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Pricing Raw Product in Complex Milk Markets

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The dairy industry is based on the production of a raw product that is nearly homogeneous—whole milk—on farms geographically scattered, and the disposal of this raw product in alternative forms—fluid milk, cream, manufactured products—and to alternative metropolitan markets. Alternative markets represent concentrations of population. These also are geographically dispersed, but with patterns imperfectly correlated with milk and product production. The problem faced in the study that formed the basis for this paper was to examine the interactions of supply and demand conditions and the interdependent determination of prices and of raw product utilization. As his paper shows, the author approaches the problem by first considering a greatly simplified model based on static conditions and perfect competition. This is modified to admit dynamic forces, especially in the form of seasonal changes in supply and demand. Noncompetitive elements are then introduced in the form of segmented markets and discriminatory pricing, based on ultimate utilization of the raw product. Finally, these models are used to suggest principles of efficient pricing and utilization, within the constraint of a classified system of discriminatory prices.

This paper was originally prepared in connection with the study of class III pricing in the New York milkshed currently being conducted by the Market Organization and Cost Branch of the Agricultural Marketing Service. The object was to develop theoretical models that would provide a framework within which the empirical research work could be organized and carried out. The paper is published here because of its evident value as an analytical tool to research workers engaged in analyzing the efficiency of alternative pricing and utilization systems for milk and other agricultural products. It should perhaps be emphasized that the theoretical models presented involve a considerable degree of simplification, and that various amendments may be necessary in the empirical analysis of any particular milk marketing situation. It should also be understood that not all analysts will necessarily concur fully with some of the stated implications of Professor Bressler's model, particularly with respect to the explanation of classified pricing wholly in terms of differing demand elasticities and the extent to which classified pricing may act as a barrier to freedom of entry. Readers with a particular interest in the economics of the milk market structure may wish to examine the AMS study, "Regulations Affecting the Movement and Merchandising of Milk," published in 1955, which also contains analyses bearing on some of the problems considered in this article.

OUR THEORETICAL MODELS are based on a number of simplifying assumptions, the most important of which are:

1. A homogeneous raw product, regardless of final use. This is later relaxed by considering the effects of qualitative differences in raw product for alternative uses.

2. Given fixed geographic patterns of production of milk and of consumption of fluid milk in local markets. This will then be relaxed (a) to permit changes associated with the elasticity of demand and supply; and (b) seasonal variations in supply and demand.

3. Transport costs that increase with distance and that, on a milk equivalent basis, are inversely related to the degree of product concentration; that is, cream rates lower than milk rates, butter rates lower than cream rates (and so on) per hundredweight of milk equivalent. Graphically, we treat these as relationships linear with distance. This does not distort our consideration of the nature of decisions, but actual determination of a margin between alternative products can only be specified in terms of actual rates in effect.

4. Total processing costs for a plant include a fixed component per year (reflecting the type of equipment available, and so on) plus constant variable costs per unit of product or per hundredweight of milk equivalent for each product handled. The effects of scale of operation are not considered originally, but these could be introduced in the analysis without difficulty.

Competitive Markets—Static Conditions

The General Model

Consider the case of a central market with given quantities of several dairy products demanded. To be specific, assume that whole milk, cream, and butter are involved. For each product we know: (1) The conversion factor between raw product and finished product; (2) the processing costs for plant operation; (3) the transportation cost to market. Neglect for the moment any byproduct costs and values. The market is surrounded by a producing area, and production, while not necessarily uniform throughout the area, is assumed to be fixed in quantity for any sub-area. Under these conditions and with perfect competition, how will the producing area be allocated among alternative products, and what will be the associated patterns of market and at-country-plant prices for products and raw material? We limit our detailed discussion to the interrelations between two products, as the same principles will apply at each two-product margin.[1]

