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STRUCTURAL TRENDS AND ECONOMIES OF SCALE IN AGRICULTURAL MARKETING AND PROCESSING

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A first requirement with a topic as broad as the "Changing Pattern of Economic Size of Farm and Business Unit" is to define the limited area this paper will cover. It will center on the "business" rather than the "farm" unit and will emphasize economies of scale, a relevant phenomenon in terms of the motivtion it provides for change in economic patterns and its importance as a tool in economic analysis of such changes. It will deal with principles and theory bearing on economies of scale rather than attempt to describe in detail the changing pattern of economic size. Consideration is not given to questions of how size of unit is related to the possibilities and effect of product differentiation, to the selection of product line, to the possibility and consequences--both to the individual firm and public--of the growth of monopoly elements as well as many other attributes that frequently accompany increased size of the individual firm. The necessity of a narrower focus in this paper presumably is recognized.

The materials and ideas presented here are drawn in part from studies of the processing and marketing of agricultural products, but the principles deduced therefrom are presumed to have application in other sectors of the economy.

Outlines of the Changing Pattern in Agricultural Marketing and Processing

While avoiding a detailed description of the changing pattern of economic size in the processing and marketing of agricultural products, several widely recognized aspects of these changes should be noted briefly./1 These include:

1. Changing functions in processing and marketing--in particular an expansion of the processing role through development of a growing number of precooked foods, "mixes," and other consumer convenience items.

2. Changing technology involving new processes such as the freezing or irradiation of foods, cooling leafy vegetables by a vacuum process, controlled atmosphere storage for fruits and vegetables, low-temperature

/1 For more detailed treatment see, for example, Mehren, G. L., "The Changing Structure of the Food Market," Journal of Farm Economics, vol. 36, no. 2, May, 1957, pp. 339-353; Mueller, Willard F., and Norman R. Collins, "Grower-Processor Integration in Fruit and Vegetable Marketing," Journal of Farm Economics, vol. 36, no. 5, December, 1957, pp. 1471-1482; and Evans, Homer C., The Nature of Competition Among Apple Processors in the Appalachian Area (Morgantown: West Virginia University, June, 1957). (Agricultural Experiment Station Bul. 405.)

dehydration, electronic color sorting of lemons, and grading and packaging of eggs. This category also includes improved techniques in existing processes generally with emphasis on mechanization--and tending toward automation.

3. Significant changes in the structure of costs and margins in marketing agricultural products and in economies of scale in particular processes which stem from functional and technological changes.

4. A tendency toward vertical integration in some lines of production, reflecting three important influences. First is the growing emphasis on product differentiation, grade labeling, and quality standardization which leads to efforts to control the quality of raw products received for processing. Second is a desire to improve processing efficiency through better scheduling of raw product deliveries and processing plant operations. Third is the effort to reduce risk and uncertainty through control of a larger sector of the production and marketing operations for a particular commodity.

5. The continuing development of multiproduct, multiplant operations in which contributing influences are: seasonal harvest and processing of many agricultural products with low annual rate of utilization of plant facilities in processing a single product, and marketing advantages--such as national branding and advertising in handling a "product line" rather than a single product.

Marketing and technological developments such as the above suggest a basis for trends to increased size of economic unit and to increased emphasis in production on the use of durable factors in the form of machines and equipment. This is the background within which the following principles bearing on economies of scale are considered.

Indicated Modifications in the Theory of Economies of Scale

The conventional concept of economies of scale, well established in economic theory of the firm, has certain attributes of particular relevance here./1 Economies of scale in this theory are explained in static terms. The theory assumes a given technology with a variety of specific techniques for performing particular operations. Production at each "scale" of output is assumed to be technically organized so as to minimize the cost of output at that scale. A known structure of prices for products and factors

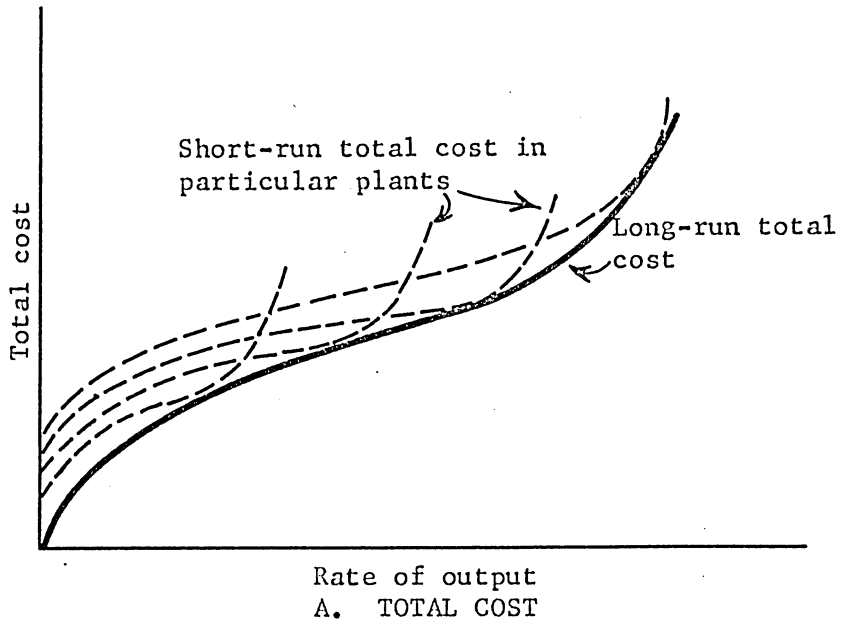
/1 The conventional theory of the firm referred to is as developed in Carlson, Sune, A Study on the Pure Theory of Competition (New York: Kelley and Millman, Inc., 1956), 128p; or Stigler, George J., The Theory of Price (New York: MacMillan and Company, 1952), 310p. The application of this theory to the problem of economies of scale follows: Viner, Jacob, "Cost Curves and Supply Curves," Zeitschrift für Nationalokonomie, vol. 3, September, 1931, pp. 25-46.

exists that is either constant or functionally related to rate of output of the particular good under consideration. Variable factors are homogeneous and perfectly divisible, and some degree of substitutability among factors is commonly assumed. Production and sale are simultaneous so that there are no capital requirements other than investment in the fixed factor, and there are no storage or transit delays in disposal of the product. A long-run situation is recognized in which all factors are variable, and there is a short run in which one or more factors are fixed in amount. The long run permits variation in scale of output while the short run permits variation in rate of output in a plant of given scale through more or less intensive use of the fixed factors. Similarly, technique (but not technology) is variable in the long run but not in the short run. With short-run variation in output through intensification on the fixed factor, the short-run production and cost curves are curvilinear. Under the assumption of perfect divisibility in factor inputs and of production of given outputs at minimum cost, the production and cost curves are single valued and continuous. In terms of total input-output or cost relationships, they commonly are represented by the familiar sigmoid curve form reflecting the Law of Diminishing Returns. Scale of output is related to the size of the fixed factors and through this--and within the assumptions noted--to some measure of optimum plant capacity.

