough to bridge but not overlap the preceding and succeeding papers.

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*The author is an Agricultural Statistician, National Economic Analysis Division, ERS, U.S. Department of Agriculture. The views expressed are the author's and do not necessarily reflect those of the U.S. Department of Agriculture.

One of the inventories of major concern relates to existing measures of capacity and capacity utilization for industries included in a broadly conceived food and fiber economy. Another relates to data available or potentially available for the computation of those measures for certain other industries also in the food and fiber economy, particularly in agriculture. Remarks on the inventories should include notation of kinds of concepts of capacity and kinds of approaches to measurement because of the implications of concept and approach to measurement for data requirements.

Method

Perhaps it is best to explain that the usual notion of method does not apply to this paper. Hypotheses are not stated and tested. Rather a group of topics is addressed. The topics are thought to be considered important as background if one were to plan an attempt to measure agriculture's capacity and the rate of capacity utilization. Consequently, there is a chronology of topics addressed in place of the usual sense of method.

In the discussions that follow, the stress nearly always resolves to some aspect of data base, either directly or by implication. Keeping this in mind, the topics that follow, in order, are: (1) existing capacity measurement efforts, (2) industries not covered regularly, (3) choices among measures and methods, and (4) some aspects of the data bases for agriculture pertinent to attempts to measure capacity.

EXISTING MEASUREMENT EFFORTS

Since World War II, as Spielmann has pointed out, there has been a growing literature on measurement of industrial capacity and capacity-related measures (9). And there has been a growing list of institutions sponsoring the estimation of capacity and its related measures.

Spielmann conducted a literature review of the measurement of capacity (9), and Spielmann and Weeks have published an inventory and critique of estimates of U.S. agricultural capacity (10). The latter suggests some special characteristics of agriculture that should be considered if capacity is to be measured. It also reports some of the authors' summary notes on alternative capacity measurement approaches.

If there is potential for estimating capacity and related measures for agriculture on a regular basis, we need to ask ourselves if the measures should be designed to be consistent with one or more of the measures for industries that are closely interrelated with agriculture. To expore this question, we should recall what industries in the food and fiber economy, or are important to it, are included among existing estimations of capacity and capacity-related measures. We should also note what kinds of data bases are used and what other uses are made of them.

Industries Covered and Measures Used

One group of authors (4) presented a synopsis of measures of manufacturers' capacity utilization (4, pp. 54-55). This synopsis covers seven measures identified by source as follows: Bureau of Economic Analysis, Federal Reserve Board Manufacturing, McGraw-Hill Publications Co.-Annual, McGraw-Hill Publications Co.-Monthly, Federal Reserve Board-Major Materials, The Conference Board, and the Wharton School, University of Pennsylvania. Of these seven measures, the authors say "...A maximum practical capacity concept generally underlies all except the Wharton School series. In that series, capacity is generally measured by the output attained at production peaks. The BEA and McGraw-Hill annual series are based entirely on survey data, and the Wharton School series entirely on indirect, deductive calculations. The others--a monthly McGraw-Hill series, the two Federal Reserve Board series, and The Conference Board Series--are based on combinations of survey data and calculations (4, p. 56).

The BEA measures are published for 11 industries and for several categories. The industries are broadly defined, but the ones that probably hold interest for us include machinery except electrical, food including beverage, textiles, chemicals, and petroleum. However, the empirical representation of these industries is achieved starting with assignment of company responses to a greater number of industries (4, p. 56). We have made no attempt to explore with the originators of survey data series the possibility, for example, of getting measures for industries to the level of fertilizer or farm machinery and equipment manufacturing industries.

There are no series, to the author's knowledge, yielding an ongoing comparable measurement of capacity and its utilization for agriculture.

Data Bases

The two measures identified above that are based on survey responses are, obviously, at least partially involved in the creation of the data base from which they spring, although other data are needed in order to weight company data into industries. These include 1969 IRS gross depreciable assets weights and current employment weights. Industries are combined into groups using 1969 capacity weights and the FRB index of IP 1967 value-added weights.

The FRB index of Industrial Production figures prominently in the data base for several of the measures of capacity and capacity utilization. These include those of the Wharton School, the Federal Reserve Board, and the McGraw-Hill-monthly.

Other Uses for the Data Base

Quite a large part of the other uses for the data base collected by the survey for capacity estimation is consistent with situation and outlook type work, particularly with respect to plant and equipment expenditures, prices of capital goods, and changes in sales and plans. In general, the agencies measuring manufacturing capacity utilization entirely by survey data appear to have more related forecasting series in capital goods markets than do the agencies who make heavier use of secondary data.

INDUSTRIES NOT COVERED REGULARLY

With a number of prestigious institutions measuring capacity and industry operating rates, one can fairly assume that the overall notions of capacity, capacity utilization, and the desirability of their measurement have been tested and found useful. There has been time enough to test the accuracy and usefulness of the measures; it seems that estimation would have ceased if the measures did not offer net informational benefits. Instead, they have been refined and extended. With the exception of the Wharton School measurement efforts, the estimation of capacity and its utilization seems to be concentrated on manufacturing industries, processed material goods industries and, to a lesser extent, utilities.

The Wharton School now estimates capacity and its utilization for six service or service-type industries including rail, airlines, trucking, residential housing, offices, and hotels. We are not aware of other capacity and capacity utilization measurement efforts applied to service or trades industries. Nor, with the possible exception of mining, are those well established and continuing capacity measurement efforts widely applied to the extractive industries of logging, fishing, agriculture, etc.

It was noted in the Penn paper that there are a number of possible reasons for being interested in the measurement of capacity and capacity utilization. If these interests include the monitoring and assessment of the capability of industries vertically ordered to deliver particular kinds of goods to final demand, the "system" obviously includes the activities of trade and service industries, both as inputs to the system and as distributors of goods. Trades, services, and the extractive industry of agriculture are important in the system in which we are interested. And possibly the system should be extended to include fishing, but we shall not try to consider it in this discussion.

Measurement Problems

Given the large efforts and attention devoted to capacity and capacity utilization measurement, one has to wonder why more attention isn't paid to the trade, service, and extractive industries. Is it because capacity and related measures for these industries is not considered important? Or is it because measurement problems have been considered too formidable?

The Marketing and Input Industries

It would seem that the principal broad industries supplying inputs to farmers for which we do not have any regular measurement of capacity and capacity utilization are of the service and trade type or are inputs originating on farms. And similarly, the principal broad industries processing and distributing farm outputs for which there are no regular measurements of capacity and its utilization are also of the trade and service type.

We shall try to avoid a discussion of whether estimation of capacity and its utilization is considered important for these industries. But we shall note that the measurement problems become very acute in situations which require definitions of output in terms referring to other than tangible goods. Input-Output accounting conventions, for example, usually value the outputs of a service industry by its total charges to customers. And the same conventions usually value the outputs of a trade by deducting the cost of goods purchased for resale from the industry's total charges to customers. In these instances the quantities of output are very difficult to characterize in terms of volume, weight, or other physical descriptors commonly applied to the outputs of manufacturing or basic materials producing activities.

The Farming Subsector

Spielmann and Weeks have listed some of the characteristics of agriculture that seemed pertinent to the estimation of capacity and capacity-related measures (10, pp. 924-5). The major problems, it appears, lie in achieving consistent (year-to-year) measurements of capacity. We already have commodity-by-commodity lists by which total outputs are estimated for the purpose of estimating productivity. These could be used for the total output measure that is the numerator in the capacity utilization fraction.

How can we know agriculture's capacity to produce, given currently used technology and current levels of land and capital stocked in the industry? That is the question that led to this session in this workshop. In investigations to date, Spielmann found that the concept of capacity didn't hold still very well from researcher to researcher in the literature of agricultural economics (9). Then Spielmann and Spielmann and Weeks noted that a number of people, in the literature of business economics, define concepts of capacity that are sufficiently similar to each other that, by comparison, differences appear minor (10). Finally, the same authors noted some special characteristics of the farm sector for capacity measurement and identified and critiqued some alternative capacity measurement approaches.

CHOICES AMONG MEASURES AND METHODS

In review, we have noted that there are several agencies involved in regular activities aimed at measuring capacity and capacity utilization. The majority of these efforts are concentrated in the manufacturing and basic materials industries. But the Wharton School has used secondary data to measure capacity and its utilization in some service and service-like industries. We have noted three kinds of data bases currently used in the estimation of capacity and its utilization--those from surveys taken for that purpose, secondary data from public and trade sources and combinations of these two. For those agencies collecting survey data, significant related series are published such as operating rates for mining and utilities, actual and expected plant and equipment expenditures, expected changes in prices, etc.

Also in review, we have noted that a number of trade, service, and extractive industries are not covered regularly with estimations of their capacity and its utilization. For many of these industries, it is either difficult to define the outputs or to characterize the production process in terms of a concept of capacity or in terms of potential "bottlenecks" which might give it measurable content.

Concepts of Capacity

For the agencies engaged in estimating capacity and capacity utilization, it appears that the emphasis is on what one author calls macro capacity (12). Quite specific production data are indexed together into broad industries and then into industry groups. Survey responses from firms to a capacity utilization question essentially are treated the same way. Winston (12) says this makes sense in some aspects of macroeconomics such as investment demand analysis, real causes of price inflation, variations in trade flows, and relationships between capacity utilization and factor productivity over the business cycle.

Winston then asks what is happening in a typical firm when the economy is operating at capacity. The accepted macroeconomic construct of capacity implies a technical engineering defintion of capacity for the firm. But it implies, also, the most efficient level of output for the firm (12). He, like Spielmann (9) points out that Perry, Klein, de Leeuw, and others have devoted time and effort to defining capacity in economic terms at the firm level.

The purpose of the above is not to open a discourse on macro and micro capacity. It is to register the author's opinion that most of the capacity measurement work that is conducted on a regular basis is handled predominantly as if it were a macro capacity function. The industry measures, as published, probably cover groups of industries too highly aggregated for very precise observation of potential "bottlenecks" in end-to-end chains of interdependent industries, arrayed that way to represent commodity flow systems. And they may cover groups of industries too highly aggregated for accurate description by traditional production function forms for relating meaningful industry short run average cost levels to output.

Those agencies who survey firms to collect responses to capacity-related questions ask respondents for preferred operating rates. In one sense this is tantamount to asking each of the responding officials to name the operating rate at which the company's plant and equipment are used most efficiently in terms of the company's objectives. We can readily understand how this information would be considered useful, or even valuable, although we do not think we are ready or need, for the purposes of this paper, to argue its efficacy in provision of a bridge between "micro" and "macro" capacity. Again, we simply note that the practice exists and probably deserves to be listed as having a place in the concepts of capacity measurement.

Hickman (5) studied changes in capacity and production for industries defined as narrowly, for example, as wheat flour and cotton spinning. For an engineering concept of capacity, he distinguishes between "theoretical" or "rated" capacity and "practical" capacity in terms of whether allowances have been made for seasonal fluctuations in output or unavoidable shut-downs (5, p. 419).

Hickman (5, p. 420) also states that in the examination of resource allocation, it is usual to define capacity as the level of output produced at minimum average total cost when the prices of resources and the production function of the firm are fixed. Actual output could then be greater or less than 100 percent of capacity utilization.

The authors of another article say that an engineering interpretation of capaicty demands that a plant operate around the clock 7 days a week (4, p. 47). These authors go on to say "With a normal operating schedule and with high-cost inefficient facilities brought into production, a physical limit is reached at which no more output can be obtained. This output level has been interpreted as the maximum practical capacity ..." (4, p. 48). They further state that preferred output may not necessarily be that output which corresponds to the minimum point on the short-run average cost curve because marginal revenue can equal marginal cost at other levels of output in the short run (4, p. 48).

The capital stock held by an individual firm yields another interpretation of capacity. Given a stock of capital goods, an output may be reached which renders it advisable to add to the capital stock (6). At this point, lower operational costs can be achieved by appropriate changes in plant and equipment. Thus is defined a concept of capacity as an anticipated economic limit to output from existing fixed capital.

Spielmann and Weeks observed that "In the literature reviewed, we found no work which specifically addressed itself to the construction of time series indicative of current capacity utilization levels for agriculture" (10, p. 922). Instead, the major concern seems to have centered around the determination of "excess" capacity. More often than not, that concept is related to notions of low equilibrium market prices, low factor returns, and/or factor misallocation or adjustment problems. Thus a concept of capacity usually must be inferred from a concept of "excess" capacity or some related judgmental modifier.

Hickman observed that data he used are based on an engineering rather than a cost concept of capacity. He said that any restrictions imposed on the analyst by the noncost character of the data depend considerably on the purpose of the analyst. If the purpose is resource allocation efficiency, for example, concern rests precisely with the cost concept of capacity unless there are definite and important parallels between the cost and engineering concepts (5, pp. 419-20). Then he goes on to state that "there is no essential dichotomy between the two concepts in qualitative terms." If there are structural changes in factor prices the cost curve may be shifted in a way that has no analog in engineering capacity except that the changes in relative factor prices may lead to changes in the organization of production. On the other hand, changes in the production function result in capacity changes for both concepts of capacity.

We are not so sure that the preceding discussion represents a bona fide inventory of concepts of capacity as much as it does a checklist of concepts that comes to mind readily. One thing is clear. The concepts plopped onto the griddle are taken from the literature outside that of agricultural economics. We would be remiss if we did not note the concepts listed in our own literature.

For the most part, references to agricultural capacity in the literature of agricultural economics can be classified into two sorts. One is addressed to concerns over our capability to satisfy anticipated future demands for the output of agriculture. Illustrative of these is the outlook for capacity for the 1980's (2).

Bosworth believes that present concerns over the inadequacy of industrial capacity in the 1973-74 period really pertain to a "relatively small set of primary-materials industries." (1, p. 29) He says that these industries are "process-related" industries for which a concept of capacity involving a physical limit to output would have the most meaning. Production can be increased in many industries with a given capital stock by adding workers or workshifts.

Approaches to Measurement

Although we don't think we can say anything more than we have said before on this subject, maybe we can say it again summarized in different words (9, 10). We shall treat more with the generic kinds of approaches than with specific procedures. These approaches are treated in reference to whether the capacity-related estimations are arrived at through the use of primary or secondary data.

Approaches with Primary Data

Some available utilization rate series such as BEA and McGraw-Hill, Annual are based entirely on company surveys. Businessmen are asked to estimate their operating rates as a percent of capacity. Monthly estimates by FRB and McGraw-Hill combine information from monthly production indexes and from less frequent utilization rate surveys (8, p. 893).