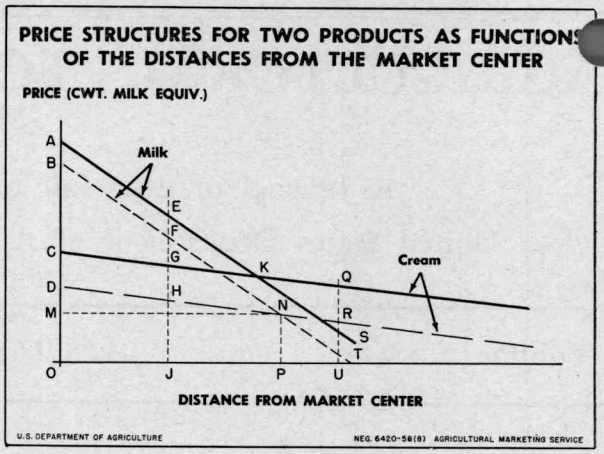

Figure 1.

Geographic Price Structures and Product Zones

Assume that a particular set of at-market prices for products has been established. These market prices and the transportation costs, then, establish geographic structures of product prices throughout the region, so that the price at any point is represented by the market price less transportation costs. This is suggested by figure 1, where all prices and costs are given in terms of milk equivalent values. If there were no processing costs, it is clear that at-plant values for milk in whole form would equal at-plant values for milk in cream form at some distance from market, such as at point K in the diagram. But differences in processing costs do exist, and these, as well as differences in transportation costs, must be considered.

Suppose country-plant costs equal AB for milk and CD for cream. Then *net values* of the raw product at various distances from market would be represented by line BT for milk as whole milk, and by line DR for milk as cream. At any distance from market such as OJ, a plant operator would find that net value of raw product would be JF

[1] Technically speaking, we compare sets of joint products (byproducts). This modification will be covered later.

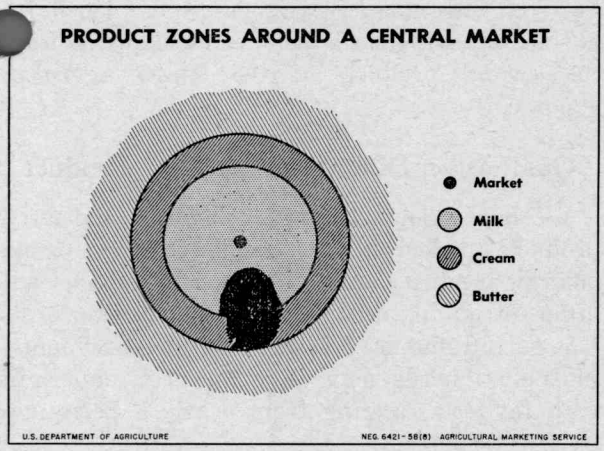

Figure 2.

for whole milk and JH for cream. Moreover, competition would *force* him to pay producers the highest value to obtain the raw product—and this would be JF. Thus, competition would lead him to select the highest value use, for in any other use he would operate at a substantial loss.

At some distance OP the net values for raw product would be exactly equal in the alternative uses. At this location, a manager would be indifferent as to the shipment pattern, and this distance would represent the competitive boundary or margin between the area shipping whole milk and the area shipping cream under the given market price. A plant operator still farther away from market would find that shipping cream would be his best alternative, in fact, the only one through which he could survive under the pressure of competition.

Disregarding the peculiar characteristics of terrain, road and rail networks, and transportation charges, this and other two-product boundaries would take the form of concentric circles centered on the market (fig. 2). The product zone for whole milk—the most bulky product with highest transport costs per unit of milk equivalent—would be a circle located relatively close to the market; zones for less bulky products would form rings around the milk zone. These rings would extend away from market until the margin of farm dairy production was reached, or until this market was forced to compete with other markets for available supplies.

In all of this, we assumed a particular set of market prices. If these had been arbitrarily chosen, the quantities of milk and products delivered to the market from the several zones would only by chance equal market demand. Suppose, for example, that the allocations illustrated resulted in a large excess of milk receipts and a deficiency in cream receipts at the market. This would represent a disequilibrium situation, and the price of milk would fall relative to the price of cream. The decrease in the price of milk would bring a contraction of the milk-cream boundary, and the process would continue until the market structure of prices was brought into equilibrium—where the quantities of all products would exactly equal the market demand.