The above framework accommodates the concept of a family of curvilinear short-run cost curves for plants of different scale. If represented in terms of total cost of different outputs and if constructed for plants of different scale, such curves might appear as in Figure 1. If many such curves are considered, an "envelope" curve may be visualized (Figure 1) which reflects cost-volume possibilities (assuming minimum-cost output at any plant scale) in relation to scale of output. When expressed in terms of average total cost, the result as scale of output increases is decreasing unit cost to an optimum plant scale in which unit cost is a minimum. Beyond the optimum scale of output, unit costs increase (Figure 1).

The downward sweep of the long-run average cost curve as scale of output is increased is explained on the ground of the introduction of different and "more efficient" production techniques that are uneconomical with small-scale output, pecuniary advantages as scale of factor purchase increases, and better utilization of management and more efficient management techniques as scale of output increases. While increasing unit costs for within-plant physical operations as scale of output increases appear extremely unlikely if not precluded, this is not presumed to be so for management. Decreasing unit costs hypothesized in the lower range of plant size are presumed to be accompanied by tendencies toward increased costs as the management function becomes increasingly complex and unwieldly with increased scale. This effect is presumed ultimately to become dominant, and the long-run cost curve turns upward from its minimum level. Increasing unit outlays for management services as well as increased unit costs of other operations due to less effective management may both contribute to this effect. This suggests that, in contrast with other services, management is not truly variable in the long run and so diseconomies of scale accompany intensification on the partially fixed management inputs.

Without presuming to challenge the basic concepts of the theory outlined above, essential modifications in its application to current types of organization



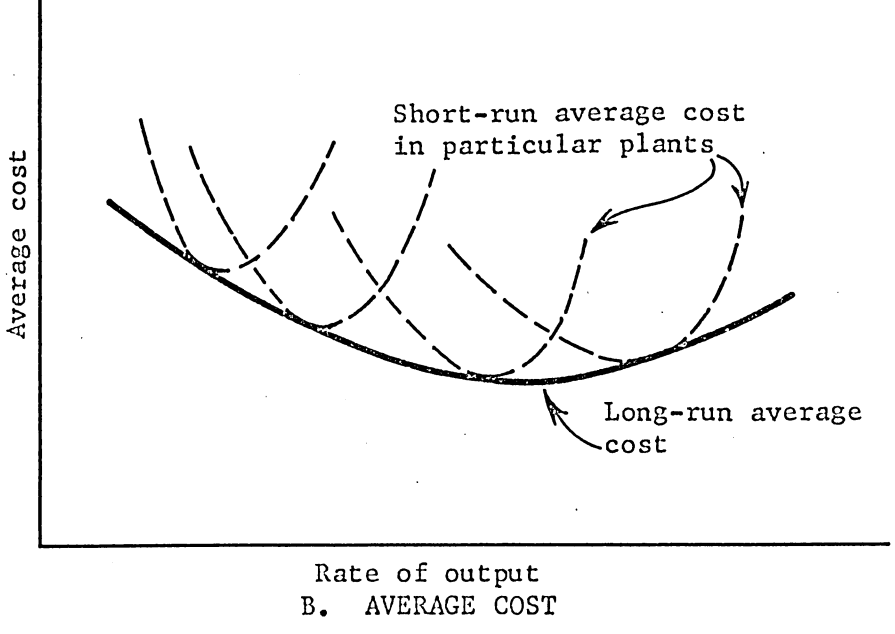


Figure 1. TOTAL AND AVERAGE LONG-RUN COST CURVES BASED ON CURVILINEAR SHORT-RUN COST RELATIONSHIPS AS DEVELOPED IN CONVENTIONAL THEORY

in processing and marketing must be noted./1 These become evident on examination of the physical plant layout and organization of a modern processing plant. In such plants production usually is organized on a continuous product-flow basis, modified by temporary low-volume storage delays (the "surge tank" principle widely applied in liquid-flow processes). Particular operations on the product follow a necessary or logical sequence and are performed at a succession of separately manned work stations. Frequently, job groupings in identifiable "plant stages" representing portions of the total process can be conveniently isolated for engineering and economic analysis. Except in the smallest plants, "plant segmentation" is widely practiced./2 This involves provision of several similar production lines (or units) capable of independent operation and in this respect representing a group of "plants" at a single site and under one management.

The techniques and operations typical of processing plants ordinarily afford little opportunity in the short run for factor substitution. And discontinuity rather than continuous variation prevails in regard to change in rate of input for most factors. A fork-lift truck and its operator, for example, are combined in a fixed 1 to 1 ration, and additional units are made available--and additional costs are incurred--in a series of discontinuous steps./3 With individual equipment units, there frequently are compelling technical reasons for constant-rate operation--for example, process (or legal) requirements in milk pasteurization or process requirements in separators of the centrifuge or air-flotation type. Even where technically feasible, factor substitution may be restricted by institutional limitations, such as custom, legal requirements, or union agreement. Where not required for technical or institutional reasons such as these, constant-rate operation frequently is dictated for reasons of cost minimization. This occurs, for example, with excess capacity and the possibility of storage or transit delay in product sale--conditions frequently encountered in agricultural processing. Under these circumstances, the costs of any given total output per production and sale period will be minimized by constant rate operation at the minimum average cost rate of output./4 Moreover, output in

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/1 For a more adequate description of typical processing plant organization and a more complete development of the modifications to the conventional theory, see French, B. C., L. L. Sammett, and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia, vol. 24, no. 19, July, 1956, p. 545.