In the past, the FRB has estimated capacity and its utilization for manufacturing and for a number of basic materials industries. The Board has plans to replace these distinct sets of estimates by a "single integrated system of measures of output, capacity, and capacity utilization covering manufacturing, mining, and utilities. Capacity utilization rates will then be published for total industrial production and for the major market and industry groupings shown in the IP indexes. The basic data to be used in the contemplated system will be the IP indexes and the figures on capacity utilization rates published yearly by the U. S. Bureau of the Census in its Survey of Plant Capacity..." (8, p. 892).

For the most part, the approaches to acquisition and handling of primary data for estimation of operating rates are straightforward. Most of the agencies collecting primary data for this purpose are heavily involved in making forecasts and summaries of business conditions. The surveys afford them an opportunity to query businessmen on preferred operating rates and on investment intentions.

The approaches which combine primary and secondary data generally involve series of adjustment and linking operations. They generally involve the use of the McGraw-Hill Annual Capacity Utilization rates and the FRB index of IP as benchmarks or starting points. For systems such as these, care must be exercised to arrive at the same industries from both data sets.

Approaches with Secondary Data

Perhaps the most straightforward approach to the measurement of capacity and capacity utilization is employed in the development of the Wharton School measures. Peaks in plotted quarterly data are identified and connected by straight lines. These peaks and the straight lines connecting them are assumed to represent capacity for the industry. The capacity utilization rate is obtained through division of actual output by capacity output.

Klein and Preston (7) have experimented with an aggragate production function for capacity estimation for some nonfarm sectors. But Walters (11) concludes that aggregate production functions may be meaningful for only narrow sections of the economy.

Hathaway (3) thought that supply elasticities tend to become highly inelastic as capacity levels are approached. We are very dubious that a supply function, particularly for an industry like agriculture, can serve as a basis for estimating capacity. Capacity is a short-run measure. There seems to be general agreement that short-run supply elasticities in agriculture are quite inelastic. And, really a supply function is a schedule of quantities that holders would offer for sale at various prices. Unless the goods are very perishable, good prices might result in the sale of beginning inventories plus current production or low prices might result in substantial withholding for ending inventories.

Hickman (6) has reported on an approach based on the demand for net investment as being proportional to the difference between actual and desired capital stock levels. After several steps, capacity output (at a given level of capital stock) becomes a function of relative prices and time. This approach has a large aesthetic appeal because it involves the optimum capital output ratio in relation to the equilibrium output of the firm.

Implications for Data Practices

The capacity-related concepts and approaches to measurement that have been enumerated in the preceding discussions make up a lengthy list but certainly not an inventory. Nevertheless, the mention of them implies certain important properties and practices for the management of data sources.

The combined lists of concepts and approaches include the use of primary data only, secondary data only, and combinations of both primary and secondary data.

The principal collectors of data for primary use in the estimation of capacity and its utilization are McGraw-Hill, BEA, and more recently the Bureau of the Census with its annual Survey of Plant Capacity. Of these three, the first two collect company data and the third collects establishment data. We know that establishments can be classified to the 4-digit industry level (SIC Manual). A question that should be explored with the other two primary data collectors relates to how refined the industry designations can be with their company data. Components of the FRB index of IP are available generally at the 3-digit industry level and some are available at the 4-digit level for manufacturing and materials industries that are importantly related to agriculture by either processing the outputs or supplying inputs. We feel that if we wish to include observation of potential "bottlenecks" in food and fiber commodity flow systems it will be necessary to estimate capacity and its utilization in industries more narrowly defined than they are now in their predominant published versions. This is based, in turn, on the feeling that "bottlenecking" usually occurs at a specific place or with some specific function in a system.

With reference to the above, the SIC manual lists 11 3-digit level industries in agriculture and 36 industries at the 4-digit level. If we were to collect primary data on capacity utilization in agriculture, care should be exercised to try to "match" industries into systems with respect to flows of meaningful commodity groups. We feel that it would be difficult to obtain meaningful capacity utilization data from farmers for specific single commodities in many instances. Therefore, care should be taken to identify farms by type when farmers are asked for their estimate of the utilization of capacity. And it is important to recognize that farm resources could be used more than once on the survey if the questions are addressed to single commodities taken one at a time. It would be important to have the farmer understand that his fixed factors (short-run) and output mix are really fixed.

If it is feasible to estimate capacity and its utilization rate for industries at a sufficiently narrow level to be able to infer "bottlenecking" potentials in commodity flow systems, the specification of the narrowly defined industries should make sense from two standpoints in addition to consideration of business unit vis-a-vis commodity group capacity. We have already alluded to the importance of end-to-end "matching" of industries in the same commodity flow systems. The other standpoint of reference is to be sure the disaggregations of broad industries like, say, agricultural production or food and beverage manufacturing make sense within the broadly defined industries. The criteria used for defining the sub-industries should be clear and meaningful. The production function for hops, for example, may be characteristically more similar to one for deciduous tree fruits than to one for grains or one for vegetables. And we probably would want to make clear and specific provision for the examination of substitution in the output mix as a source of capacity for specific commodities or commodity groups.

Finally, the by-products of capacity utilization rate measurement can be valuable and important. Investment and output plans as well as preferred operating rates can be asked for on questionnaries designed to estimate capacity utilization with primary data. If reliable, this information could reinforce efforts at short-to-intermediate run forecasting and help to "reveal" the thinking of farmers and businessmen about their economic environment. Attempts to estimate capacity utilization by use of secondary data, on the other hand, should yield a more sharply defined concept of capacity and measures more susceptible to revision over time. The initial estimating effort might yield estimates for enough preceding years that analyses of investment behavior, capacity changes, industry stability, and companion-type productivity measures could be initiated much more quickly than would be possible if capacity-related measures were estimated with primary data.

EXISTING DATA AND MECHANISMS--THE FARMING SUBSECTOR

The purpose of this section is to note observations of existing data and mechanisms for acquiring data that might contribute to our capability to estimate capacity and capacity utilization in agriculture. Data collection vehicles for primary direct estimation of capacity-related measures will be discussed separately from secondary data available for computing similar measures.

Data Collection Vehicles

This component of this paper will be very short. The paper to follow this one will address this subject with sufficient detail and clarity that anything said here would probably be redundant.

The principal agencies in the business of collecting nationwide data on agriculture are the Statistical Reporting Service of the Department of Agriculture and the Bureau of the Census. The Census of Agriculture is currently in a period of transition to a quinquennial schedule to coincide with the Censuses of Business and Manufactures. Presumably, questions on capacity-related measures could be asked on the Census if the opportunity costs would warrant them. And, presumably an annual survey of agricultural capacity similar to the one taken for manufactures could be taken if considered valuable enough to warrant the budget and additional respondent burden.

SRS now regularly makes three surveys which might appropriately carry questions on capacity-related measures. The one taken in December seems to be somewhat slanted toward livestock. There is an enumerative survey conducted in June. And the Annual Economic Survey is taken in the first quarter of the calendar year. The competition for space on these surveys is severe. Questions related to capacity might be asked on one or more of these surveys if given the priority. Also, SRS has the apparent technical capability to make special capacity surveys if agricultural capacity can be estimated this way and if such seems to warrent budget, effort, and the extra respondent burden.

Secondary Data

The Department of Agriculture already collects a great deal of data that are usable or potentially usable for the estimation of capacity-related measures should an approach utilizing secondary data be selected for that purpose.

SRS collects acreage, production, and price data for nearly all the major crops and for many of the so-called miscellaneous and minor ones. These data are available for most of these crops individually. Consequently, the crops could be classified into groups that make sense in relation to most of the approaches likely to be considered feasible.

SRS also reports production of livestock products and production and farm disposition of livestock, as well as livestock inventories by several categories such as age, weight, sex, and use classes. Because biological stages are not very long and new production capacity in terms of breeding and producing herds and flocks can be built up fairly quickly for poultry, hogs, and sheep, there may not be much cause to worry about separation between inventories and capital stocks. But dairy and beef may represent another situation. While we have monitors of the size of breeding and milking herds, we do not have dependable statistics on the annual or quarterly sales of milking and breeding herd animals for slaughter or the same-period entries into those herds. Statistics on the value or price of animals entering the breeding and milking herds would also be useful. As a matter of fact, these statistics appear to be essential if we wish to analyze farmer's investment behavior toward this class of capital stocks--a class of capital stock that may be capacity limiting if we hold a "bottleneck" notion of capacity determinants.

The observation presented above also applies to the perennial plantations of trees, vines, bushes, etc., from which crops are seasonally harvested. On a national level, we do not think we can monitor the annual gross production of replacement and expansion stocks. And for the most part, stand values are reflected only in aggregate average land prices.

Land use statistics are available, and while there may be several problems with them, they are probably usable--at least for experimental purposes. Statistics on land availability in the short run and its relative quality appear to be even more questionable.

Series are reported in Farm Income Statistics on farmers' gross capital expenditures for buildings, land improvements, and machinery and equipment. Also, series are reported for capital consumption in these categories. While they are the best data we have for these activities on capital account, there are several serious problems. One is that nonpurchased contributions to the value of gross capital formation are not recorded. These include land improvements and building construction accomplished by farmers with "force labor." It is not entirely clear whether these unrecorded capital values are finally depreciated. Another problem is that if we wished to convert the capital stock and formation series to "real" capital, the currently available deflators would not distinguish between quantity and quality in the year-to-year changes and thus admit bias to the series.

In the construction of its measure of output per unit of input, ERS computes indexes of outputs and inputs used in current year production. These indexes are "built up" from components. The indexes of outputs may very well represent a convenient assemblage of statistics to "take off" from in constructing a numerator for computation of either capacity utilization or change in capacity utilization. We are not so sure about the usefulness of the indexes of inputs for the estimation of capacity. Each input category is listed as a national total across all subindustries and represents an estimate of the quantity actually used. There is no hint of how much could have been produced, given the availability of fixed assets and currently used technology.

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A CRITICAL REVIEW OF ALTERNATIVE APPROACHES TO ESTIMATING CAPACITY AND CAPACITY UTILIZATION FOR THE FOOD AND FIBER SYSTEM

John B. Penson, Jr. and William E. Kibler

Measures of economic capacity, or the current level of real output desired by producers, and capacity utilization rates have been widely utilized in the past outside the food and fiber system. Malabre, in discussing some of the estimation difficulties associated with existing measures, indicated that the Carter Administration examines current capacity utilization rates when assessing the potential effects of expansionary economic policies.

Perhaps the greatest use of capacity utilization rates, however, has been as an independent variable in previous economic studies of investment behavior. These studies usually hypothesize, for example, that a higher capacity utilization rate in the current period would suggest a higher level of real net investment in plant and equipment for a given change in relative prices. Jorgenson, in an in-depth survey of previous economic studies of investment behavior, observed that "capacity utilization appears as a highly significant determinant of the desired capital in most of the studies we have considered" (p. 1130). In fact, the study by Meyer and Glauber, who used the ratio of the Federal Reserve index of industrial production to the McGraw-Hill capacity index, was the only study which found a measure of current capacity utilization not to be a significant determinant of desired capital. As Jorgenson pointed out, however, the Meyer-Glauber findings differed sharply from those reported by Bourneuf.

An added dimension in agriculture is the political interest in the ability of the U.S. food and fiber system to meet the growing demands in both domestic and foreign markets. One has only to think back to 1973, for example, when many capacity-related questions were raised in light of the then world-wide crop shortages to see the need for a measure of economic capacity for the farm production sector in particular. At present, however, analysts and policy makers having a continuing interest in the current economic capacity of the U.S. food and fiber system and those factors which cause changes in either its utilization or expansion are without a measure conceptually equivalent to those developed for other sectors of the economy. Given the need for and present lack of such a measure, the question becomes one of where do we as agricultural economists and statisticians go from here. Several alternatives appear available.

If we can assume complete unanimity for the moment on how we define economic capacity, there appear to be two alternatives to estimating economic capacity and capacity utilization using primary data. Initially, we could utilize data on commodity specific production intentions supplied by existing commodity surveys conducted on a regular basis by the U.S. Department of Agriculture. By coupling data provided on planting intentions, for example, with current yield expectations, we could estimate the economic capacity for crops desired by producers given the relative prices, production practices and farm program policies existing at the time the survey was taken. Alternatively, we could develop an entirely new global survey along the lines use by McGraw-Hill, for example, to obtain data on current firm-wide capacity and capacity utilization as well as planned future plant expansion. Therefore, should we use the commodity survey approach, modifying existing commodity surveys and developing new ones to fill identified data gaps, or should we adopt the global survey approach for each of the sectors comprising the food and fiber system?

If cost or other factors prohibit additional surveys, however, we can instead choose among several alternative positive and normative approaches to estimating economic capacity and capacity utilization which utilize secondary data. Hickman, for example, proposed using an investment behavioral model estimated from secondary data to infer changes in economic capacity. Even if we find these models to be applicable to the food and fiber system, however, can we rely on their ability to estimate economic capacity and capacity utilization rates without periodically assessing their relative performance by comparing their estimates with primary data from producer surveys?

The purpose of this paper is to critically review these alternatives, citing the advantages and disadvantages we see with each as they apply to the U.S. food and fiber system in general and the farm production sector in particular. Several potential directions are then reviewed and a course of action which also considers the relative costs involved is recommended.

ESTIMATION USING PRIMARY DATA

The modification and use of existing commodity surveys to estimate the economic capacity of the food and fiber system will require procedures which differ sharply from the global survey approach used by McGraw-Hill and others to estimate capacity utilization for selected industries in the nonfarm business sector. The remainder of this section contrasts these two approaches and discusses issues related to the timing of surveys and level of aggregation.

Use Of Existing Commodity Surveys

Although the U.S. Department of Agriculture does not conduct surveys designed specifically to estimate the economic capacity and capacity utilization of the farm production sector, there are many existing surveys that may provide significant amounts of relevant data for this purpose (USDA 1976a). There are also a number of other surveys that could be modified slightly to provide additional primary data to fill existing gaps (USDA 1975b). Many of these surveys also lend themselves to the development of quarterly or semi-annual estimates and can also be used to develop estimates of economic capacity along commodity and geographical lines as well as U.S. totals. Potential subsectors of the farm production sector could include field crops (including fruits and vegetables), meat animals, poultry and dairy while geographical groupings could follow the ten farm production regions frequently used by the Economic Research Service. While the U.S. Department of Commerce (USDC) releases numerous reports providing data on production in the input supply sector such as building materials, fertilizer, pesticides, motor vehicles and farm machinery, USDC surveys designed to measure capacity utilization do not separately identify the input supply, processing and distribution sectors of the food and fiber system from other nonfarm businesses.