More generally, both consumption and production would respond to price changes—demands and supplies would have some elasticity—and the final equilibrium would involve balancing these and the corresponding supply area allocations to arrive at perfect adjustment between supply and demand for all products. Notice that the product equilibria positions will be interdependent—an increase in the demand for any one product, for example, would influence *all* prices and supply area allocations. But in the final equilibrium adjustments, the situation at any product boundary would be similar to that shown in figure 1.

Minimum Transfer Costs and Maximum Producer Returns

We have demonstrated that, under competitive conditions, plant operators would select the dairy products to produce and ship by considering market prices, transportation costs, and processing costs, and that by following their own self interest they would bring about the allocation of the producing territory into an interdependent set of product zones. In algebraic terms, the at-plant net value (N) of raw product resulting from any alternative process (Products 1, 2, . . .), is represented by:

$$N = P - t - c$$

in which P represents the market price, t the transfer cost (a function of distance), and c the plant processing cost—all expressed per unit of raw product. The boundary between two alternative products 1 and 2, then, is:

$$N_1 = N_2$$
$$\text{or, } P_1 - t_1 - c_1 = P_2 - t_2 - c_2$$

It should be recognized that final equilibrium must involve higher market prices (in milk equivalent terms) for the bulky, high-transport-cost products, with lower and lower prices for more-and-more concentrated products. If this were not true, there would be no location within the producing area from which it would be profitable to ship the bulky product, and the market would be left with zero supply. Prices for these bulky products therefore "push up" through the price surfaces of competing products until market demands are satisfied.

It is easy to demonstrate that these free-choice boundaries minimize total transportation costs for the aggregate of all products, so long as market requirements are met. Suppose we consider shifting a unit of production at some point 1 in the milk zone from milk to cream, and compensate by shifting a unit of production at any point 2 in the cream zone (and therefore farther from market than point 1) from cream to milk.

The indicated shifts will represent a net increase in the distance that milk is shipped, and an exactly equal decrease in the distance that cream is shipped. But as it costs more to ship milk than cream any distance (per hundred-weight of milk equivalent), it follows that the shift must increase total transportation costs. This would be true for any pairs of points considered—the points selected were not specifically located and so represent any points within the two product zones. Moreover, a similar analysis is appropriate between any two products—the milk-cream boundary, the cream-butter boundary, and so on.

Not only do these boundaries represent the most efficient organization of transportation; they also permit the maximum return to producers consistent with perfect competition. Point 1 is located in the milk zone, and so is closer to market than point 2 in the cream zone. We know that at point 1 the net value of the product is higher for milk than for cream, while the reverse is true for point 2. Shifting to cream at point 1 would thus *reduce* the net value, and shifting to milk at point 2 would also reduce net value. On both scores, then, net values would be reduced. As net values represent producer payments (at the plant), it is clear that the competitive or free-choice boundaries are consistent with the largest possible returns to producers. From a comparable argument, it follows also that these competitive zones permit consumers at the market to obtain the demanded quantities of the several products at the *lowest* aggregate expense.

Qualitative Differences in Raw Product

We have assumed that the several alternative products are derived from a completely homogeneous raw product. Actually, the raw product will differ in quality and in farm production costs. One such difference relates to butterfat content—individual herds may vary by producing milk with fat tests ranging from nearly 3 percent to well over 5 percent.