/2 Early recognition and designation of this type of plant organization and its significance in regard to plant costs will be found in Dean, Joel, Statistical Cost Functions of a Hosiery Mill (Chicago: University of Chicago Press, 1941), 116p.

/3 With inputs such as these, a distinction is recognized between factor availability and the assumption of its costs and realized rate of input. While there clearly is discontinuity in the supply of additional units and in the cost function, the rate of realized input may be continuously variable from zero up to machine capacity as "idle" time for the unit varies.

/4 Detailed analysis of this problem is given in French, et al., op. cit., p. 557; also, Sammet, "Economic and Engineering Factors in Agricultural Processing Plant Design" (Unpublished Ph.D. thesis, University of California, Berkeley, 1958), p. 70.

a given period may be "segmented" in two ways: by variation in the number of similar production units used and by variation in the number of hours operated--up to the maximum available--within the period.

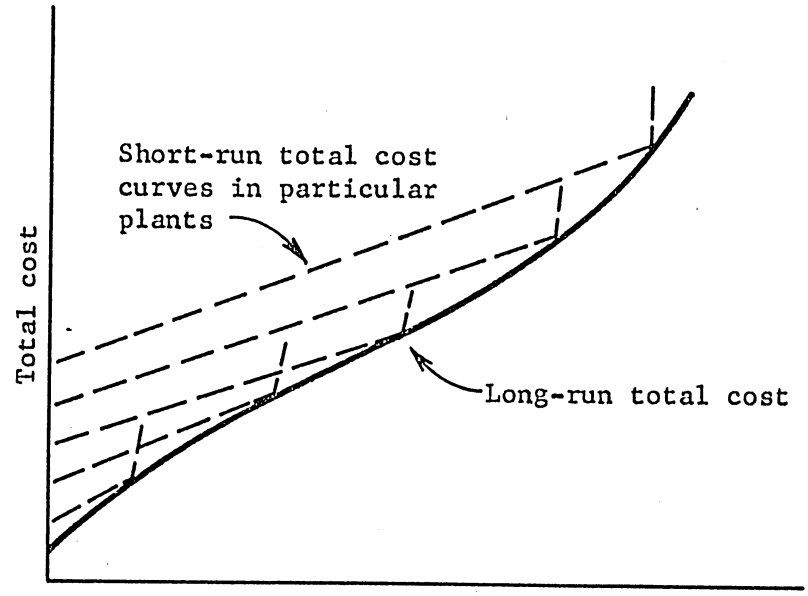
Of particular importance in agricultural processing is seasonality in plant operation frequently resulting from the necessarily close link between farm harvesting of perishable crops and their processing. The significance of this is evident when the costs of durable factors are introduced, a necessity in consideration of the long-run situation. Different long-run cost curves (or economies of scale curves) relating costs and output rate may then be visualized for each length of operating season. Since different techniques require varying amounts of durable factors--and capital-using techniques become more economical as length of operating season is increased--the level and shape of the economies of scale curve as well as the technical organization of production implied in it depend on both scale of plant and length of operation per period.

Under circumstances such as described, the short-run cost curve for a plant of particular scale involves a "fixed cost" representing the costs of the durable and other fixed factors comprising a plant of that scale. Short-run expansion of output rate is accomplished primarily by the successive addition of discrete variable factor inputs. This involves the activation of idle production units or lines in the fixed plant. The short-run input-output relationships typically result in discontinuous "step" functions. With constant rate operation on indivicual jobs and equipment units--hence, the absence of intensification on fixed factors--the short-run production and total cost curves are basically linear, although discontinuous, up to plant capacity. At plant capacity output rate, they break sharply upward (Figure 2).

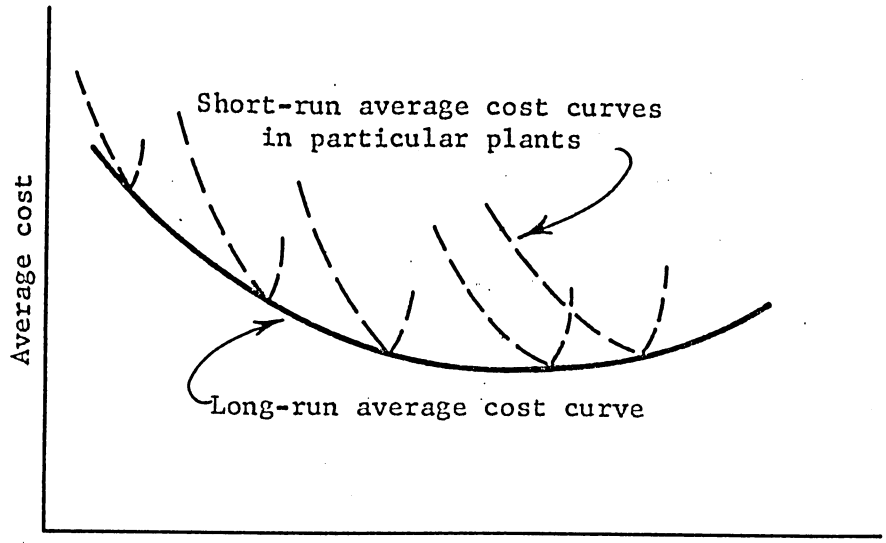
Along lines similar to those described for the conventional cost theory, a series of short-run cost curves for plants of different scale can be visualized and with them an envelope curve reflecting optimum total cost-volume relationships as scale of output is varied. If there are no changes in technique as plant scale varies, the long-run total cost curve would--with respect to technical inputs--be linear in relation to scale of output. This follows from the fact that, with uniform technique, long-run changes in scale of output are achieved by the linear addition of similar equipment units or production lines. If the usual assumptions were applied with respect to the relation of unit costs and management inputs as scale of plant (decreasing unit costs to a minimum level, then increasing), a curvilinear long-run total cost curve would result (Figure 2).