Sources of commodity primary data

Table 1 presents a listing of the existing primary data sources available to assist in estimating alternative measures of capacity and capacity utilization for the farm production sector while Table 2 presents a listing of additional primary data that could be obtained with only minor modifications to existing surveys. For example, primary data provided by planting intentions surveys for field crops and vegetables, when adjusted for current yield expectations, provide an estimate of current economic capacity for these commodities given existing relative prices, resource availability and quality and existing farm program policies.[1/] Similarly, the primary data provided by the placement intentions survey for cattle on feed as well as surveys of breeding intentions for hogs and the expected calf crop would appear to represent estimates of current economic capacity for these livestock production activities. Primary data on "acres of land that could be double cropped" and capacities of laying and broiler houses, milking facilities and feed lots, on the other hand, appear to represent estimates of current engineering capacity.

Based upon these primary data, we could then compute estimates of several capacity utilization rates. For example, the ratio of actual output of field crops-to-planting intentions adjusted for current yield expectations represents an estimate of the current economic capacity utilization rate for these commodities. This ratio reflects the effects of weather and insects as well as changes in price expectations, input supply bottlenecks and other economic factors occuring between the time the survey was taken

Table 1. -- Timing of Existing Surveys Pertaining to Capacity and Capacity Utilization for the Farm Production Sector.

Subsector and Detailed Primary Data Collected	TIMING OF SURVEY		
	Semi-annually	Quarterly	Other
Field crops:			
1 Planting intentions for field crops	x	x	
2 Fruit trees of bearing age			x
3 Planting intentions for vegetables	x	x	
4 Monthly crop and fruit production	x	x	x
5 Monthly vegetable production	x	x	x
6 On farm and off farm grain and oilseed stocks	x	x	
7 Potato stocks	x	x	
8 Rice stocks	x	x	
9 Conditions of range and pastures	x	x	
10 Hay stocks			x
Meat animals:			
11 Cattle inventory	x	x	
12 Cattle on feed	x	x	x
13 Hog and pig inventory	x	x	
14 Sheep and lamb inventory			x
15 Livestock slaughter	x	x	x
16 Calves born			x
17 Expected calf crop	x		
17 Breeding intentions for hogs	x	x	
19 Feed lot capacity			x
20 Expected fed cattle marketings	x	x	x
Poultry:			
21 Broiler hatchery report	x	x	x
22 Egg production	x	x	x
23 Broiler and egg type chicks	x	x	x
24 Turkey hatchery report	x	x	x
25 Poultry slaughter	x	x	
26 Broiler pullets for hatchery supply flocks	x	x	x
27 Egg-type pullets for hatchery supply flocks	x	x	x
28 Potential layers on farms	x	x	
29 Number of hatcheries and capacity			x
Dairy:			
30 Number of milk cows and milk production	x	x	x
31 Dairy product production	x	x	x
32 Milk production per cow	x	x	
33 Grain fed per milk cow	x	x	
34 Inventory of milk cows and milk heifers	x		

Table 2. -- Timing of Other Surveys Which Can Provide Data on Capacity and Capacity Utilization for the Farm Production Sector.

Subsector and Detailed Primary Data Collected	TIMING OF SURVEY		
	Semi-annually	Quarterly	Other
Field crops:			
1 Acres of land double cropped			x
2 Acres of land with capital improvements			x
3 Acres of land that could be irrigated			x
4 Acres of idle cropland			x
5 Land cleared for cultivation in past 12 months			x
6 Acres of land that could be double cropped			x
7 Ownership of land that could be cropped or pastured			x
8 Acres of improved pasture			x
9 Acres of cropland that was converted to other uses			x
10 Capacity of on farm grain storage facilities			x
Meat Animals:			
11 Feeding rates for cattle and hogs	x	x	
12 Rates of gain for cattle and hogs	x	x	
13 Placement intentions for cattle on feed	x	x	x
Poultry:			
14 Feeding rates for hens, pullets and broilers	x	x	x
15 Capacities for laying and broiler houses	x	x	x
Dairy:			
16 Capacities of milking facilities	x	x	x

and the crop was actually planted. The ratio of "acres of land double cropped" -to- "acres of land that could be double cropped", on the other hand, represents an estimate of the preferred capacity utilization rate, reflecting the degree to which economic capacity or the optimal output level differs from engineering capacity or maximum output possible if these acres were fully employed. Illustration of yet another ratio is possible if we examine the fed cattle industry. The ratio of placement intentions for cattle on feed-to-feed lot capacity represents an estimate of the preferred capacity utilization rate. The ratios of cattle on feed-to-feed lot capacity and cattle on feed-to-placement intentions for cattle on feed represent measures of the current engineering capacity and current economic capacity utilization rates, respectively. The former rate, because it is based upon engineering capacity, cannot exceed one while the latter rate can. Finally, the ratio of the current engineering capacity utilization rate-to-the current preferred capacity utilization rate yields what is defined in the literature as the effective capacity utilization rate. A high effective utilization rate, for example, would suggest that output will not likely increase unless present economic conditions improve.

The primary data identified in this section are supplied by existing surveys which, for the most part, have sufficient reliability to permit subsector and geographical disaggregation without requiring substantial survey modifications. Data from a number of other surveys, such as the recent Soil Conservation Service study (USDA 1977a) of potential crop land, are available to supplement these surveys. Research should be undertaken to determine what additional primary data are needed and which of the many possible data sources identified above can most effectively provide them.

Need for type-of-farm orientation

One of the principal disadvantages from an analytical viewpoint of using the commodity survey approach described in this section is that it is commodity oriented rather than type-of-farm oriented. The lack of a tie to a specific type of farm coupled with a lack of questions designed to gather information on investment intentions and the reasons behind annual changes in production intentions, makes if difficult to explain why changes in economic capacity are occurring over time. While we can presumably account for the effects of weather and insects in any one year for field crops, for example, by adjusting for differences between expected and actual yields, additional information regarding the economic forces which cause producers to expand their economic capacity or shift their present resources among commodities is required to adequately explain past changes as well as forecast future expansion. For example, primary data on current expectations producers hold regarding relative prices and availability of variable production inputs would give us an insight to the reasons behind their current intentions to utilize their existing capital stock conditioned by current farm program policies. This information, when coupled with primary data on their investment intentions over an intermediate-term horizon and the impact that such factors as environmental regulations or price variability would have on their decisions, would enable us to identify the forces behind sector expansion.

Many of these factors, however, may be difficult to quantify. Research should be undertaken to determine whether producers are both willing and able to assess the quantitative impact they expect these factors to have upon their economic capacity and capacity utilization. If subsequent survey tests show that responses are either unreliable or impossible to obtain, consideration should instead be given to adopting a qualitative approach by requesting producers' intuitive response to the impact that these factors would have upon their "practicable achievable economic capacity." Under this approach, we instead would be requesting producers' response to the degree of influence (i.e., major, minor, etc.) these factors would have upon their current preferred capacity and future capacity expansion. Use of this approach would no doubt require several years of experimentation with alternative survey designs, including questionnaire design and content, as well as sampling strategy and evaluation of responses. Additional questions designed to measure the reasons behind deviations from earlier producer expectations could also be asked. Some potential causes would likely include weather, insufficient market information, factor availability, changes in government programs as well as changes in managerial goals. Obtaining qualitative responses to the above factors, however, may well require considerable expansion of existing questionnaires.

In summary, a large volume of detailed primary data is already available for the farm production sector on a time series basis and its quality is well known. The data collection procedures used are sound and the survey designs are flexible enough to permit additional related questions. Furthermore, relatively little research would be required to modify and implement these survey procedures. Before proceeding, however, general agreement is needed on which surveys are to be modified, which definitions are to be followed and what additional information is required. On the negative side, the capacity data collected by the commodity survey approach for the farm production sector will not be consistent with existing estimates for the nonfarm business sector which are firm rather than commodity oriented. Finally, there is practically no data base to build upon for the remaining sectors comprising the food and fiber system if we should desire to adopt the commodity approach there as well.

Use of New Global Surveys

The global survey approach, while untested in the farm production sector, is widely used in selected industries in the nonfarm business sector. Under this approach, firms surveyed are requested to provide information related to their current capacity utilization at the firm level. In the case of multi-product firms, this may include several unrelated resource constraints. These survey results are then aggregated within broadly defined subsector quidelines (i.e., durable versus nondurable goods or manufacturing versus nonmetallic, etc.) rather than along product lines required by the commodity survey approach.

Present use in other sectors

Three major users of global survey data to estimate capacity utilization rates are identified in this section: (1) McGraw-Hill, (2) the Bureau of Economic Analysis, and (3) the Board of Governors of the Federal Reserve System. McGraw-Hill, for example, uses two surveys; one designed to estimate annual changes in "maximum" capacity utilization as of December and another to estimate monthly "operating" rate changes. The questionnaires used by McGraw-Hill are reproduced in the Appendix to this paper. Data from these surveys are supplied by a purposively selected sample of business firms in twenty selected industries who hold about two-thirds of total fixed business capital. Interestingly, the terms "capacity", "maximum capability" and "operating" rate are not defined by the questionnaires but are instead left up to managements' intuition. In addition, a rather large proportion of the questionnaire is devoted to surveying the investment intentions and management expectations regarding future sales, research and development outlays, employment and the effects of environmental regulations over an intermediate-length planning horizon.

The Bureau of Economic Analysis also conducts a global survey which covers 2,400 manufacturing firms representing approximately 75 percent of total manufacturing assets. The questionnaire used by the Bureau of Economic Analysis is also reproduced in the Appendix. In their survey, firms are requested to report information pertaining to the current engineering and preferred capacity utilization rates from which the economic capacity utilization rate can be computed. This survey is conducted on a quarterly basis with firms stratified into three asset size categories by type of goods manufactured (durable versus nondurable). The survey is part of a larger survey program that collects primary data on actual and expected plant and equipment expenditures.

The Federal Reserve Board estimate of capacity utilization covers 15 materials industries (steel, lumber, ect.) and the manufacturing industries. A survey of the materials industries provides December production data. This series is then divided by an estimate of year-end engineering capacity provided by supplemental information from government and trade associations adjusted to a three shift operating schedule to obtain their index of actual capacity utilization. For the manufacturing industries, the Federal Reserve Board uses the Bureau of Economic Analysis estimate of fixed capital stock, the Federal Reserve Board industrial production index and the McGraw-Hill capacity utilization rate to derive a capacity utilization rate for these industries.

Application to the food and fiber system

Several advantages could emerge from adopting the global survey approach to the food and fiber system. Initially, the primary data collected for the input supply, farm production, processing and distribution sectors would be conceptually consistent with existing estimates for other sectors if one of the existing survey designs were adopted. The McGraw-Hill survey questionnaire, for example, may serve as a useful model for us to pattern after. This would also make it easier to reach agreement on specifications, definitions and data requirements. The primary data needed to estimate capacity utilization and future capacity expansion would also be collected by a single set of surveys (one of each sector) rather than through numerous commodity specific surveys which are always subject to change.

Research should be undertaken to determine whether or not managers in the farm production sector in particular have some concept of the capacity of their firms based upon previous operating experience. If subsequent survey tests prove successful, it may be possible to obtain these data for the farm production sector through the Annual Economic Survey initiated in 1976 (U.S. Senate). While this survey currently provides data on past annual expenditures for fixed and variable production inputs, some flexibility apparently exists to shift survey emphasis from year to year. An investigation should be undertaken to see whether this survey can be broadened periodically to obtain information on: (1) producer investment intentions over an intermediate-term horizon, (2) current producer expectations regarding prices and availability of variable production inputs, and (3) the impact producers expect other factors such as price and yield variability to have upon their current and future capacity decisions.

While the firm-wide approach used in global surveys would likely work as well for the other sectors in the food and fiber system as it does now for those industries covered by the McGraw-Hill survey, one would expect some difficulty in adopting the global survey approach to farm firms at the sector level. Several characteristics unique to farm production, for example, would make cross-comparisons with other sectors difficult. Fixed capital in the farm production sector is much less commodity specific than true in other sectors and annual switches among crop commodities may affect the accuracy of aggregate capacity utilization estimates and our ability to interpret them. In addition, weather, insects and diseases are thought to uniquely affect the capacity utilization rate in the farm production sector. Unlike other sectors, there is little opportunity to adjust the production process in the farm production sector once it has been initiated due to its biological nature. Producers, for example, cannot put on an extra shift to produce a given level of output faster. This factor, coupled with the longer production cycles in the farm production sector (several years in the case of cattle and fruit crops), suggests that firms in other sectors can more easily adjust their preferred capacity utilization rate. Thus, the diversity and large number of firms, the flexibility of fixed capital inputs among commodities and the impact of random biological events make measurement and interpretation of capacity utilization estimates for the farm production sector more difficult and therefore less suited to the global survey approach at the <u>sector</u> level.

Timing of Surveys

The length of the production cycle for most farm production extends from several months for such commodities as vegetables to several years for cattle and fruit crops. Yet, primary data on the utilization of current economic capacity probably cannot be collected more than once a year. The timing of this survey could be in the early spring when producers in general are completing their crop production plans for the current year based upon their expectations of what factor and product prices will be. If the need for semi-annual data is justified, however, a second survey could be taken in the early fall when first seedings for the upcoming crop year are made and producers have better information on their expected year-end financial position.

Primary data on investment intentions for fixed producer capital as well as expected shifts in production among several existing enterprises could probably be obtained on a bi-annual basis. Justification for collecting this data on a more frequent basis could probably be made however in periods of relatively high income variability. By regularly scheduling these surveys on a bi-annual basis, however, it may be possible to survey producers in sufficient numbers to permit subsector and geographical disaggregation.

Data presently exist for some commodities to update capacity utilization rates - both economic and engineering - on either a quarterly or monthly basis. For those commodities covered less frequently, proration based upon breeding intentions, seasonal trends and expected capacity utilization can be used to update these utilization rates on a monthly basis.

Level of Aggregation

The level of aggregation possible in the near future is tied closely to the current availability of primary data provided by existing commodity surveys. For our longer run needs, however, research should be undertaken to determine whether or not capacity utilization rates and future capacity expansion in the farm production sector can be accurately estimated and interpreted if we adopt the global survey approach at the sector level. We expect this research to show, however, that the only way to accurately estimate and interpret changes in aggregate capacity of the farm production sector is to maximize the degree of disaggregation possible along subsector and geographical lines subject to a budget constraint. These subsector estimates at regional levels could then be aggregated to sector totals at the national level if desired. Importantly, the results of this investigation will have a substantial impact on our choice of survey design.

Other capacity-related data such as expenditures for fixed and variable production inputs provided by the Annual Economic Survey are available on an annual basis only and probably should not be collected more frequently. Yet, since this survey is a global survey of firms in the farm production sector with emphasis placed upon accuracy at the national level, it does not provide the basis for the subsector and geographical disaggregations we desire. To modify its survey design to overcome this "weakness" for our purposes would likely require major changes in the design of the sample and substantial increases in cost.

Consideration should also be given to determining whether annual disaggregations are of significant value to justify the additional costs. One alternative is to consider the suitability of using secondary cross-sectional data provided by the Census of Agriculture to estimate an econometric model which can in turn be used to "interpolate" between five-year benchmarks at subsector and regional levels.