We shall not comment on differences in the fat test other than to point out that, under competitive conditions, the determination of equilibrium prices for products varying in butterfat content simultaneously fixes a consistent schedule of prices or butterfat differentials for milk of different tests. This is true also in fluid milk markets where standardization is permitted.[2]

In many markets, milk for fluid consumption must meet somewhat more rigid sanitary regulations than milk for cream, and this involves some difference in production costs. These differences will modify our previous equilibrium analysis. Assume that farm production costs for milk for fluid purposes are higher than costs for milk for cream by some constant amount per hundred-weight. The equilibrium adjustment at the milk-cream margin, then, will not involve equal net values for the raw product, for under these conditions a farmer near the margin would find it to his advantage to produce the lower cost product. The net value for milk for fluid purposes must exceed the value for cream by an amount equal to the higher unit production costs. In equation form:

$$N'_1 = N_2$$

$$P_1 - t_1 - c_1 - s_1 = P_2 - t_2 - c_2$$

in which s represents the higher farm production costs, and in which the setting of these equations equal to each other defines the new boundary.

This presentation is greatly oversimplified, though it may be adequate for present purposes.

[2] For details, see Clarke, D. A., Jr. and Hassler, J. B. PRICING FAT AND SKIM COMPONENTS OF MILK. California Agr. Expt. Sta. Bul. 737. 1953.

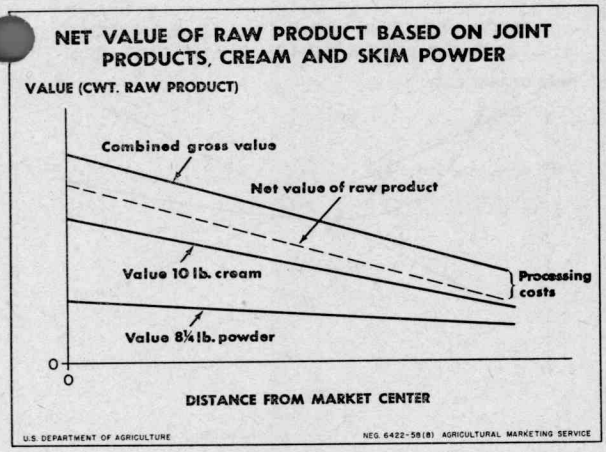

Figure 3.

Actually, differences in production costs would not enter in this simple way—for every farm would have somewhat different costs. Differences in sanitary requirements will influence farm production decisions and so modify supply. In equilibrium, the interaction of supply and demand will determine not only the structure of market prices and product zones, but also the supply-price to cover the changed production conditions. In short, this price differential will be set by the market mechanism itself, and at a level just adequate to induce a sufficient number of farmers to meet the added requirements. The cost difference that we assumed above, therefore, is really an equilibrium supply-price for the added services. Moreover, it may vary throughout a region, reflecting differences in conditions of production and size of farm.

Byproduct Costs and Values

We have assumed also that the alternatives facing a plant operator were in the form of single products. Yet it is clear that most manufactured products do not utilize all of the components of whole milk, nor use them in the proportions in which they occur in whole milk. Cream and butter operations have byproducts in the form of skim milk, and this in turn can be processed into such alternative forms as powdered nonfat solids or condensed skim. Cheese yields whey or whey solids as byproducts, plus a small quantity of whey butter. Evaporated milk will result in byproducts based on skim milk if the raw product has a test less than approximately 3.8 percent butterfat, and cream if the test exceeds 3.8 percent.

For any given raw product test, the alternatives open to a plant manager form a set of joint products, with each bundle of joint products produced in fixed proportions. With 100 pounds of 4 percent milk, for example, the joint products might be approximately 10 pounds of 40-percent cream plus 90 pounds of skim milk, or 5 pounds of butter and 8.75 pounds of skim milk powder. Net value of raw product at any location, then, will represent the quantity of each product in the bundle multiplied by market price minus transportation costs with the gross at-plant value reduced by subtracting aggregate processing costs. This is suggested in figure 3 for the joint products cream and skim powder. With this modification, our previous analysis is essentially correct. But note that the product zones now refer to joint products rather than to single products—and so to real alternatives in plant operation.

Plant Costs and Efficient Organization

Before completing our consideration of static competitive models, we should be more specific with reference to plant or processing costs. In the foregoing, these have been treated as constant allowances for particular products. As in the case of differences in production costs, processing costs are not adequately represented by a given and fixed cost allowance but rather are determined in the marketplace. In short, these too represent equilibrium supply-prices, adequate, but only adequate, to bring forth the required plant services.