With shifts to different techniques as scale of output increases--and presumably to techniques requiring greater outlays for durable factors but reduced costs for variable inputs--the long-run total cost curve visualized above might take the form of a series of discontinuous segments, each reflecting increased fixed factor costs and relatively lower variable costs (Figure 3).

The above modifies in several important respects the conventional theory of short- and long-run cost curves as they apply to the cost-volume relationships commonly found in agricultural processing plants. The basic



A. TOTAL COST



B. AVERAGE COST

Figure 2. TOTAL AND AVERAGE LONG-RUN COST CURVES BASED ON MODIFICATIONS OF CONVENTIONAL THEORY THAT REFLECT OPERATING CONDITIONS COMMON TO PROCESSING PLANTS/a

(/a The short-run curves consist of smoothed representations of discontinuous curves that recognize factor inputs to be predominantly discontinuous, with relatively little opportunity for factor substitution in the short run; with non-simultaneous production and sale; and with short-run variation in output per period achieved primarily through "segmentation" in plant operations and in the time dimension, rather than by intensification on the fixed factor.)

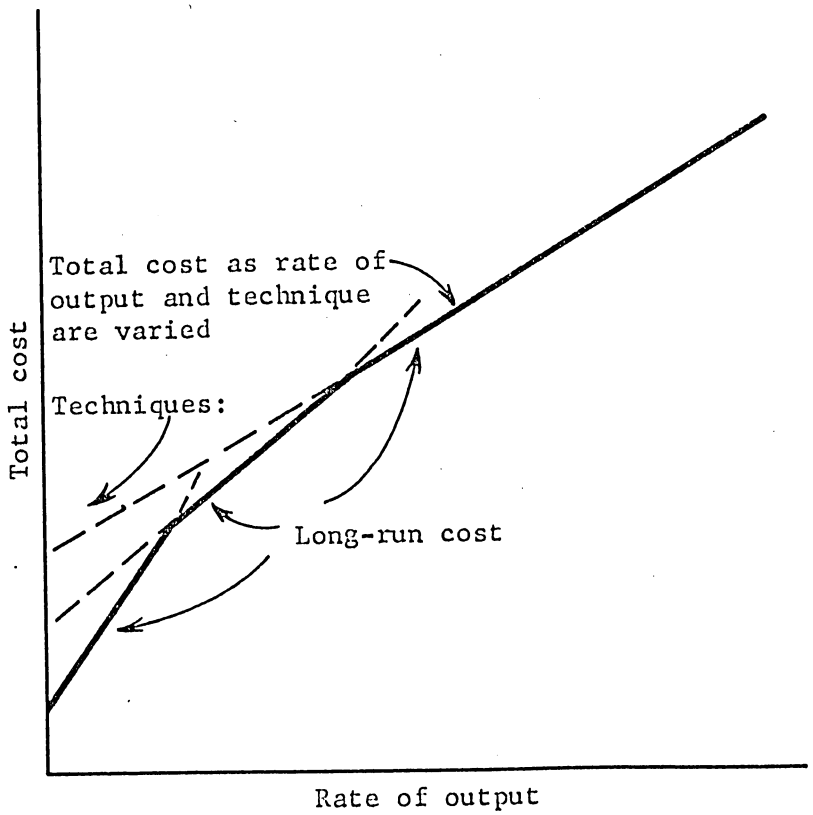


Figure 3. SEGMENTED LONG-RUN TOTAL COST CURVE, WITH LINEAR REPRESENTATION OF EACH SEGMENT/a

(/a The linear representation in each segment ignores, within each segment, the possibility of curvilinear cost relationships due to pecuniary advantages or with respect to the management state as plant scale increases. The successive segments reflect shifts, with increasing output rate, to technically feasible methods that are economical only with relatively large-scale output.)

concept of the economy of scale curve is undisturbed, however, and it remains a potentially significant explanation of the changing economic structure in marketing and processing agricultural products.

Empirical Determination of Economies of Scale

The presence of economies in large-scale production and their relevance to changes in economic structure make their empirical determination of great interest. Numerous specific techniques are applicable to such studies, and these fall in two major categories: methods based on accounting costs of firms of different scale, and cost synthesis based on physical inputs required for specified scales of output as determined from engineering data.

Under favorable circumstances either method may be expected to give at least approximate indications of economies of scale. In analysis of accounting data, this requires adjustment of raw data in certain respects so as to obtain comparability among plants with respect to such factors as wage rates, charges for durable factors, form of output, and--except as they might be affected by scale of output--materials prices. Of particular importance is recognition of two realities with respect to the cost-volume relationships of particular firms in given production periods. These are: (1) that ordinarily average total costs in a given plant will be higher if operated at less than capacity rate than with capacity operation and (2) that in any sample of plants actual cost-volume relationships will reflect varying degrees of efficiency in plant organization and operation. Consistency with the underlying concepts of the economies of scale curve, however, requires establishment of cost-volume relationships reflecting minimum cost for any given output. This requires adjustment of observed costs in each plant so as to approximate cost-volume relationships with capacity plant operation and the development of "envelope" cost curves./1 The latter, in contrast with the more obvious "average" relationships commonly developed, would reflect cost-volume relationships at the lower boundary of adjusted cost-volume points for specific outputs in particular plants.

As an alternative to analysis based on accounting costs, it is possible--with appropriate engineering data--to develop a synthesis of costs involved in efficient production of any specified output and with respect to different scales of output. The task is comparable to fitting together an elaborate mosaic representing the physical input requirements of a hypothetical plant in which the individual pieces are shaped and joined together with the aid of engineering and economic data concerning equipment capacities, labor production

/1 The basis for economies of scale curves drawn at the lower boundary of a scatter of cost-volume points is developed in Bressler, "Research Determination of Economies of Scale," Journal of Farm Economics, vol. 27, no. 3, August, 1945, pp. 526-539; for an application of this technique, see Donald, James R., and Charles E. Bishop, Broiler Processing Costs (Raleigh: 1957), 49p. (North Carolina State College, Agricultural Experiment Station Series No. 59.) A methematical treatment of this problem is given in Farrell, M. J., "The Measurement of Production Efficiency," Journal of the Royal Statistical Society, Series A. (General), vol. 120, part 3, 1957, pp. 253-290.