ESTIMATION USING SECONDARY DATA

In a recent review of the literature on capacity and capacity utilization Spielmann identified the positivistic approaches proposed by Hickman and Klein and Preston which, because they require only secondary data for estimation purposes, represent potential alternatives to direct surveys of firms in the food and fiber system. The purpose of this section is both to extend Spielmann's remarks to cover other advantages and disadvantages we find associated with these proposals as they relate to the food and fiber system and to identify and evaluate other selected positive and normative approaches as alternatives to those proposed by Hickman and by Klein and Preston.

Positive Economic Capacity Models

Three general categories or aggregate positive models purporting to estimate economic capacity are reviewed in this paper: (1) investment behavioral models, (2) production function models, and (3) supply function models. The theory underlying each approach is briefly reviewed and the potential problems we face in attempting to implement them in the food and fiber system are discussed.

Investment behavioral models

Hickman has proposed a method by which the level of economic capacity, which he defines as that output produced at minimum average total cost given the technology or efficiency units associated with the existing capital stock and expected relative prices, can be inferred from observed net investment behavior. If we assume for the moment that the original purchase price expressed in constant dollars adequately reflects the technical progress embodied in new producer capital, Hickman would then hypothesize that the optimal or desired year-end stock of fixed producer capital (K_{t+1}^{*}) is given by

$$(1) \quad K_{t+1}^{*} = a_0 + a_1 Y_t^{*} + a_2 (P/C)_t^{*}$$

where Y_t^{*} represents expected real output, P_t^{*} represents expected product prices and C_t^* represents the expected implicit rental price of an additional unit of producer capital, all in time period t. Thus, K_{t+1}^* represents the optimum stock of capital to be used in combination with the labor input implied by Y_t^* given present production practices and relative prices. Included along with the purchase price of producer capital in period t and the current interest rate in Hickman's specification of C_t^* is the assumption of a declining balance capacity depreciation pattern. This depreciation pattern rests on the assumption that fixed producer capital is utilized more intensively and therefore consumed more rapidly during the early stages of its service life than during the latter stages. After allowing for testing of the partial adjustment hypothesis, Hickman shows that current real net investment is given by

$$(2) \quad K_{t+1} - K_t = \Theta a_0 + \Theta a_1 Y_t^* + \Theta a_2 (P/C)_t^* - \Theta K_t \qquad (0 < \Theta \leq 1)$$

where

$$(3) \quad a_1 Y_t^* = a_{11} Y_t + a_{12} Y_{t-1}$$

$$(4) \quad a_2 (P/C)_t^* = a_{21} (P/C)_t + a_{22} (P/C)_{t-1}$$

Hickman then estimates the statistical model associated with equation (2) expressed in logarithmic form using ordinary least squares regression, solves for K_{t+1} and then divides the resulting short-run coefficient estimates by the partial adjustment coefficient Θ to obtain the long-run elasticities associated with the a_i coefficients in equation (1). Finally, Hickman inverts the relationship between the desired capital stock and expected output to obtain a corresponding relationship between current economic capacity (Y_t^C) and the existing capital stock given current expected relative prices, or

$$\text{(5)} \quad \log Y_t^C = [(-\log a_0 - a_2 \log (P/C)_t^* + \log K_t)/\ a_1]$$

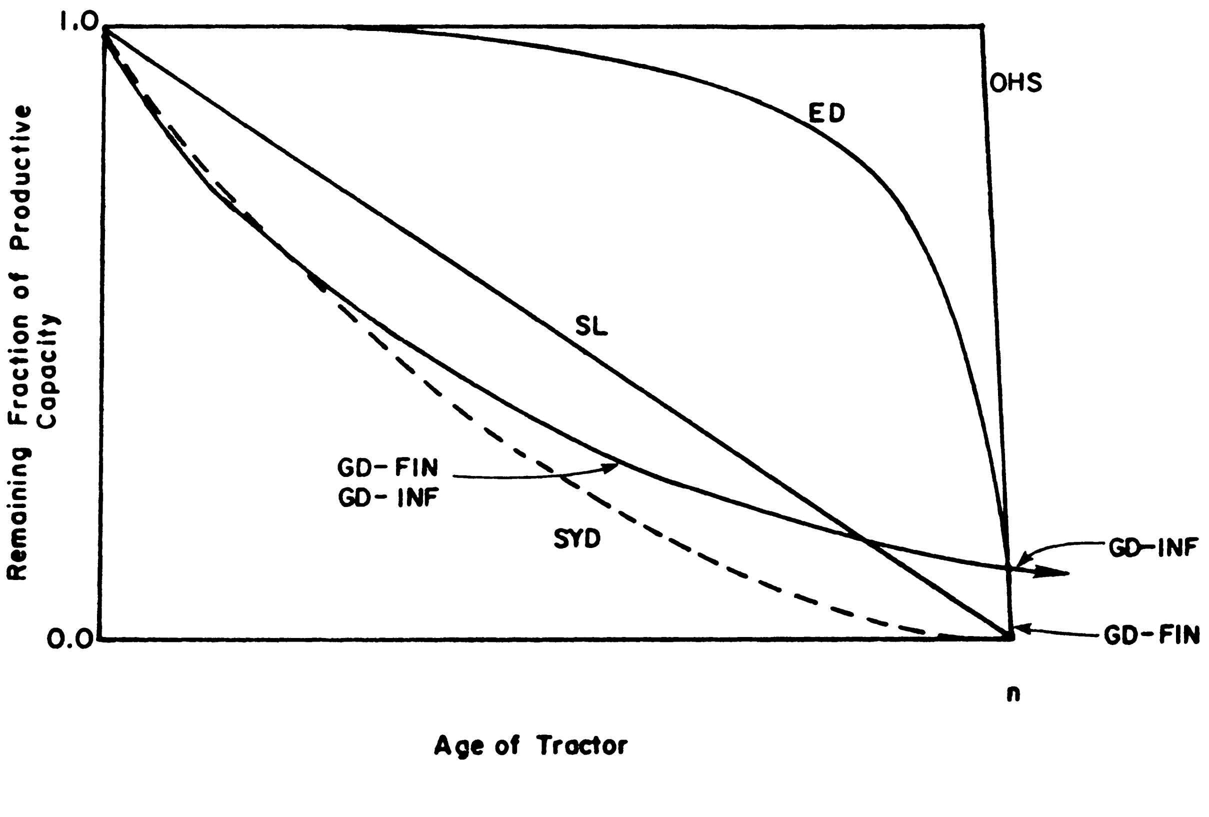
Thus, the economic capacity of the existing capital stock and the optimum use of labor will vary with producer expectations regarding relative prices. As Hickman notes, the a_1 coefficient carries an important economic meaning in his model. If a_1, for example, is equal to unity, a doubling of the capital stock (and labor input) would imply a doubling of capacity, or constant returns to scale. If, on the other hand, a_1 is less than unity, capacity would more than double if the capital stock and other inputs double, thus implying increasing returns to scale.

Hickman found that both the actual and normal utilization rates, or (Y_t/Y_t^C) and (Y_t^*/Y_t^C) respectively, often exceeded one for those nonfarm industries studied. Hickman suggests, however, that this may merely mean that firms were operating between optimum capacity, or that output which minimizes costs per unit, and peak capacity, or the maximum output technically possible under normal operating conditions. Hickman also acknowledged, however, that the utilization rate estimated by this approach will be biased if the estimate of Y_t^C is biased as a result of either measurement error or specification error associated with equation (2).

The approach proposed by Hickman has some desireable features. For example, it proposes an explicit accounting of those economic forces causing firms to expand their present fixed capital stock, thereby allowing researchers to explain the current change in capacity given the assumption of fixed factor proportions. In addition, it does not require direct estimation of a cost function or a production function although the properties of each can be inferred from equation (1). Finally, this approach would seemingly work well for those industries characterized by firms with vastly-held ownership and producer capital that is unique to a single production process.

There are several problems seen, however, with attempts to adapt this approach to the U.S. food and fiber system in general and to the farm production sector in particular. Of a general nature, the declining balance depreciation pattern assumed by Hickman can be questioned in light of the recent results found by Penson, Hughes and Nelson. They suggest that the productive capacity of farm plant and equipment, assuming normal repairs and maintenance, likely declines over their service lives in a manner characterized by a path (ED) concave in nature falling between that suggested by the straight line (SL) and one-hoss shay (OHS) depreciation patterns (see Figure 1).[2/] The depreciation pattern adopted by Hickman, on the other hand, falls below that suggested by the straight line pattern and is convex rather than concave to the origin.[3/] This difference has important implications for the value of C_t^* in equation (1) and elsewhere in Hickman's model. This suggests that the depreciation of producer capital should be measured rather than arbitrarily assumed for each of the sectors comprising the food and fiber system. Additional problems seen with Hickman's specification of C_t^* relate to the absence of an accounting of the effects of changes in tax laws such as investment credit, or of real capital gains associated with price sensitive farm assets. Respecification of C_t^* for

Figure 1.-- Alternative Capacity Depreciation Patterns.



each sector of the food and fiber system to more adequately reflect their implicit rental price of capital would no doubt lead to improved estimates of Y_t^C, other things constant. Finally, one would expect difficulty from an operational standpoint in forecasting current economic capacity (Y_t^C) based upon equation (5) since current actual relative prices $(P/C)_t$ and real output (Y_t) are not known in advance unless perfect knowledge is available. To account for the effects of uncertainty on investment behavior, Birch and Siebert regress the expectational variable on past actual outcomes and other variables hypothesized to be relevant.

Several characteristics thought to be unique to the farm production sector also raise serious questions as to the feasibility of employing Hickman's approach to estimating aggregate economic capacity. For example, production assembly lines in the input supply sector or canning lines in the processing sector of the food and fiber system are likely unique to the general nature of the product being produced. As such, the level of output will likely be unaffected by whether peas or corn are being canned or any one of several kinds of feed supplements are being bagged. Thus, if data on expenditures for new plant and equipment are available for selected industry groupings within these sectors, we probably stand a reasonable chance of being able to estimate economic capacity for these sectors by aggregating industry-by-industry estimates of real output valued in constant prices provided by Hickman's model.

Disaggregation along broadly defined industry guidelines may not be sufficient in the farm production sector, however. While capital inputs are generally industry specific in their application for those industries comprising the livestock subsector of the farm production sector, plant (including land) and equipment used in crop production is generally not. How do we then evaluate the economic capacity of the crop subsector given the difference, for example, in the number of bushels of soybeans per acre versus bushels of corn which can be produced by the same flow of capital services? Since many firms follow crop rotational practices or diversify as a risk management strategy, Y_t^c in the crop production subsector will depend not only upon the level of net additions to existing capital but also <u>where</u> this capital is used. What is seemingly needed to make the Hickman approach work in the crop subsector in particular is data on the capital stock and capital flows associated with current production of each commodity, an informational requirement that places an obvious strain on our present economic accounting system. Even if these data were available, we must also question whether an increase in economic capacity can be inferred from net investment in selected farm capital items such as on-farm storage facilities or whether we instead should restrict our coverage to only those capital items directly involved in actual production. In addition, the degree to which the present USDA data series on capital stocks and flows expressed in constant dollars reflect all changes in input quality for which a price is paid is an issue addressed by Griliches. If the implicit deflator removes a portion of those changes in quality for which a price is paid or if there are changes in quality not reflected in the original purchase price, the ensuing estimates of Y_t^c will be biased downward.[4/] Still another problem faced in attempting to implement the Hickman approach in the farm production sector is the absence from coverage of own-account capital formation of such capital items as breeding livestock and perenial vines, shrubs and trees. The existence of producer capital leased from outside the sector may also require coverage of the net increase in capital <u>controlled</u> as opposed to observed net investment by farm producers. Finally, the farm production sector remains predominantly comprised of many closely-held farm firms who are thought to collectively display an aversion to increasing business and financial risk (Barry and Fraser). Failure to reflect this when adopting Hickman's approach in the farm production sector will likely lead to an over-estimation of Y_t^c in periods of relatively high price and yield variability.

The magnitude of the capacity utilization rate for the farm business sector is also thought to be uniquely affected by weather and disease. It would not be surprising, for example, for the economic capacity utilization rate for any one commodity or group of commodities in the crop subsector to exceed one due to the existence of weather conditions exceeding those reflected in the value of Y_t^* given by equation (3). Obviously, adverse weather conditions or livestock losses due to disease can also lower the economic capacity utilization rate in any one year.

In short, we conclude that, while the Hickman approach to estimation of economic capacity has some theoretically appealing features, its implementation for the food and fiber system in general and the farm production sector in particular is prevented by those specification and measurement issues identified above.

Production function models

Klein and Preston have also proposed an alternative to direct surveys of sector participants. Their approach involves estimating economic capacity via an aggregate or industry-wide production function. They suggest that economic capacity output is given by

$$(6) \qquad Y_t^c = AL_t^{\hat{\alpha}} K_t^{\hat{\beta}} e^{\hat{\gamma} t}$$

where L_t represents total available manhours in period t, K_t represents fully utilized capital services in period t, $e^{\gamma t}$ is a proxy for technical progress and α and β are the production parameters associated with L_t and K_t, respectively. Assuming conditions of perfect competition and cost minimization behavior, Klein and Preston determine the relative factor shares for labor and capital by

$$(7) \qquad \widehat{(\alpha/\beta)} = 1/m \sum_{t=1}^{m} [(r_t \, K_{ut})/(w_t \, L_{et})]$$

where r_t is the cost of capital services in period t, w_t is the money wage rate in period t and K_{ut} and L_{et} represent capital utilization and manhours employed in period t, respectively.

To partition $\hat{\alpha}$ and $\hat{\beta}$ as well as estimate the remaining parameters in equation (6), Klein and Preston estimate the following equation using ordinary least squares regression

$$(8) \qquad \ln Y_t = \ln A + \gamma t + \hat{\alpha}[\ln L_{et} + (\hat{\beta}/\hat{\alpha}) \ln K_{ut}] + \ln \nu_t$$

where ν_t represents the disturbance term in period t. Based upon the estimates of A, $\hat{\gamma}$, $\hat{\alpha}$ and $\hat{\beta}$ provided by equation (8) and the assumption first advanced by Solow that the labor utilization rate (L_{et}/L_t) is equal to the capital utilization rate (K_{ut}/K_t), Klein and Preston merely had to estimate either K_t or L_t at the industry level for those industries studied in the corporate nonfarm business sector to complete equation (6).[5/] Choosing to tackle L_t at the industry level, Klein and Preston begin by estimating full-employment manhours for the economy as a whole and then allocate this total, which they assume to be a monotonic increasing function of time, among the industries comprising the sector. The allocation weights used were based upon the relative importance of each industry to the production of aggregate output at those full-employment peaks identified by Klein and Preston. They then fit linear segments between these shares, thereby obtaining a time series for L_t at the industry level for the time period covered by the study. Once Y_t^c has been determined by inserting L_t and K_t into equation (6), the ratio of actual output to full capacity output or (Y_t/Y_t^c) represents their estimate of the economic capacity utilization rate.