In the present discussion, we have considered these in relation to the raw product and indicated a flat deduction to cover plant costs. In sections to follow we shall find it essential to distinguish between fixed and variable costs, but we shall view the process correctly as involving decisions that can be expressed ultimately in terms of costs and return per unit of raw product.

If we represent plant costs as a constant "price" resulting from the competitive market equilibrium, we disregard the effects of scale of plant. More exactly, we assume that equilibrium involves an organization of plants that is optimum with respect to location, size, and type. With these assumptions, the long-run costs for any particular type of operation are taken to be uniform and at optimum levels.

We shall proceed on this basis, but we emphasize that this will not be strictly correct, even under

ideal conditions. The optimum size for a plant of any type will depend on the economies of scale that characterize plant costs and on the diseconomies of assembling larger volumes at a particular point. These are balanced off to indicate that size of plant which results in the lowest combined average costs of plant operation and assembly.

But assembly costs are affected by such factors as size of farm and density of production: Costs increase with total volume assembled under any situation, but they increase at more rapid rates in areas with small farms and sparse production density. Consequently, the ideal plant will be of somewhat smaller scale in such areas, and plant costs (as well as combined costs) somewhat higher. Moreover, these factors will have a differential effect on costs and optimum organization for plants of different types because each type will have characteristically different economy-of-scale curves. This may mean some modifications to the perfectly circular product zones—and so provide a rational explanation of the persistence of a particular form of plant operation in what would otherwise appear to be an inefficient location.

We have suggested that competitive market conditions would balance off plant and assembly costs, and eventually result in a perfect organization of plant facilities with respect to location, size, and type. A further digression on this subject seems necessary, for these situations are unavoidably involved in elements of spatial or location monopoly. Under perfect market assumptions, the plant manager obtains raw product (and other inputs) by offering a given and constant market price, obtaining all that he requires at this price. But apparently in this country plant situation, increases in raw product can be obtained only by offering higher and higher at-plant prices—prices increasing to offset the higher assembly costs. In short, the manager is faced with a positively inclined factor supply relationship—and so finds himself in a monopsonistic situation. He cannot be unaware of this, and so he can be expected to take it into account in making his decisions.

With a given price for the finished product at the country plant location—representing the equilibrium market price minus transfer costs—and raw product cost that increases with increases in plant volume, the manager faces a price spread or margin that decreases with increases in volume.

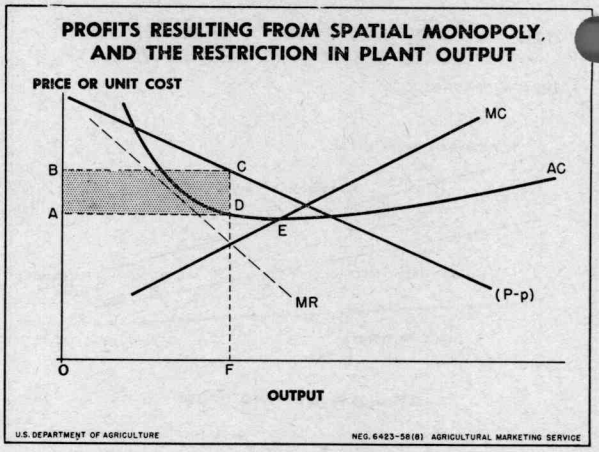

Figure 4.

This is illustrated in figure 4 by the line $(P-p)$—the at-plant finished product price (milk equivalent) minus the increasing price paid to obtain raw product. Marginal revenue from plant operation is then represented by the line MR and the manager would maximize profits by operating at output OF where marginal revenue and plant marginal costs are equal. Average plant costs would then be FD and average revenue FC, yielding monopsonistic profits equal to CD per unit or ABCD in total. Notice that optimum long-run organization would have been at point E if the prices paid for raw product had been constant rather than increasing with volume, and that this is the minimum point on the average cost curve. Because of spatial monopoly elements, however, plant volume will be lower than the cost-minimizing output, costs will be higher, payments to producers lower, and profits greater than normal.