standards, and requirements as to other services. Such specifications are easily converted to estimated costs by the application of appropriate prices. Ordinarily, this analysis is carried out at the level of individual plant operations and stages and involves consideration of all available techniques. Stage-cost functions with each technique form the basis of selection of least-cost technique in each stage. Aggregation of such relationships in all stages then provides an estimate of total plant cost. From cost synthesis for plants of different scale, an estimate of the economies of scale curve can be developed./1

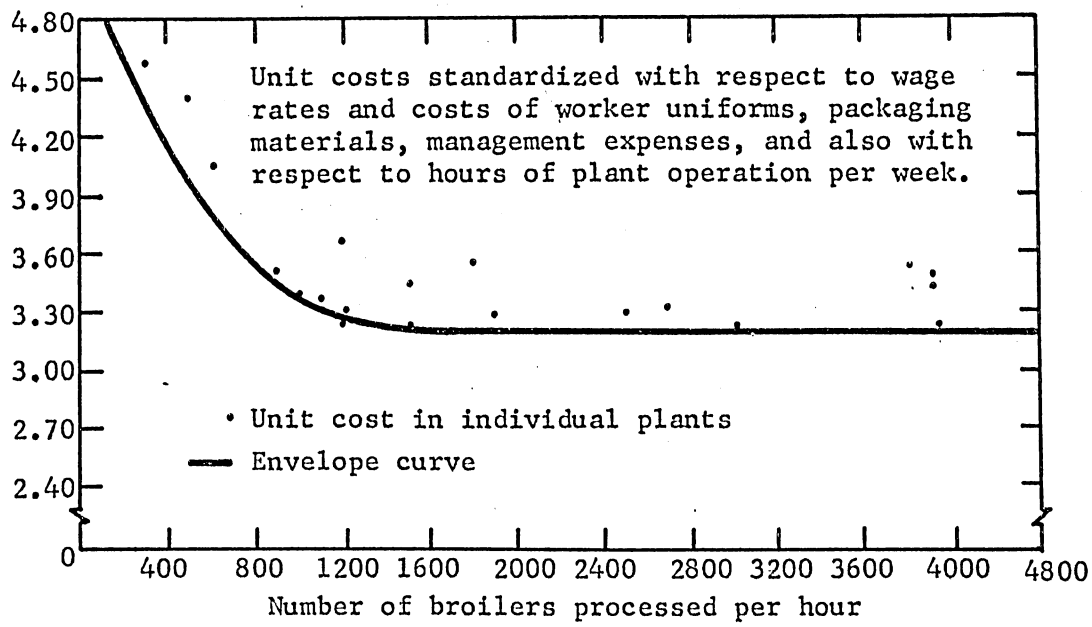
Examples of empirically determined economies of scale curves are given in Figure 4. Part A shows the variation in long-run unit cost of output in a broiler processing plant and consists of a curve drawn as an "envelope" to the lower boundary of points representing adjusted unit cost-volume relationships in a sample of processing plants. Substantial economies of scale are indicated, but there is no apparent upward swing of the long-run average cost curve in the higher output ranges. Part B presents total and average cost curves for packing fresh pears that were developed by means of cost synthesis. Short-run cost curves for several selected plants are shown as well as the long-run total cost functions. The curves shown are "smoothed" representations of discontinuous cost relationships. The range of discontinuity around the smoothed curves is, however, small./2 As in the example based on analysis of accounting costs, decreasing average costs are indicated throughout the range of plant costs considered. No diseconomies of scale are demonstrated.

While analysis of accounting data and cost synthesis both are useful in providing approximations of the economies of scale curve, the results of cost synthesis ordinarily may be expected to provide more information and in a form particularly useful in studies bearing on changing economic patterns. In addition to indicating potential reduction in total unit cost through expansion in scale of output, cost synthesis provides, for example, a specification of least-cost technique in individual plant stages. It thus permits isolation of the individual stage for examination of its relation to economies of scale. This is of particular interest in studies of changing economic size of the business unit. It provides management with results on which decisions may be based as to specific plant design and technique as well as economic size of unit (at least with respect to costs). The pattern of change is formed by such decisions. To students of this problem, analysis at the level of the individual plant stage offers improved opportunities of discovering causal relationships that would help explain the "changing pattern."

/1 For a detailed presentation of the method of plant cost synthesis, see French, et al., op. cit.; also, Sammet, op. cit.

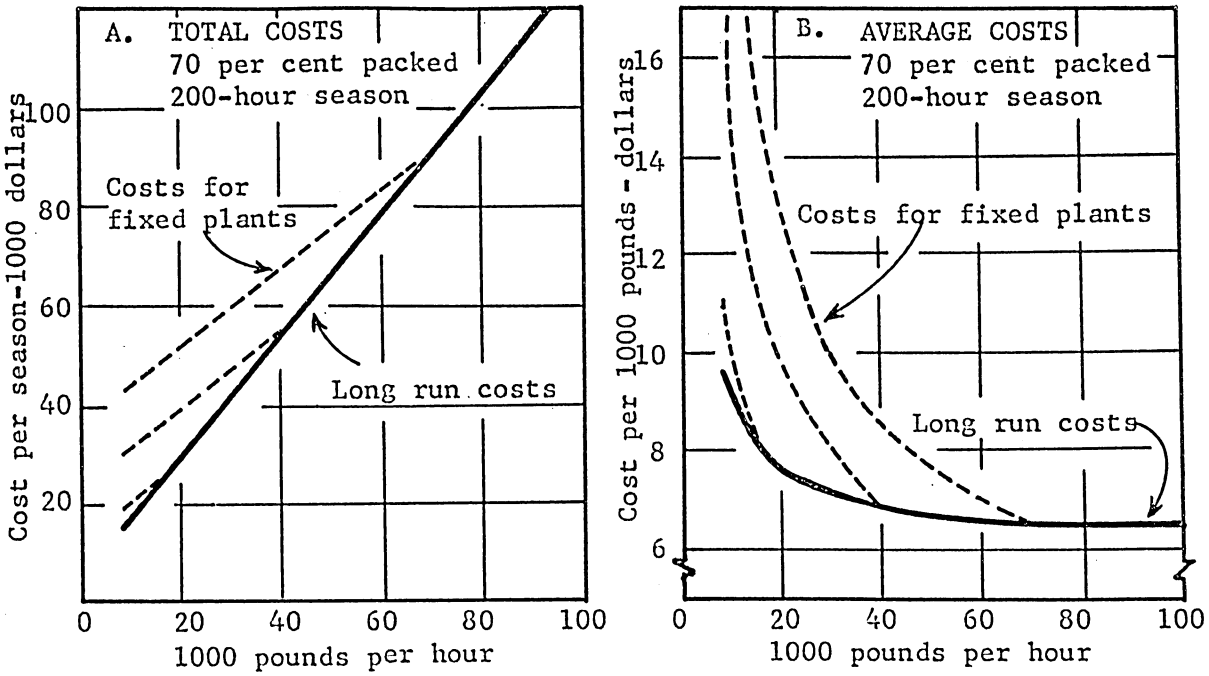
/2 Least-squares equations based on the synthesized cost-volume points on which the curves are based gave correlation coefficients in excess of 0.98. This, of course, is in no sense a test of statistical validity, but it does indicate that the smoothed, linear cost functions fit the synthesized cost points very well.