Like the Hickman approach, the procedure proposed by Klein and Preston has some theoretically appealling features. For example, use of the weighted average of past values for $(\hat{\alpha}/\hat{\beta})$ rather than their most recent value avoids the bias associated with the industry's current position on its business cycle. That is, Klein and Preston attempt to make the ratio of the factor shares for labor and capital independent of capacity utilization for the purposes of estimating equation (8). If $\hat{\alpha}$ and $\hat{\beta}$ have been trending in opposite directions for some time, however, the most current estimates may well be preferred. In addition, the Klein-Preston approach focuses on observed factor shares rather than observed net investment, thereby conceivably avoiding those problems associated with own-account capital formation and producer capital leased from outside the sector mentioned above in connection with the Hickman approach. Thus, the Klein-Preston approach would seemingly work well in those sectors where capital inputs are unique to the general nature of the product being produced.

Spielmann cites several problems we would likely face in attempting to implement this approach in the food and fiber system in general and the farm production sector in particular. Of a general nature, Spielmann points to the difficulty associated with measuring K_{ut} as it requires the identification of r_t. One can further question how Klein and Preston would partition K_{ut} among selected categories of variable and fixed capital inputs given the desireability of doing so. Spielmann also identifies the problems associated with partitioning labor and entreprenuerial income in the farm production sector, a problem that no doubt led Klein and Preston to avoid coverage of those sectors characterized by self-employed proprietors. Klein and Preston also appear to merely assume when estimating Y_t^c that firms within each industry will actually desire to employ that labor input L_{et}^* given by their estimate of L_t (i.e., $L_t = L_{et}^*$). Finally, Spielmann suggests that it is difficult to estimate L_{et} for the farm production sector due, in part, to the mixing of labor and entreprenuerial incomes noted above. However, the USDA published an annual estimate of total manhours used for farm work by enterprise groups which seemingly would meet our informational requirements (USDA 1975a). Instead, the difficulty we see associated with the labor input lies in following the Klein-Preston procedure for estimating L_t or the total labor available to the farm production sector. Measurement of K_{ut}, on the other hand, does appear to present a problem as Spielmann suggests if we attempt to follow the Klein-Preston approach, particularly if we wish to partition K_{ut} into separate input categories.

A somewhat different twist to the same approach is offered by Tyner and Tweeten who initially estimate an aggregate Cobb-Douglas production function for the farm production sector based upon the knowledge that production elasticities (E_i) equal input factor shares (F_i) under conditions of perfect competition and market equilibrium. Assuming a disequilibrium situation exists ($E_i \neq F_i$), Tyner and Tweeten suggest that producers organize their production plans in such a manner that actual factor shares adjust to equilibrium factor shares in a geometric distributed lag fashion. Using constant dollar data for output (Y_t) and nine input categories (labor (L_{et}) and eight variable and fixed capital input groups (K_{uit})) along with the above factor share estimates, Tyner and Tweeten determined the constant term A for each decade during the 1912-1961 time period by estimating

$$(9) \qquad Y_t = A(L_{et}^{\hat{\alpha}} K_{u1t}^{\hat{\beta}1} K_{u2t}^{\hat{\beta}2} \;\ldots\ldots\; K_{u8t}^{\hat{\beta}8}) + \nu_t$$

using ordinary least squares regression.[6/]

Rather than assuming L_t to be a monotonic increasing function of time or assuming equal utilization rates for labor and capital as Klein and Preston did, Tyner and Tweeten determined the optimal input use for each decade during the 1912-1961 time period by first taking the partial derivative of

$$(10) \qquad C_t^0 = w_t \, L_{et} + \sum_{i=1}^{8} r_{it} \, K_{uit} + \lambda (Y_t^0 - AL_{et}^{\hat{\alpha}} K_{u1t}^{\hat{\beta}\omega} K_{u2t}^{\hat{\beta}2} \;\ldots\ldots\; K_{u8t}^{\hat{\beta}8})$$

with respect to L_{et}, each of the K_{uit} and λ where C_t^0 represents total costs associated with a prescribed level of output Y_t^0 and λ represents the Lagrange multiplier.[7/] These derivatives are then set equal to zero and the resulting set of simultaneous equations are solved to estimate the minimum cost combination of inputs. Interestingly, Shumway, Beattie and Talpaz show that Tyner and Tweeten apparently solved for the minimum-cost input use levels using a set of r_{it} assumed to equal one 1947-49 dollar for the entire 1912-1961 period rather than using their implicit price both before 1947 and after 1949. They go on to show that use of the correct implicit prices for the set of r_{it} during the 1912-46 and 1950-61 periods substantially affects the Tyner-Tweeten conclusions concerning the optimal resource allocation during these periods. If we instead treat w_t and an appropriate set of r_{it} as expectational variables and use the most recent values for $\hat{\alpha}$ and $\hat{\beta}^i$, we could form a profit function, set its partial derivatives equal to zero and solve for the input demand equations. Having done this, we could substitute in the current set of expected prices, solve for the optimal input use levels and then, by substituting these values into equation (9), solve for Y_t^c. The actual capacity utilization rate would then be computed in an identical fashion to that followed by Hickman and Klein and Preston. While this approach may be empirically possible, several inherent limitations should be identified. Initially, the suitability of the depreciation flows used by Tyner and Tweeten in measuring the real estate and machinery input use series can be questioned in light of the results found by Penson, Hughes and Nelson referred to earlier. Furthermore, Griliches suggests that the prices paid index used to deflate the capital input flows will remove increases in quality if they fail to cover all relevant type and size classes for those capital items included in these input use groups. Both sources of measurement error will affect the value of some or all of the capital input use groups and therefore the estimate of Y_t^c. The argument advanced earlier regarding the substitutability of farm producer capital among different commodities suggests that we should attempt to disaggregate the production function approach along subsector and geographical lines. While presently available time series data preclude estimation of production functions below the farm production sector level, cross-sectional data such as that provided by the 1974 Cost of Production Survey could be used to directly estimate the parameters of a set of Cobb-Douglas production functions for selected type-of-farm subgroups at sub-regional levels for 1974 (USDA 1976b).[8/] While one would expect some difficulties in aggregating to the sector level, the estimate provided by a disaggregated production function approach may suffer less from aggregation problems than that associated with a single production function for the entire U.S. farm production sector.[9/] Thus, we feel the type-of-farm production function approach using cross-sectional data as it becomes available deserves further study. Along this line, continued Cost of Production Surveys conducted perhaps every three years providing sub-regional data on input use levels and output at the type-of-farm level should be encouraged. The disaggregated informational flow provided by this approach would also likely be of more interest to policy makers than the current aggregate estimates.

Supply function models

The following discussion of supply function models as they provide the basis for estimating the economic capacity of the food and fiber system is necessarily brief for two reasons: (1) a supply function represents a schedule of quantities supplied at specific price levels and thus also reflects the effects of simultaneous producer inventory management decisions with respect to the marketing of current and previous production, and (2) the present crop of supply function models estimated for the farm production sector either differ little from the net investment behavior model proposed by Hickman or they do not include a statistical linkage to those economic variables which explain changes in the demand for the various factors of production.

Initially, the quantities of goods supplied in any one year will differ from current output levels by the amount of farm production internally consumed and the net change in farm inventories. Because of this, an examination of the schedule of quantities marketed at specific price levels will not necessarily relate to the current economic capacity as defined in this paper (also see Spielmann and Weeks). Thus, only if we assume that the net change in farm inventories and current output internally consumed are reflected in the supply and demand schedules will the quantity supplied equal the level of current output.

Implying the adoption of this assumption, Tweeten and Quance hypothesize that the aggregate supply function for farm products is given by

(11) $Y_t = a_0 + a_1 \; (Pr/Pp)_{t-1} \; T_t + a_3 \; Sp_t$

where Y_t again represents actual farm output, $(Pr/Pp)_{t-1}$ represents the lagged ratio of the index of prices received for all farm products-to-prices paid for production inputs, T_t represents their measure of productivity and Sp_t represents the stock of productive assets expressed in constant dollars at the beginning of the year. Thus, the Tweeten-Quance supply function model, which regresses output on a set of "independent" variables, bears a strong resemblance to the net investment behavior model presented earlier in equation (5). Technical progress included in K_t in equation (5), for example, is included in both T_t and Sp_t in equation (11). While their model has received its share of criticism on statistical grounds, it also has many of the disadvantages cited earlier for the net investment behavior model as an approach to estimating economic capacity.

While there have been numerous aggregate demand and supply simulation models for the farm production sector, we choose to discuss the Yeh model as it represents the most recent application. Yeh recently reported the properties of a simulation model which centers around a synthesized system of two simultaneous equations representing the supply and demand for farm products. If we again assume away the issue of inventories for the moment, the Yeh model provides a method for accounting for relative price effects and alternative assumed shifts in supply and demand rather than a complete empirical explanation of the forces causing change. There appears to be no statistical linkage, for example, between those factors causing a change in desired input use levels such as fixed capital and supply other than by assuming that such a change would result in a specific shift in the supply curve. Thus, the Yeh model, while undoubtedly useful in other contexts, would appear to be of limited value to us in explaining and forecasting changes in economic capacity and capacity utilization.

Normative Economic Capacity Models

Two general categories of aggregate normative models which prescribe the optimal production response at the sector or subsector level given existing technology, available resources and quantities demanded are reviewed in this paper: (1) consumer plus producer surplus maximization linear programming models, and (2) cost minimization linear programming models. Rather than discuss the limitations of linear programming in general or review the unique properties of the present crop of aggregate surplus maximization and cost minimization models, we choose instead to focus on one representative from each category assembled by the same research team. Because both models are otherwise essentially identical, we should be able to discern the impact that the researcher's choice of objective function has upon the estimate of economic capacity as well as the relative efficiency of the two approaches.

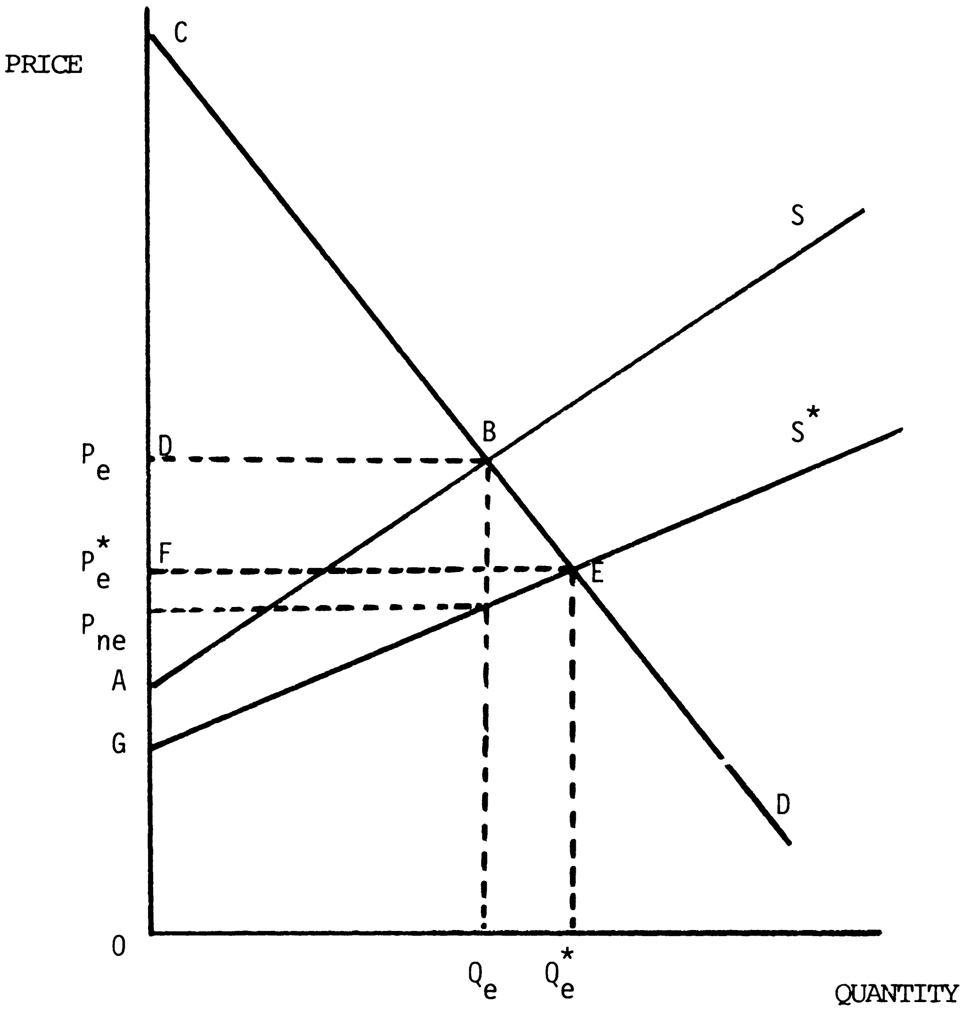
Surplus maximization models

Two national spatial equilibrium linear programming models for the U.S. crop subsector were recently developed by Taylor, van Blokland, Swanson and Frohberg. They initially divided the U.S. into unique production regions based upon the homogeneity of crop production. In addition, 21 consuming regions were also identified. Of interest to us here is their model which maximized consumer plus producer surplus associated with the production and transportation of eight commodities given existing physical resource availability, technology and the demand curve for each consuming region.[10/] Their inclusion of net export demand and several transportation alternatives between consuming regions is of significance to us because it endogenizes several aspects of the distribution sector of the food and fiber system.

Rather than present the objective funciton and constraints or the matrix representation of their surplus maximization model, the nature of the solution is instead illustrated graphically in Figure 2. Letting curves S and D represent the current demand and supply functions and assuming for the moment the existence of an equilibrium situation, price and quantity would equal P_e and Q_e while consumer plus producer surplus is equal to area ABC or area CDB (consumer surplus) plus area DBA (producer surplus). If we now assume a once-and-for-all shift in the supply function to S^* as the result of our adopting a new technology, the equilibrium price and quantity would instead be P_e^* and Q_e^*. Consumer surplus would now equal area FEC while producer surplus would equal area FEG. Thus, the adoption of the new technology has increased consumer plus producer surplus from area ABC to area GEC for a total gain of area ABEG. The latter area therefore represents the change in social welfare resulting from the technological change.