This analysis indicates that the country organization will consist of plants with average volumes approximating OF. A plant in an isolated location would have a circular supply area, but with competition from other plants the resulting pattern of plant supply areas would resemble the large network of hexagonal areas shown in figure 5. But with excess profits, the industry would attract new firms, and they would seek intermediate locations such as points D, E, and F. A new plant at point E will compete for supplies with the established plants and eventually carve out a triangular area (HJM) with half the volume of the original plant areas. Such entry will continue until the entire

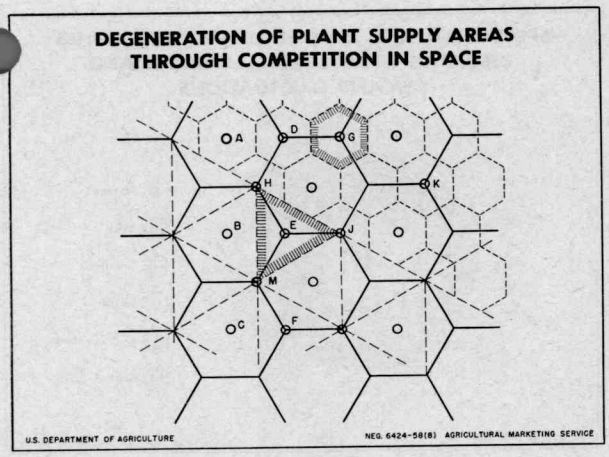

Figure 5.

district has been reallocated—with twice as many plants, each handling half the original average volume.

But this is not the end, for still more plants can force their way into the area, occupying such corner positions as H, M, J, G, and K on the triangular plant areas. Again the district will be reallocated among plants, eventually forming a new hexagonal network as shown around point G—now with three times as many plants as in the original solution. This entry of new firms might be expected to continue until excess profits disappear, or until line $P-p$ in figure 4 is shifted to the left so far that it is tangent to the average cost curve.

But even this is not the limit. The regular encroachment of new firms will result in increased costs and so make it impossible for any firms to be efficient. With a regular increase in costs for all plants, the market price (P) for the product will be forced up and the producer prices for raw product (p) forced down—in short, competition is not and cannot be effective in bringing about low costs and the optimum organization of plants and facilities.

Within this framework of industry inefficiency, there are still opportunities for firms to operate profitably and efficiently through plant integration and consolidation. When the situation becomes bad enough, a single firm (private or cooperative) may buy and consolidate several plants in a district, thus returning the overall organization toward the efficient level. But now the whole process could start over again, unless single firms were able to obtain real control of local supplies, and thus prevent the entry of new firms.

In any event, it is clear that spatial monopoly creates an unstable situation and can be expected to result in an excessive number of plants and correspondingly higher-than-optimum costs. This tendency is sometimes called "the law of mediocrity," and its operation is not limited to country phases of the dairy industry. In retail milk distribution, for example, the overlapping of delivery routes reduces the efficiency of all distributors, and so limits the effectiveness of competition in bringing about an efficient system. The mushrooming of gasoline stations is a familiar example where spatial monopoly and product differentiation result in a type of competition that is unstable and inadequate to insure efficiency in the aggregate system.

Competitive Markets—Seasonal Variation

Seasonal Changes in Production, Consumption, and Prices

We now complicate our model by recognizing that production and consumption are not static, but change through time. Specifically, we consider seasonal changes, and inquire into the effects of these on prices and product zones. Even a casual consideration of this problem will suggest that such supply and demand changes must give rise to seasonal patterns in product prices. These in turn affect the boundaries between product zones through seasonal contractions and expansions. As a consequence, the boundary between any two products is not fixed but varies from month to month, and between zones that are always specialized in the shipment of particular products there will be transitional zones that sometimes ship one product and sometimes another.