Figure 4. EXAMPLES OF RESULTS OBTAINED IN EMPIRICAL STUDIES OF ECONOMIES OF SCALE



A. Economies of scale curve drawn as an "envelope" to adjusted cost-volume points representing unit costs based on accounts of a sample of firms processing broilers./a

(/a Taken from: Donald, James R. and Charles E. Bishop, Broiler Processing Costs (Raleigh: 1957), p. 23. (North Carolina State College, Agricultural Experiment Station Series No. 59.)



B. Total and average short- and long-run cost curves for plants packing fresh pears as developed by means of cost synthesis. The short-run curves are "smoothed" representations of discontinuous short-run cost functions. Very slight curvilinearity in the long-run cost curve due to changes in technique--limited to the low-volume ranges--was ignored in deriving the long-run cost curve, and the use of linear cost-volume relationships with respect to management precluded curvilinearity from that source./a

(/a Taken from: French, B. C., L. L. Sammet, and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia, vol. 24, no. 19, July 1956, p. 680.)

Economies of Scale and the "Changing Pattern"

Existence of economies of scale in particular processes, their significance relative to changing economic structure, and the possibility of empirical determination lead to consideration of practical questions in the application of this concept in studies of economic structure.

One important practical question in such applications is the extreme difficulty of specifying a "production" and "cost" function for management. This is particularly true because the nature of the management inputs appears to preclude their consideration under the assumption of homogeneity in factor inputs. Determinations with respect to the quality of the management input then would have to accompany efforts to relate type and quantity of management input to its "output." With the present state of management science, this obviously is a difficult undertaking. Inadequate treatment of this problem would, of course, handicap the establishment of the economies of scale curve. In particular, this would obscure the facts as to diseconomies of scale since increasing unit costs due to diminishing effectiveness of management are assumed to account for this aspect of the economies of scale curve.

Another practical problem concerns the terms in which scale of output are defined. Empirical studies of this relationship frequently are made at the level of a single plant, very often on the assumption of a single product and ignoring--at least with respect to analysis--the costs of raw materials assembly and product distribution. In such studies, "scale" usually is defined in terms of instantaneous rate of output and specified lengths of operation per production and sale period or--what amounts to the same thing when time of operation per period is fixed--in terms of volume of output per period. All elements of cost are considered, including management. Even in the most detailed studies, however, management usually is included in a very approximate way that shows roughly the average level of administrative expenditures relative to scale of output. This provides, however, virtually no opportunity to indicate optimum management technique in relation to plant scale or to assess the effects of differences in quality of management. Such studies generally demonstrate <u>decreasing</u> average unit cost as scale of plant increases. But it is not surprising that, under the usual limitations as to treatment of the management function, they provide little empirical support for the <u>increasing</u> unit cost phase of the long-run average cost curve.

The essential nature of the problem is the same if expanded to include raw materials assembly and distribution of finished product where these services are merely purchased by the firm. Such activities may conveniently be regarded as "off premise" activities subject to the same types of analysis as within-plant operating stages. If the technique of cost synthesis were employed, stage-cost analysis of these operations and their integration in total plant cost relationships would follow the lines previously described for within-plant stages. Studies in the expanded framework might demonstrate some economies of large scale in the assembly and distribution stages. But increasing length of haul as supply area for raw materials and market area for products expand may eventually offset these economies as well as those

from continuing expansion of scale in the processing operations. Thus, long-run average costs of processing and distribution involving a single plant site may ultimately reflect diseconomies of scale in the physical operations as plant size increases. In this situation, however, the significant unit in terms of the firm is not a single plant but the total operation possibly involving a single management controlling operation at several plants as well as an integrated, within-firm, procurement, and distribution system. This admits the possibility of an optimum scale of output relative to the total operation as well as optimum scale in each of several plants. With respect to the changing pattern of the business unit, the optimum scale of total firm output is, of course, the more significant consideration.

In the preceding illustrations, raw materials production and distributive services for products were assumed to be performed outside the direct control of the firm and to appear in the firm's cost calculations merely as purchases of outside services. With vertical integration, however, direct management control may be applied throughout the process of raw materials production, processing, and distribution. The additional operations are incorporated directly in the firm's production and cost functions. New possibilities are introduced as to technical integration of the entire production, processing, and marketing system for a given final product. Economies of scale with respect to both physical operations and management are modified. And there may be need for redefinition of the "index" of plant scale. In the simplest case, this might, for example, be defined as above in terms of instantaneous output rate of the processing plant. But as new operating functions are undertaken in raw materials production or product distribution or the possibility is introduced of varying plant output through time (coupled with storage operations), this simple index becomes less satisfactory. An index that more closely relates management input and costs to the scale of the total enterprise may be essential.

A still more complex situation is encountered if there are multiple products from a single plant. This may involve essentially single-product output of several products either from separate facilities at a single site or at different sites, the processing of different products with the same physical plant but at different time periods, or simultaneous production in a given plant in which there are joint products or joint use of some elements of plant equipment. With any such possibilities, the definition of scale of output is greatly complicated.