The objective function of the surplus maximization model developed by Taylor, <u>et. al</u>. includes a piece-wise linear approximation of the

Figure 2. -- Illustration of Alternative Model Solutions.



area under the demand curve and total cost or the area under the supply curve.[11/] Thus, maximization of this objective function subject to crop land constraints, consumer demand, transportation constraints and crop production flexibility constraints provides a competitive spatial equilibrium solution which can approximate ABC and GEC (before and after adoption) with alternative runs of the model. The difference between the solution values therefore would approximate area ABEG or the change in social welfare.

There are several advantages to adopting the surplus maximization model as a means of estimating the optimal response or economic capacity of the food and fiber system as compared to other normative models: (1) it automatically provides a competitive equilibrium solution in a single pass, and (2) it identifies the social welfare gain from the adoption of new technologies. Once Q_e^* has been determined, the actual capacity utilization rate can be determined by dividing observed output by Q_e^*. The use of arbitrarily specified flexibility constraints to reflect differences in resource quality within regions or producer behavior toward risk via product diversification, the absence of financial considerations, and the lack of information on the speed of adjustment to the new equilibrium situation are among the deficiencies we see with the Taylor et. al. surplus maximization model. Yet, models of this type appear to offer a systematic approach to examining the effects of changes in exogenous variables upon the inter-relationships between regions and sectors of the food and fiber system.

Cost minimization models

The principal difference between the surplus maximization model and the cost minimization model developed by Taylor, et.al. lies in their objective functions. While the surplus maximization model provides a competitive spatial equilibrium solution, the cost minimization model may not. The cost minimization model. for example, minimizes the cost of producing and transporting the same eight commodities, given existing resource availability, technologies and quantities required for consumption by consuming regions. The cost minimization model will provide the same solution as the surplus maximization model only if Q_e^* is specified as the quantity demanded by the consuming regions, however. Referring back to Figure 2 for the moment, let us again assume that we are at the equilibrium situation Q_eP_e. Given the same shift in the supply function from S to S^*, the cost minimization model would continue to produce and ship Q_e but now at price P_{ne}. Thus, the model accounts only for the price effect of the new technology, ignoring the quantity effect by understating price by $P_e^* - P_{ne}$ and quantity by $Q_e^* - Q_e$. Only in the case where the cost minimization model is required to supply Q_e^* would it duplicate the results provided by the surplus maximization model. While this quantity can be found by parametrically solving for different quantities, this procedure is less efficient than the surplus maximization model. This is true for cost minimization models in general, including the one reported by Nicol and Heady. Thus, we would prefer the surplus maximization model over the cost minimization model based upon an evaluation of both theoretical and efficiency criteria.

In summary, the normative approach to estimating the aggregate economic capacity of the food and fiber system has both its advantages and disadvantages. Unfortunately, the disadvantages cited above will bias our estimate of economic capacity as well as the economic capacity utilization rate. Adoption of the surplus maximization approach appears to minimize these problems, although we remain troubled over the lack of information on the speed of response to the new equilibrium situation. Further model respecification to address other issues such as the incorporation of financing considerations and producer response toward increasing business risk will likely improve the acceptance of this approach for our intended use.

POTENTIAL DIRECTIONS FOR THE FOOD AND FIBER SYSTEM

The principal purpose of this paper was to critically review specific alternative approaches to estimating the economic capacity and capacity utilization for the food and fiber system in general and the farm production sector in particular. Much of the above discussion, however, admittedly focuses on applications in the farm production sector. This should surprise no one since this sector not only represents a unique challenge due to the diversity and number of farm firms, the flexibility and seasonality of fixed capital and the effects of biological events on output but also suffers less from primary and secondary data gaps.

Several proposals were made for further research in the previous sections. These proposals ranged from investigating the desireability of alternative survey designs to evaluating the conceptual completeness and feasibility of one or more empirical approaches using existing secondary data. Yet a necessary condition to these activities must be the attainment of a concensus of opinion on the definition of economic capacity. Relaxing the assumption made at the beginning of this paper regarding the unanimity on how we define economic capacity, we must admit to some confusion over what output level constitutes economic capacity. Spielmann and Weeks concluded that

> "Capacity, then, is an output measure and a short run concept. In economic terms, it is output at minimum per unit cost levels and is independent of demand." (p. 932)

This conclusion, however, seems at odds with the conditions of economic efficiency. If the average total cost curve is both "U" shaped and symetric, we would expect profit maximizing firms in the short run under conditions of perfect competition to desire to produce beyond the economic capacity output level specified by Spielmann and Weeks except for the specific case where firms are in short run equilibrium. It is also difficult to see how an aggregate measure of economic capacity can be "independent of demand" even in the short run unless one makes the limiting assumption that firms are in short run equilibrium. While Hickman also defined economic capacity as that output level corresponding to the minimum point on the average total cost curve, he was clearly dealing with the adjustment to long run equilibrium as he was concerned with the determinants of the desired stock of fixed capital or that plant size where total costs are minimized. Winston, in explaining why we can observe both idle fixed capital and still be at economic capacity, suggests that the <u>economy</u> is at its "macro capacity" when individual firms are producing at their minimum average total cost. Thus, previous authors including Winston appear to be unanimous in defining economic capacity as that output where per unit costs are minimized, implying that economic capacity exists only when general equilibrium conditions exist. Since firms typically require several production periods to adjust their existing capital stock to desired levels, however, why not instead assume a more general definition of macroeconomic capacity at the sector level as that output where marginal costs equal product price? Such a definition would appear to more accurately reflect the current economic goals of firms as they adjust to disequilibrating events under conditions of perfect competition, seeking that output where they maximize their profits given existing relative prices, resource availability and production practices. Such a concept would cover both the equilibrium and disequilibrium case.[12/] Perhaps the basis for distinction is whether we are interested in the current versus desired economic capacity, where the latter concept is limited to the equilibrium case under conditions of perfect competition. If we relax the above assumption of perfect knowledge, however, we would expect risk-averse producers to desire to operate at that level where their expected utility rather than profit is maximized. It can be argued that risk-averse producers may well desire to produce at that output level where per unit costs are minimized rather than where total profits are maximized!

Several potential directions for estimating economic capacity and capacity utilization exist for the food and fiber system. Because the potential directions for the farm production sector differ substantially from those available for the remaining sectors of the food and fiber system, we shall discuss these sector groupings separately below.

Farm Input, Processing and Distribution Sectors

The input supply, processing and distribution sectors play an important role in the performance and expansion of the entire food and fiber system. Their macro linkages to the farm production sector as well as with the rest of the domestic economy and international markets cannot be ignored. Unfortunately, there does not appear to be any surveys which collect primary data on the production and investment intentions of nonfarm businesses which focus solely on these sectors. Furthermore, because secondary data on annual expenditures for fixed and variable production inputs by firms in these sector are also not available, we cannot use the approaches proposed by Hickman or Klein and Preston, for example, even though they may be more appropriate for these sectors than for the farm production sector.

The question thus becomes one of whether the global survey approach employed at the sector level is sufficient or whether further disaggregation is required. Because plant and equipment expenditures more nearly approximate the expansion of existing productive capacity than thought to be true for the farm production sector, the McGraw-Hill global survey design, with some minor modifications, may serve our needs. Several characteristics of these sectors also make them much easier and less costly to survey than noted earlier for the farm production sector. For example, the number and location of firms in these sectors is considerably smaller and more highly concentrated near urban areas. As indicated earlier, producer capital in these sectors is also thought to be more unique to the product or service being provided. Finally, the managers of firms in these sectors are likely to have a better concept of capacity and therefore be better able to respond to some loosely-defined concept of capacity and capacity utilization than would farm producers.

We should consider disaggregating the processing sector, however, to be consistent with the subsector groupings chosen for the farm production sector since these processing firms are likely to be rather closely tied to the farm production cycle, particularly in the case of seasonal commodities such as fruit and vegetable canning. The timing of surveys for the processing sector should also be consistent with that suggested for the farm production sector. Issues related to the timing and aggregation of surveys in the input supply, processing and distribution sectors, however, will probably be easier to deal with than those related to aggregating capacity estimates at the food and fiber system level if such an estimate is desired.

Farm Production Sector

Based upon the discussion presented in the previous sections of the paper, several directions were indicated for the farm production sector. Initially, we can proceed to further improve and expand the existing commodity surveys to include data required to estimate and interpret changes in capacity utilization rates. For example, attempts should be made to link existing commodity surveys to a type-of-farm basis to facilitate descriptive analyses of production intentions and other economic information requested above. If research shows that it is difficult to obtain reliable quantitative information on the effects producers expect specific exogenous factors to have upon their utilization and expansion of existing capacity, attempts to obtain qualitative responses should be explored. One of the principle advantages that the direct survey design where the goal function of producers is left undefined has over the approach of inferring changes in economic capacity from empirical models is that it does not suffer from measurement and specification error if the sample is representative of the population. That is, the respondent necessarily considers all relevant factors - pecuniary and nonpecuniary - when completing the questionnaire while empirical models are typically hampered by missing data. In short, we recommend utilizing the desireable properties of both the commodity and global survey approaches by seeking commodity-specific production intentions data as well as firm-wide investment intentions data for selected type-of-farm subsectors in the farm production sector. Consideration should be given to using the Annual Economic Survey to periodically obtain information at the subsector level for key type-of-farm groups on a rotating basis over time. We could start, for example, by requesting special subsector treatment for grain farms and dairy farms and then not seek this information for several years unless conditions warrant. If the cost of expanding this survey is prohibitive, estimation of the type-of-farm production function model discussed earlier based upon cross-sectional data provided by periodic Cost of Production Surveys appears to merit further examination. The availability of data from future surveys of this type which are apparently planned would provide the statistical support required to maintain this approach over time. The performance of this model could be measured if model estimates were aggregated to those levels covered by other existing or proposed surveys.

Further development of normative models such as the consumer plus producer surplus maximization linear programming model discussed earlier in this paper should also be considered, although past experience suggests that they are relatively costly to construct and maintain over time.

Procedural Recommendations

Several alternatives exist for developing measures of economic capacity and capacity utilization for the farm production sector and the remaining sectors of the food and fiber system. The uniqueness of the farm production sector, its importance to the food and fiber system and the relative availability of primary and secondary data suggest that we view it as a candidate for initial study because of its relatively high potential for a short-term payoff. This does not suggest that adequate estimates of economic capacity and capacity utilization can be obtained for the farm production sector without a substantial effort on the part of agricultural economists and statisticians. Clearly, much preliminary work must be done to finalize concepts, identify existing data gaps, and address issues regarding the timing of surveys and desired level of aggregation.

The task identified above must involve both agricultural economists and statisticians and is of sufficient magnitude to require the input of professional associations, Federal agencies, industry and the academic community; the very interest groups represented at this workshop. The papers presented at the workshop and the ensuing discussion should provide the necessary foundation to build upon.

High priority should be given to setting up a study team to further evaluate additional data needs and survey designs required to estimate the economic capacity of the farm production sector. Included in their report should be a complete listing and justification for additional data requirements.

Longer run efforts will necessarily involve implementing survey designs for the farm production sector and developing and testing similar designs for the input supply, processing and distribution sectors. Further evaluation of models using secondary data for the farm production sector should also be conducted as "missing" data become available. Finally, additional efforts should include defining the macro linkages to other sectors of the economy as well as the linkages within and between the sectors comprising the food and fiber system.

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FOOTNOTES

1. If primary data on current yield expectations cannot be obtained through existing detailed surveys for the commodity in question, we can estimate this expectational variable by estimating one or more lag distributions (i.e., geometric, polynomial, etc.) based upon secondary data.

2. Capacity depreciation, or that outlay in current prices required if producers were to replace the plant and equipment used up during the year, should not be confused with either economic capacity (loss in market value) or tax depreciation (loss in book value).

3. Several researchers have defended use of the declining balance pattern on the grounds that it closely approximates the declining "blue book" value for used capital items. Yet, there are several reasons why the decline in price observed in used machinery markets can be less than the decline in remaining productive value to the firm. For example, a systematic negative bias is incurred if used tractor prices, particularly those traded in during the early stages of their service life after any warranties have expired, are used to value all tractors of an identical size, technology and age still on farms. Those tractors traded in will likely have a lower productive value than those retained on farms because they have either been used more than average or they have not received normal repairs and maintenance. As a result, the market price for used tractors observed in used machinery

markets is apt to be less than the average productive value for those tractors still used in production. A second hypothesis advanced is that the risk-averse producer will likely assign a greater weight to the likelihood of acquiring a tractor with less than average remaining productive value in used machinery markets than he would the likelihood of acquiring a tractor with greater than average remaining protective value. Thus, he will discount the price he would have been willing to pay if he had perfect knowledge of the tractor's remaining productive value. Finally, the producer may encounter less favorable financing arrangements with respect to the length of loan, the downpayment required and interest rate charged on loans to purchase used machinery than available for loans to finance new machinery purchases, thereby depressing used tractor prices still further.

4. Hickman's use of $e^{\gamma t}$ to account for the effects of technical progress is viewed as being less satisfactory than measuring capital expenditure flows in constant dollars as long as producers are charged the full price for new technological developments and the implicit deflators are properly specified.

5. Klein and Preston also excluded self-employed persons.

6. Tyner and Tweeten assume the error is additive rather than multiplicative in this instance.

7. The following input caterories were examined: fertilizer and lime; feed, seed, and livestock; labor; machinery; real estate (fixed);

machinery operating expenses; miscellaneous current operating expenses; crop and livestock inventory (interest); and real estate taxes.

8. Rather than follow state lines, their regions were delineated according to the homogeneity of production.

9. One option is, of course, to assume the same aggregation weights that were applied to the original sample in 1974 continue to remain valid.

10. These crops included corn, soybeans, wheat, barley, rye, grain sorghum and cotton.

11. Taylor et. al. used an area function rather than the steps of the demand function in deriving their piece wise linear approximation to the demand curve in the surplus maximization model. For a more complete description of this procedure, see Taylor, van Blokland, Swanson and Froberg.

12. Any difference between these concepts will be minor in those areas of the economy such as the farm production sector where the supply curve is highly inelastic.

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No. CH·______

BUSINESS' PLANS FOR NEW PLANTS AND EQUIPMENT--1977-80
(All questions apply to U.S. only)

PART I

1. How much did you invest in new plants and equipment in the U.S. in 1976? (This includes all purchases charged to capital accounts, whether for replacement, expansion or other purposes. Please include value of new plants and equipment leased to others. Do not include acquisitions.) $______

   a. Please indicate the division between:

      Manufacturing $______ Nonmetallic Mining $______ Other $______

   b. Of the total amount you invested in 1976, how much was for:

      Expansion______% Replacement & Modernization______%

   c. Of the total amount you invested in new plants and equipment in 1976, how much do you estimate was for pollution control?

      Air______% Water______% Solid Waste______%

   d. Of the total amount you invested in new plants and equipment in 1976, how much do you estimate was for your employees' safety and health? ______%

   e. At the end of 1976, how did your capacity, measured in terms of physical volume, compare with what it was at the end of 1975? Greater______% Smaller______%

   f. At the end of 1976, at what rate of capacity were you operating? ______%

2. How much do you now plan to invest in new plants and equipment in the U.S. in 1977? $______

   a. Please indicate the division between:

      Manufacturing $______ Nonmetallic Mining $______ Other $______

   b. If you carry out this program, what will be the net change in your company's physical capacity? Greater______% Smaller______%

   c. Of the total amount you now plan to invest in 1977, how much will go for:

      Buildings______% Motor Vehicles______% Machinery & Equipment______%

   d. How much will go for: Expansion______% Replacement & Modernization______%

   e. Of the total amount you now plan to invest in 1977, how much do you estimate will go for pollution control? Air______% Water______% Solid Waste______%

   f. How much do you estimate will go for your employees' safety and health? ______%

3. How much do you now plan to invest in new plants and equipment in the U.S. in 1978, 1979 and 1980? (Please try to give approximate answers to this question, even if you have not made definite plans.) 1978 $______ 1979 $______ 1980 $______

   a. Please indicate the division between:

	1978	1979	1980
Manufacturing	$______	$______	$______
Nonmetallic Mining	$______	$______	$______
Other	$______	$______	$______

   b. If you carry out this program, what will be the net increase in your company's physical capacity from the end of 1977 to the end of 1980? ______%

   c. Of the total amount you now plan to invest in 1978-80, how much will go for:

      Expansion______% Replacement & Modernization______%

d. Of the total amount you now plan to invest in 1978-80, how much will go for:

Buildings________% Motor Vehicles________% Machinery & Equipment________%

e. Of the total amount you now plan to invest in 1980, how much do you estimate will go for pollution control?

Air________% Water________% Solid Waste________%

f. How much do you estimate will go for your employees' safety and health in 1980? ________%

4. Under the most optimistic assumptions regarding liberalized investment incentives and growth in demand for your company's--produtcs or services, what is the maximum your company would invest for new plants and equipment in 1977 and 1978?

1977 $______________ 1978 $______________

5. How soon do you expect 1977 replacement and modernization outlays to pay off? _____years

a. How soon do you expect 1977 outlays for new capacity (expansion) to pay off? _____years

6. Roughly, how much of your company's capacity was shut down permanently in 1976 because of environmental and safety regulations? ________%

a. How much do you estimate will be shut down in 1977? ________%

7. How much were your company's sales including exports in 1976? $______________

a. How much do you think sales including exports of your company will increase or decrea between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

b. How much do you think prices of goods and services your company sells will increase o decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

8. How much do you expect your company's employment will increase or decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

9. How much did your company's productivity (unit output per employee) increase or decrease in 1976? Increase(decrease)________%

a. How much will productivity increase or decrease in 1977? Increase(decrease)________

10. In your view what is the rough estimate of the total cost of bringing all of your company existing facilities up to present pollution control standards? $______________

PART II

1. Roughly, what percent of your 1980 sales do you think will be in new products? (Either products not produced by your company in 1976 or products sufficiently changed to be reasonably considered new products.) ________%

2. What was the cost of all research and development performed by your company in the U.S. in 1976? $______________

a. How much of the R & D performed by your company in 1976 went for pollution control and for energy related research?

Pollution Control Research________% Energy Related Research________%

b. How much of the R & D performed by your company in 1976 went for:

New Products________% New Processes________% Improving Existing Products________%

3. How much do you estimate your U.S. expenditures for R & D will increase or decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

a. How much of the estimated R & D to be performed by your company in 1977 and 1980 will go for pollution control and for energy related research?

Pollution Control Research	1977 ______%	1980 ______%
Energy Related Research	1977 ______%	1980 ______%

b. How much of the estimated R & D to be performed by your company in 1977 will go for:

New Products ______% New Processes ______% Improving Existing Products ______%

PART III

How will your 1977 and 1978 capital investment be divided by regions? (Even a rough approximation will be useful.)

	1977	1978
New England Maine, Vermont, New Hampshire, Connecticut, Rhode Island, Massachusetts	____%	____%
Middle Atlantic New York, New Jersey, Pennsylvania	____	____
South Atlantic Delaware, Maryland, Virginia, West Virginia, North Carolina, Georgia, Washington DC, South Carolina, Florida	____	____
North Central Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas	____	____
South Texas, Oklahoma, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi, Alabama	____	____
West Washington, Oregon, California, Montana, Idaho, Wyoming, Nevada, Colorado, Utah, Arizona, Alaska, Hawaii, New Mexico	____	____
	100%	100%

NAME ____________________ TITLE ____________________

COMPANY ____________________

ADDRESS ____________________

Total Gross Fixed Assets (U.S.) end of 1976 $__________

Number of Employees (U.S.) end of 1976 __________

COMMENTS: ____________________

ALL YOUR ANSWERS WILL BE HELD STRICTLY CONFIDENTIAL

McGRAW-HILL PUBLICATIONS COMPANY
Dpeartment of Economics
1221 Avenue of the Americas, New York, NY 10017

No. GU______

BUSINESS' PLANS FOR NEW PLANTS AND EQUIPMENT--1977-80
(All questions apply to U.S. only)

PART I

1. How much did you invest in new plants and equipment in the U.S. in 1976? (This includes all purchases charged to capital accounts, whether for replacement, expansion or other purposes. Please include value of new plants and equipment leased to others. Do not include acquisitions.) $____________

   a. Of the total amount you invested in new plants and equipment in 1976, how much do you estimate was for pollution control?

      Air________% Water________% Solid Waste________%

   b. Of the total amount you invested in new plants and equipment in 1976, how much do you estimate was for your employees' safety and health? ________%

   c. How much did your company increase or decrease its system's capacity between the end of 1975 and the end of 1976? Increase(decrease)________%

   d. What percent of your company's maximum capability were you utilizing for the December 1976 max day? ________%

2. How much do you now plan to invest in new plants and equipment in the U.S. in 1977? $____________

   a. If you carry out this program, what will be the net change in your system's capability? ________%

   b. Of the total amount you now plan to invest in 1977, how much will go for:

      Buildings________% Motor Vehicles________% Machinery & Equipment________%

   c. Of the total amount you now plan to invest in 1977, how much do you estimate will go for pollution control? Air________% Water________% Solid Waste________%

   d. How much do you estimate will go for your employees' safety and health? ________%

3. How much do you now plan to invest in new plants and equipment in the U.S. in 1978, 1979 and 1980? (Please try to give approximate answers to this question, even if you have not made definite plans.) 1978 $____________ 1979 $____________ 1980 $____________

   a. If you carry out this program, what will be the net change in your system's capability from the end of 1977 to the end of 1980? ________%

   b. Of the total amount you now plan to invest in 1978-80, how much will go for:

      Buildings________% Motor Vehicles________% Machinery & Equipment________%

   c. Of the total amount you now plan to invest in 1980, how much do you estimate will go for pollution control? Air________% Water________% Solid Waste________%

   d. How much do you estimate will go for your employees' safety and health in 1980? ______%

4. Under the most optimistic assumptions regarding liberalized investment incentives and growth in demand for your company's products or services, what is the maximum your company would invest for new plants and equipment in 1977 and 1978?

   1977 $____________ 1978 $____________

5. How soon do you expect 1977 replacement and modernization outlays to pay off? _____years

   a. How soon do you expect 1977 outlays for new capacity (expansion) to pay off? _____years

6. Roughly, how much of your company's capacity was shut down permanantly in 1976 because of environmental and safety regulations? ________%

a. How much do you estimate will be shut down in 1977? ________%

7. How much were your company's revenues in 1976? $____________

a. How much do you think revenues of your company will increase or decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

b. How much do you think the prices of services your company sells will increase or decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

8. How much do you expect your company's employment will increase or decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

9. How much did your company's productivity (unit output per employee) increase or decrease in 1976? Increase(decrease)________%

a. How much will productivity increase or decrease in 1977? Increase(decrease)________%

10. In your view what is the rough estimate of the total cost of bringing all of your comapny's existing facilities up to present pollution control standards? $____________

PART II

1. What was the cost of all research and development performed by your company in the U.S. in 1976? $____________

a. How much of the R & D performed by your company in 1976 went for pollution control and for energy related research?

Pollution Control Research________% Energy Related Research________%

2. How much do you estimate your U.S. expenditures for R & D will increase or decrease between 1976-77 and between 1977-80?

1976-77 Increase (decrease)________% 1977-80 Increase (decrease)________%

a. How much of the estimated R & D to be performed by your company in 1977 and 1980 will go for pollution control and for energy related research?

Pollution Control Research	1977________%	1980________%
Energy Related Research	1977________%	1980________%

NAME____________________ TITLE____________________

COMPANY____________________ ADDRESS____________________

Total Gross Fixed Assets (U.S.) end of 1976 $____________

Number of Employees (U.S.) end of 1976 ____________

COMMENTS:____________________

____

____

ALL YOUR ANSWERS WILL BE HELD STRICTLY CONFIDENTIAL

Form Approved: O.M.B. No. 41-R2773

IMPORTANT – *This report is due Feburary 2, 1977*

FORM BE-452S
(12-6-76)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF ECONOMIC ANALYSIS

This report is authorized by law (15 U.S.C. 175). Your voluntary cooperation is needed to make the results of this survey comprehensive, accurate and timely. Your report is accorded confidential treatment and will not be used for purposes of taxation, investigation, or regulation.

PLANT AND EQUIPMENT EXPENDITURES SUPPLEMENT

4th Quarter 1976

Return to: U.S. Department of Commerce
Bureau of Economic Analysis
Business Outlook Division (52)
Washington, D.C. 20230

(Please correct any error in name and address including ZIP code)

NOTE: If the figures requested can be supplied more readily on a plant or divisional basis, additional copies of the form may be reproduced in your office, or can be obtained from the Bureau of Economic Analysis (52), U.S. Department of Commerce, Washington, D.C. 20230

INSTRUCTIONS

If answers to these inquiries are facilitated by use of quarterly data, please mark the box in Item 1 below, and supply figures for your fiscal quarter containing December 1976 in Item 2. Report sales net of returns, discounts, and commissions. If possible, exclude the value of products purchased and sold without further processing.

In answering Item 3, follow the company's usual operating practices with respect to use of productive facilities, overtime, work shifts, holidays, etc. When any of your facilities permit the substitution of one product for another use a product-mix at capacity which is most nearly similar to the composition of your actual December 1976 output.

QUESTIONS concerning this form may be directed to the Bureau of Economic Analysis by letter to the address shown above or by telephone (202) 523-0874.

1. Mark this box if answers to Item 2 are expressed as quarterly data → ☐

	Dollars
2a. What were your company's sales of manufactured products in December 1976?	$
	Percent
b. What is the usual percentage of December sales to those for a full year?	%
3a. At what percentage of manufacturing capacity did your company operate in December 1976?	%
b. At what percentage of December 1976 manufacturing capacity would your company have preferred to operate in order to achieve maximum profits or other objectives?	%

4. If this is not a company return, please indicate the name of plant or division.

Name and title of person to contact regarding this report	Telephone number			Date
	Area code	Number	Ext.	

USCOMM-DC 84101-P77

CAPACITY OF FOOD AND FIBER SYSTEM - RAPPORTEUR'S REPORT

by

Heinz Spielmann

During the session, three papers were presented, namely:

1. J. B. Penn, "Perspectives on Capacity Measures and Uses for the Food and Fiber System."
2. Eldon E. Weeks, "Current Practices Related to Capacity and Capacity Utilization Measurement for Food and Fiber Production (An Inventory)."
3. John B. Penson Jr. and William E. Kibler, "A Critical Review of Alternative Approaches to Estimating Capacity and Capacity Utilization for the Food and Fiber System."

The three papers which followed each other sequentially (with perhaps some overlap here and there) addressed themselves essentially to four questions, namely:

1. What is the concept of capacity?
2. How is it being used?
3. What are some of the methods by which it is derived?
4. How can it be applied to the agricultural sector and of what use (if any) is it there?

It was determined that while existing capacity concepts in the agricultural sector related themselves mainly to some market equilibrium position (such that excess production could be called excess capacity and production below the market equilibrium insufficient capacity) a somewhat more definitive concept of capacity arose in the non-agricultural sector. There capacity was defined in two basic concepts, namely: engineering capacity and economic capacity. Engineering capacity is that output of a firm which would be produced if the firm were to make maximum use of all of its fixed factors on a 24-hours a day and a 7-day a week basis, while economic capacity refers to an output at the minimum cost level of a firm under condition of a--for the firm--normal operating schedule. It was furthermore established that the notion of capacity itself is a short-run concept.

Still finer distinctions may be drawn if we were to differentiate between actual capacity and desired capacity (the latter concept relating to an output which a firm would like to achieve and at which it would optimize or satisfice some particular condition).

While no time series of capacity measurement exists in the agricultural sector, there are a number of organizations in the non-agricultural sector that endeavor to provide such series. The most important ones are: The Federal Reserve Board, the Bureau of Economic Analysis of the Commerce Department, McGraw-Hill, and the Wharton School of the University of Pennsylvania. Still others such as the Conference Board may be mentioned for whose description, however, there is neither time nor space. The first three of these organizations derive their data from direct surveys of individual business firms in various industries, the Wharton School, however, uses only secondary data (specifically the FRB Index of Industrial Production) for its analysis. McGraw-Hill and the BEA interview a specific sample of firms in various industries while the Wharton School in effect plots the FRB Industrial Production Index for each individual industry over time on a quarterly basis and regards peak quarters connected by straight line links as capacity output of each industry under consideration. Note that in all cases, capacity measurements are made on a highly disaggregated basis and are specific to a given industry.

What purpose do capacity measurements serve various industries in the non-agricultural sector? Capacity measurement is an important component of the Wharton School's Econometric Model of the U. S. Economy. Both Lawrence Klein and Albert Summers contend that an analysis of utilization rates is indicative of the presence or absence of slack in an industry and the extent to which it uses its fixed factors. Strong pressures on the normal level of capacity in an industry are indicative of early changes in capital and capital equipment requirements for that industry. Considerable slack on the other hand particularly if it exists under persistent demand pressures is quickly indicative of the existence of some bottleneck. While this measure does not directly put its finger on the kind of problem that might exist in an industry, it does raise a flag of warning indicating that something is wrong. Bosworth, for example, ascribes the trend of lagging capacity utilization rates in recent years in U.S. industry to (a) the relatively high cost of capital, and (b) the ever increasing diversion of capital into non-productive use such as environmental clean-up and various government regulatory restraints.

McGraw-Hill renders reports on the general health of the economy and indicates anticipated capital good purchase requirements and capital requirements of the industries under consideration.