Finally, situations are recognized in which all the above circumstances are present. That is, the firm is organized on the basis of complete--or some degree of--vertical integration and produces a variety of different products in several different plants at least some of which are jointly used in the output of several different products. Such circumstances are illustrated by the product line and plant facilities of one of our major food packers, and organization with more than 100 different products, 47 canneries, 7 research facilities, 4 can factories, 1 label printing plant, 6 seed preparation plants, 90,000 acres of farms and plantations, plus warehouse and miscellaneous facilities./1

/1 As described in the Annual Report for the Year Ending February 29, 1958, California Packing Corporation.

The argument and illustration leads to the obvious fact that studies of the changing pattern of economic size of business unit are meaningful only in a context of realized--or potential--industry organization involving very large and very complex units. Studies of these circumstances that aim at more than mere description clearly will fall short of complete quantitative analysis. Useful quantitative studies of parts of the whole problem do, however, seem feasible. One such line of investigation would answer the question of cost advantages in large-scale output. Despite serious problems in such studies with reference to the management function and difficulty with practical definitions of scale of output, some success seems possible in regard to this aspect of the changing pattern.

Static Analysis but Dynamic Situation

In passing it should be recalled that the theory of economies of scale is framed in static terms where technology with respect to both physical operations and management is given. The prospect is recognized, however, of technological development and growth at all levels of the production and marketing system. Such developments may profoundly affect production and cost functions and economies of scale. This leads to the likelihood of a progression of cost functions in which an important dimension is time. With technology moving in the direction of more complex and more highly mechanized techniques, there is a reasonable presumption of continued expansion over time in the "optimum scale" when defined in terms of long-run cost minimization.

Summary and Conclusions

The foregoing describes in very general terms, and without documentation, some aspects of changing pattern in the marketing and processing of farm products. Economic principles bearing on these developments are presumed to have wide application in other sectors of the economy. A brief outline is presented of the theoretical basis for economies of scale both in conventional terms and as it might appear if modified by introduction of conditions more nearly reflecting types of production organization commonly found in processing plants.

Some possibilities as to appropriate techniques for empirical measurement of economies of scale are briefly outlined and examples are noted in which empirical results demonstrate such economies. Major difficulties are indicated with respect to the definition of "scale of output" as more complex forms of organization of the individual firm are considered. This is a particularly pertinent question since such forms of organization evidently evolve from as well as contribute to current trends in the pattern of economic size of the business unit in agricultural processing and marketing.

While clearly of major importance, understanding and evaluation of the changing pattern is not easily accomplished. The many relationships to be considered are too complex to be fully grasped or to permit a comprehensive solution. We can, however, study parts of the whole with advantage. One such area of partial analysis involves the question of long-run costs in

relation to scale of output. Here, quantitative determinations--despite serious practical difficulties--are possible, particularly with reference to economies of scale in physical operations. If approached in terms of cost synthesis, quantitative determination at the level of individual plant stages can be achieved. This opens the possibility, admittedly dim with currently available means, that such analyses applied to the "management stage" of the firm's operations would adequately relate management inputs and costs to total output of relatively complex firms and thus provide a powerful tool in studies of industry organization.

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DISCUSSION: STRUCTURAL TRENDS AND ECONOMIES OF SCALE IN AGRICULTURAL MARKETING AND PROCESSING

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The problem situation of concern to Dr. Sammet in his masterly discussion and analysis is the changing pattern of economic size observed in the economy. Changing functions and changing technology prompt structural changes. If these changes occur only when efficiencies are evident and every one makes the change, then there would be few problems. Even though the paper emphasizes techniques for recognizing, measuring and understanding factors influencing the growth and expansion of firms that have already occurred, the underlying assumption is that not all changes are accompanied by maximum efficiency and that economic firm expansion might be prompted if information were available on economies of scale relationships. This assumption underlies the research effort in marketing firm analysis. An explanation of what has occurred and what now exists is paramount to an understanding of what might occur and what should occur based on economic criteria.

Dr. Sammets particular contribution to the solution of research problems within the problem situation has three aspects: First, he notes essential modifications of the conventional economies of scale concept in its application to current types of organizations. Second, he recognizes alternative empirical techniques for making observations. Third, he cautions against practical difficulties that will be encountered.

Modifications to Theory

Briefly the modifications resulted in short run average cost curves that decline to a point of maximum capacity for the firm and then rise rapidly, in contrast to the conventional curve that was assumed to rise at a rate consistent with the rate of decline in the earlier stages of output. Total costs for individual plants are represented by an inclining straight line up to plant capacity and then turn sharply upward.

Modifications of conventional theory resulted from the following observations: 1. Continuous product-flow basis of output with separate independent process stages. 2. Little opportunity for factor substitution. 3. Non-continuous manner of adding inputs. 4. With increased mechanization, costs are influenced by the constant rate capacities of specialized machines.

Variables are number of machines and number of shifts of operation rather than intensification of machine use within a time period. Labor unions and institutional controls likewise have the same effect on costs. Labor inputs have less flexibility than assumed in the conventional theory. 5. Seasonality of agricultural production results in seasonality in plant operations. This has an impact on the fixed costs with the length of seasonal run the important variable in determining the nature of the average cost curve.

An additional modification that shows its impact on costs as size of operations become large is the influence a firm has on factor costs in the market. Under a situation where a firm's monopsony position increases as scale of operations increase the cost of input factors might be decreased rather than increase under the strain of increased pressures by the large firm. A surplus supply situation would permit this to happen with more ease than with a supply shortage.

Observations are more numerous to substantiate the theory that as size increases average costs decline that to substantiate the notion that beyond some scale, costs increase. It has been reasoned that management reaches the optimum and then is largely responsible for the increasing costs. This is difficult to measure and to observe. The pear packing study in California which Sammet used as a source of evidence for much of his theory modifications found little data to permit the extension of average cost curves into the stage of diseconomies. Most observations do, however, show average costs leveling off for the largest firms studied. Studies of marketing and processing firms throughout most of the western states would probably fail to show diseconomies of scale because in most of this area optimum size has not been reached even by the largest firms.