We also find that capacity data are widely used by economists, industry analysts, banks, management, and of course by government decision makers.

The papers then directed their attention to the use of capacity measurement in the agricultural sector. Penn argues that capacity as a short-run measure translates over the long run into an indication of productivity levels. He argues that "capacity at a point in time implies a fixed investment and technological level. Changes in the underlying structure of the production process may change capacity and it is desirable to sort out changes due to an increase in inputs or in fixed investment from changes in the quality of those inputs. A consistent conceptual base would facilitate attempts to identify sources of capacity change and distinguish between those due to changes in productivity and those due to changes in the quantity of inputs employed." Penn, therefore, looks at capacity as an indicator of the efficiency with which fixed factors are used over the long run.

Weeks looks upon capacity utilization measures as an indication of the presence of bottlenecks in meaningfully combined agricultural commodity groups. He considers that through capacity utilization rate measurements, investment and output plans as well as preferred operating rates expressed by farmers may be established. "If reliable, this information could reinforce efforts at short to intermediate run forecasting and help reveal the thinking of farmers and businessmen about their economic environment." Also, he alludes to productivity indication derived from capacity measurements. Penson and Kibler bring out an important and interesting point which concerns itself mainly with the integration of the capacity measurement concept in the agricultural sector with that of the non-agricultural sector: "The input supply, processing and distribution sectors play an important role in the performance and expansion of the entire food and fiber system. Their macro-linkages to the farm production sector as well as to the rest of the domestic economy and international markets cannot be ignored." The importance of this recognition is clearly indicated as we keep in mind the structural changes in the agricultural sector and the ever increasing incidence of vertical links from the farm to processing to marketing. This one paper incidentally gives recognition to the existence of a whole food and fiber system and goes beyond the narrower concept of analysis of the agricultural sector alone. The discussion then turned to the methodology of information attainment for capacity measurement in the agricultural sector. Recognition is quickly given to the difference between the factors that affect capacity measurement in the non-agricultural and the agricultural sector. The agricultural sector, of course, has to contend with the weather, with plant diseases, and with other centers of uncertainty. There is also the lack of specificity in the relationship of fixed capital inputs to output. There is also the continued intercedence through government policy in the marketing process. Finally, the behavior (i.e., expansion and contraction) of own account capital must be considered.

The choices in the gathering of information for capacity measurement are the global approach (as designated by Penson and Kibler), the commodity primary data approach and the use of secondary data incorporated in production functions (Klein and Preston, and Tweeten and Tiner). In addition, there are also investment behavioral models (e.g., Hickman) and supply function models (Hathaway, Yeh, Tweeten and Quance).

There is, of course, not time here to get into the approaches in any detail. The paper by Penson and Kibler, however, gives an excellent account of this area. Suffice it to say, however, that the global approach would, similar to the McGraw-Hill approach, entail actual surveys of individual farm firms where farmers would be specifically requested to respond to certain capacity utilization questions. In contrast the commodity primary data approach would make use of one list of existing primary data sources which can be modified (or supplemented) at relatively little cost or effort to render additional information. This modification then would form a second list. Thus the first list would give, for example, information on cattle inventory or on cattle on feed, while the additional list might render information on feeding rates for cattle and hogs, rates of gain for cattle and hogs, etc. It should be clear, of course, that all these methods also have their drawbacks. The global approach would prove to be quite costly. The primary sources approach would likely give insufficient information and the secondary data model approaches all suffer from two major problems: one associated with the lack of pertinent information, the other associated with the assumption of a perfectly competitive model at a time when structural changes in the agricultural sector indicate that that model is ever less and less applicable to the sector.

Well, the papers that were presented were excellent, thorough, and well prepared. I regret that they did only peripherally touch on the use of capacity information as it relates to the policy making process. Yet capacity utilization rates are very quick and early indicators of the presence of bottlenecks and other problems which could be alleviated through policy application.

The existence of underused capacity in one subsector of the agricultural sector and high pressures on capacity in another subsector does have distinct policy implications and can if discovered early and rapidly be suitably remedied. Thus, important policy implications may be assessed through capacity evaluation.

Presentation of the papers were hardly completed and questions came flying hard and fast. In particular, the discussants were almost without exception rather pessimistic about the whole concept of capacity measurement and capacity utilization application in the agricultural sector. While Willis Peterson responding to Eldon Weeks' paper raised questions with respect to the differentiation of supply and capacity, Leo V. Mayer responding to J. B. Penn's paper raised some questions regarding the usefulness of capacity measurement particularly with respect to their efficacy in policy formulation. Bruce Gardner was especially concerned with questions of opportunity costs of information gathering for capacity measurement vis a vis similar efforts for improved crop reporting services.

The objections were mainly with respect to the efficiency and applicability of the capacity measurement and the degree to which they would improve or rather fail to improve our existing set of knowledge of the behavior of the agricultural sector. The audience response was largely along the same lines although there were some very interesting suggestions such as the one proposed by Richard King of considering capacity measurement as a form of frontier function (in a two-product group world) for further analytical appraisal.

It is my considered opinion that many of the questions arose because of a certain lack of acquaintance with and understanding of the concepts of capacity, capacity utilization, and capacity measurement. In the face of a rather widespread and extensive use of capacity utilization measurements in the non-agricultural sector, I believe that it would be quite worthwile to go deeper into this particular subject in the agricultural sector. At the present time, we really do not know its potential in that sector. Only through research, perhaps starting at a highly disaggregated basis with fairly narrow regional constraints, can we gain some insight into what the measurements in the agricultural sector can really tell us. Ever increasing experience with the capacity concept and the gathering of information for it may also give us certain long-run indications. How do farm firms behave under conditions of strong pressure on their productive capacity? How do farm firms act in the presence of considerable slack or unused capacity? Do they act differently in one industry than in another? How can we overcome or consider some of the characteristic stumbling blocks to capacity measurement in the agricultural sector? What about the macro-links between the agricultural and non-agricultural sector which are becoming increasingly important as various forms of processing gain dominance over fresh consumption of various agricultural products?

The questions are many and only careful and systematic inquiry could hold the answer. I certainly hope that perhaps for a relatively short period--say one year--a team of researchers be formed who would look into these questions. At least then we could form opinions from a much more educated basis than was possible yesterday and is possible today.

Series A Capacity Team Recommendations that might be considered by the AAEA Economic Statistics Committee and USDA for improving data on Capacity of the Food and Fiber System:

1. Agricultural Economists need to develop a better understanding of the need for and uses that are or can be made of capacity measures. A paper should be commissioned on this topic for the Journal or some other widely distributed publication. This paper should point out some of the actual examples of capacity measure uses in public and private policy decisions, investment analysis, and capital flow, etc. The Economic Statistics Committee should take the lead in this effort.

2. For these measures to have the widest use, economists should define capacity in a very broad sense, so it could accommodate some of the diverse concepts mentioned by various participants at the Workshop. At the same time, reasonable comparability with other sectors should be maintained.

3. The importance of the farm production portion of the Food and Fiber Sector suggests that initial development efforts at measuring capacity should be focused in this sub-sector. Preliminary work on improving input data specifications needed for measuring capacity should be developed. This should not involve more than 10 to 15 items such as land, equipment, breeding stock, buildings, investment or disinvestment intentions, etc. The ability to collect such information for some geographic area for sub-sector(s) like cow-calf, fed livestock, cash grain. etc., on a vehicle like the USDA's Annual Economic or Cost of Production Surveys, could be tested.

   Concurrent with this effort, research for the same sub-sectors should be undertaken to:

   (a) Determine, through USDA pilot work, if farmers can

      (1) respond to the "global type" questions on capacity utilization, investment impacts on capacity, using the less restricted capacity definition;

      (2) understand concepts like holding commodity mix constant with current commodity prices, policy laws and input prices;

   (b) Estimate production function using existing data from cost of production studies, etc. to measure production responses (rates of capacity utilization) with alternative input and commodity price mixes;

   (c) Determine procedures for measuring the effects on capacity of:

      (1) input quality changes;

      (2) impact of owned or rented capital stocks; and

(3) on-farm capital formation on capacity measures.

These recommendations should be undertaken as a joint USDA, AAEA, and university effort.

(d) Evaluate the possibility of weather factors overshadowing capacity measures and whether alternative scenarios for favorable and unfavorable weather conditions should be considered.

4. The Economic Statistics Committee should stress the need to identify more precisely the theory and measurement issues on capital as they relate to capacity measurement.

5. Some of the problems of the input, processing and distribution sub-sectors of the food and fiber sector should also be addressed. The following actions are recommended:

(a) Changes being considered by the Federal Reserve Board (FRB), such as revising industry groupings and potential use of census data to derive capacity measures, should be monitored carefully.

The problem of linking sub-sectors should not be addressed until the final FRB decisions and procedures are set.

(b) Review and make recommendations to the FRB on procedures for sub-sectors that include fuels, fertilizer, farm machinery and equipment.

(c) Review and make similar recommendations to the FRB on the processing sub-sector,

(d) Identify gaps or deficiencies in the FRB series and suggest revisions or additions.

(e) Test alternative methods for linking capacity of the food and fiber sector to other sectors, as well as methods for linking sub-sectors of the food and fiber sector. This should be a USDA function and would help insure uniform accounting procedures across sectors. The Agricultural Economic profession should continue to provide suggestions and inputs.

6. The Economic Statistics Committee should work to keep these recommendations before the profession and to insure that research results, definitions, concepts, and capacity measures derived are published and communicated to the economic community.

AGRICULTURAL AND RURAL DATA WORKSHOP

May 4-6, 1977

WEDNESDAY, May 4, 1977

9:00 a.m. Registration -- Lobby of Hospitality House Motor Inn

CHAIRMAN: *R. J. Hildreth*, Farm Foundation

10:00 a.m. Opening General Session

A. Introduction--Purpose and Procedure
Luther G. Tweeten, Oklahoma State University

B. "A Short History of Agricultural Data Systems"
David E. Brewster, Economic Research Service

Discussant: *Harry C. Trelogan*, Consultant

General Discussion by Participants

12:00 noon L U N C H

A SERIES SESSIONS

Price Reporting and Capacity of Food and Fiber System

CHAIRMAN: *James T. Bonnen*, Michigan State University

1:00 p.m. "The Concepts of Price: Implications for Agricultural Data Collection and Use"
James P. Houck, University of Minnesota

Discussant: *Allen B. Paul*, Economic Research Service

General Discussion by Participants

3:00 p.m. "Economic Structure, Price Discovery Mechanisms and Informational Content of Agricultural Prices"
Charles H. Riemenschneider, *Ralph D. Christy* and *James T. Bonnen*, Michigan State University

Discussant: *Bruce A. Scherr*, Data Resources, Inc.

General Discussion by Participants

5:00 p.m. A D J O U R N

THURSDAY, May 5, 1977

CHAIRMAN: *Norman M. Coats*, Ralston-Purina Company

9:00 a.m. "Practical Problems in Price Reporting for Data Collection, Analysis and Forecasting"

Walter J. Armbruster, Agricultural Marketing Service and *Richard J. Crom*, Economic Research Service

Discussant: *Gene A. Futrell*, Iowa State University

General Discussion by Participants

12:00 noon L U N C H

CHAIRMAN: *Earl R. Swanson*, University of Illinois

1:00 p.m. "Perspectives on Capacity Concepts, Measures and Uses for the Food and Fiber System"

J. B. Penn, Economic Research Service

Discussant: *Leo V. Mayer*, Library of Congress

General Discussion by Participants

2:30 p.m. "Current Practices Related to Capacity and Capacity Utilization Measurement for Food and Fiber Production--An Inventory"

Eldon E. Weeks, Economic Research Service and *Heinz Spielmann*, University of Hawaii

Discussant: *Willis L. Peterson*, University of Minnesota

General Discussion by Participants

4:00 p.m. "A Critical Review of Alternative Measures of Capacity and Capacity Utilization"

John B. Penson, Texas A&M University and *W. E. Kibler*, Statistical Reporting Service

Discussant: *Bruce L. Gardner*, Council of Economic Advisers

General Discussion by Participants

5:30 p.m. A D J O U R N

B SERIES SESSIONS

Agricultural and Rural Data: Indicators of Economic Well Being of People Engaged in Farming and of People in Rural Communities, and on Data for Economic Indicators and Decisions for Rural (non-metro) Communities.

WEDNESDAY, May 4, 1977

CHAIRMAN: *Luther G. Tweeten*, Oklahoma State University

1:00 p.m. "Data for Indicators of Well Being for People Engaged in Farming"

Luther G. Tweeten, Oklahoma State University; *D. Lee Bawden*, Urban Institute; *George Irwin*, Farm Credit Administration; *Thomas L. Browning*, *Thomas A. Carlin* and *Peter M. Emerson*, Economic Research Service

Discussion Leader: *Peter M. Emerson*, Economic Research Service

General Discussion by Participants

5:00 p.m. A D J O U R N

THURSDAY, May 5, 1977

CHAIRMAN: *Gaylord E. Worden*, Office of Management and Budget

9:00 a.m. "Toward the Definition and Measurement of Farm Employment"

James S. Holt, Pennsylvania State University; *Robert D. Emerson*, University of Florida; *Conrad F. Fritsch*, Economic Research Service; *James R. Garrett*, Statistical Reporting Service; and *Varden Fuller*, University of California.

Discussion Leader: *Varden Fuller*, University of California

General Discussion by Participants

12:00 noon L U N C H

CHAIRMAN: *Clark Edwards*, Economic Research Service

1:00 p.m. "Employment Data for Rural Development Research and Policy"

Clark Edwards, *Robert I. Coltrane*, *Conrad F. Fritsch*, *Ronald W. Holling*, *Sigurd R. Nilsen* and *Jeanne M. O'Leary*, Economic Research Service

Discussion Leader: *Conrad F. Fritsch*, Economic Research Service

General Discussion by Participants

5:00 p.m. A D J O U R N

GENERAL SESSION

FRIDAY, May 6, 1977

CHAIRMAN: *Kenneth R. Farrell*, Economic Research Service

9:00 a.m.	A Series Session--Price Reporting Rapporteur's Report	*Milton C. Hallberg*, Oklahoma State University
	General Discussion and Questions	
9:45 a.m.	A Series Session--Capacity of Food and Fiber System Rapporteur's Report	*Heinz Spielmann*, University of Hawaii
	General Discussion and Questions	
10:30 a.m.	B Series Session--Data for Indicators of Well Being Rapporteur's Report	*Norman K. Whittlesey*, Colorado State University
11:15 a.m.	B Series Session--Farm and Rural Employment Data Rapporteur's Report	*W. Keith Bryant*, Cornell University
12:00 noon	A D J O U R N	
1:00 p.m.	Meeting of Economic Statistics Committee	