A brief review of cost-volume relationships found in country elevators in Montana indicated that average costs were continuing to decline throughout the range of scale of operations. Costs did decrease at a decreasing rate, however, as size increased. The modifications to the conventional economies of scale notions suggested by Sammet are only partially applicable for country elevators, but some additional modifications seem necessary. There are practical capacity limitations such as storage capacity which show little flexibility in the day to day short run, but a great deal of flexibility with increased time up to a month or the full year. The capacity of the elevator leg is a limiting factor but if supplies were available at all times, volume limitations would not hinge on the leg. Even seasonality of production may not be as severe as in the fresh fruit or vegetable industry. Farm storage has increased to the extent that deliveries to the country elevator are extended throughout the year. This was prompted by the practical capacity limitation of the elevator during the harvest season. Elevator firms have managed to handle large volumes during a year's span of time, up to seven times their house storage capacity at one point in time by influencing the flow of grain from the farm. Either by educating producers to store on the farm or by contracting for grain in the farm bins, they control the flow into the elevator. Perhaps the unique distinction between the factors that influence economies of scale in country elevators and more complex marketing or processing firms is that limitations to and variations in scale of operations are non-mechanical and not as dependent upon labor's efficiency as upon

non-engineering phenomena. For example, the government's program for grain storage and price supporting; the nature of the harvest--short period of time or extended; seasonal price expectations; availability of box cars during the rush harvest season; quality of local grain for that particular year which influences the market outlet; proportion of house space tied up by grain stored for the government, and similar factors which influence scale of operations more than the size of equipment or efficiency of labor.

Alternative Empirical Techniques

Dr. Sammet and his associates have done much to increase the usefulness of empirical observations in the problem area of firm analysis by jointly making application of the accounting costs technique and the cost synthesis process based on engineering data.

Agricultural economists make observations of what now exists and make recommendations based on the current operations of the most efficient firms observed. The usefullness of the recommendations depend mostly upon the existence of efficient firms and only to a small degree upon the imagination of the research worker concerning what could exist. It is necessary to establish cost-volume relationships reflecting minimum cost for any given output. Sammet notes that this "requires adjustment of observed costs in each plant so as to approximate cost-volume relationships with capacity plant operations and the development of 'envelope' cost curves." This is a difficult task without observations of firms that are actually operating at minimum cost levels and suggest a weakness of this technique used alone. In contrast the engineering approach synthesizes cost budgets based on rather precise measures of machine performance, of time and motion enginerring, and other physical input capacities. Unfortunately engineers are no more effective than economists in estimating or predicting management performance or even many of the human motivation elements that influence labor efficiency. The non-economic and non-engineering influences that enter into management decisions can and perhaps often do frustrate the ideals of firm operations as seen by research workers. Failure to recognize this fact may lead a research worker to discount the value of his synthesized models more than justified.

Practical Limitations in Research

I have already mentioned one of the practical limitations in making observations, namely the difficulty of specifying a cost function for management. The paper pointed out that the diseconomies expected at large volume outputs are supposedly due to diseconomies of management, but empirical evidence to bear this out is not complete.

The second limitation is the difficulty of defining scale of output. This limitation is less bothersome in studies of less complex organizations than those referred to in the paper which have multiple product outputs and are organized in semi-isolated process stages. The structural trend toward integration will increase the importance of this problem. Sammet concludes that studies of the more involved and complex units may be disappointing but that studies of parts of the whole may be productive.

Firm Analysis Research in Perspective

Commendations are due Dr. Sammet for his excellent paper. The paper and the more detailed reports from which the paper was drawn will serve as a methodological model for many who choose to conduct research in this important area. Benefits to the particular industries studied may actually be the by product of the research done by Sammet and others and the contribution to research methodology the principal product.

The increased interest in cost-volume relationships and the structural changes associated with these relationships is appropriate and overdue. However, research workers must keep this work in perspective and refrain from neglecting other important marketing research work in an attempt to get in on this type of work while the interest runs high.

Our interest in structural trends and economies of scale in marketing and processing is associated with our interest in observing important elements of the economy in order that we might be aware of what conditions are and how they might be expected to change with time. In addition we are interested in recognizing the causal factors that are associated with desired changes as a means of our influencing economic change. Market structure in the western states is subject to relatively rapid change as the western economy expands and we become conditioned to a changing setting. This environment is ideal for those who desire to effect changes that increase efficiency rather than merely observe changes.

Time was when administrators were of the opinion that experiment station money should be spent on problems as close to the farmer as possible. This usually excluded research pointed directly at problems of the marketing and processing firms distant from the farms. Industrial marketing economists were left to handle these problems. I remember my early attempts, not too long ago, at writing justifications for research projects, were greatly influenced by the notion that farmers must be the principal benefactors of the research and this was easiest to do if our concern was for marketing firms close to the farm gate. This notion seemed to be wide-spread because I observe that the great majority of marketing research has been directed toward country markets and local assembly plants.

The evolution of thinking regarding where problems lie that should be of concern to agricultural economists has included not only the economists themselves but administrators in the colleges and in state and federal governments and also our law makers in Congress. Justification for helping to solve efficiency problems within a processing firm far removed from the farm are not limited to the benefits that are expected to accrue to the producer but benefits gained by the consumer are accepted as sufficient reason for expenditures of experiment station money. As a matter of interest consumers are likely to be the principal benefactors if supply is great and the demand inelastic.

However, as the marketing or processing firm moves toward a position of monopoly or monopsony it is difficult to reason that savings resulting from a better way of operating will go to either farmers or consumers. Is there still a justification for expenditure of agricultural research money if we

can conclude only that stock holders benefit? On this point, differences of opinion are evident. The current re-emphasis on agribusiness and the attitude that the agricultural economist is concerned with agricultural products from the farm to the consumer and all who have anything to do with the products in between leads to the conclusion that time spent to aid the individual farmer is no more justified than time spent to aid the individual processing firm even though he might occupy a monopoly position and retain most of the benefits of the assistance. This may be an extreme example but such thinking is not foreign to those who find it difficult to prove that benefits will come to farmers or consumers as a result of efficiency research with processing or marketing firms. Efficiency for the sake of efficiency seems to be an appropriate objective regardless of who benefits if we use economic welfare concepts in our rational.

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