We shall now examine this situation in detail to learn how such seasonal variations influence firm decisions, and so understand how prices and product zones are interrelated. We maintain the assumption of perfect markets and the other postulates of our first model, except the assumption of constant production of milk and consumption of fluid milk. As we are interested primarily in how seasonal changes influence the system, we only specify a more or less regular seasonal cycle without attempting to delineate any particular pattern. We assume that managers act intelligently in their own self interest and are not misled by some common accounting folklore with respect

to fixed costs—although this is more a warning to our readers than a separate assumption, as it is implicit in the assumption of a perfect market.

A Firm in the Transition Zone

The general outlines of product zones with seasonal variation is suggested by figure 6. Here we show a specialized milk zone near the market, which ships whole milk to market throughout the year. Farther out we find a specialized cream zone, shipping cream year-round, while still farther from market is a specialized butter area. Between these specialized zones—and overlapping them if seasonal variation in production is quite large—are diversified or transition zones: a zone shipping both milk and cream; and a zone shipping both cream and butter.

Suppose we select a location in one of the transition zones, and explore in detail the situation that confronts the plant manager. To be specific, we shall select a plant in the milk-cream zone, but the general findings for this zone are appropriate for other diversified zones.

We assume that this plant serves a given number of producers located in the nearby territory and that this number is constant throughout the year. Production per farm varies seasonally, however, so that even under ideal conditions the plant will have volumes less than capacity during the fall and winter. We assume that the plant is equipped with appropriate separating facilities so that it can operate either as a cream shipping plant or, by not using the separating equipment, as a whole milk shipper. We further assume that market prices for milk and cream vary seasonally and that in order to meet market demands in the low-production period, milk prices change more than cream prices. With the given plant location and transportation costs to market, this means that the manager is faced with changing milk and cream prices f. o. b. his plant. Our problem is to indicate the effects of these changes on plant operations.

Consider first the cost function for this plant. Under our general assumptions, variable costs are easy to handle—each product is characterized by a given and constant variable cost per unit of output, and the manager can expand output along any line at the specified variable cost per unit up to the limits imposed by the available raw product and by plant equipment and capacity. At the same time, the plant is faced by certain fixed or overhead costs. These fixed costs are independent of the volumes of the several products, but reflect the particular pattern of plant facilities and equipment provided. So far as fixed costs are concerned, the several outputs must be recognized as joint products. There are any number of ways in which fixed costs might be allocated among these joint products but all are arbitrary.

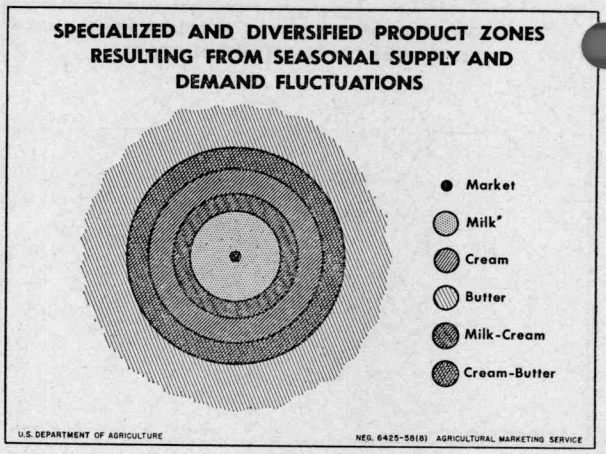

Figure 6.

Fortunately, such allocations are not necessary to the determination of firm policy and the selection of the optimum production patterns—in fact, fixed cost allocations serve no purpose except perhaps to confuse the issue. We take the fixed costs as given *in total* for the year—although even this is arbitrary for the outputs of any 2 years are also joint products and the assumption of equal fixed costs per year is thus unjustified.

The important issue is that the firm should recover its investment over appropriate life periods—if it does not, it will not continue to operate over the long run; if it more than recovers investments (plus interests, etc.,) then the abnormal level of returns will attract new firms and reduce profits to the normal level. Many of the fixed costs associated with investments and plant operations are institutionally connected to the fiscal year, however, and for this reason the assumption of given total fixed costs per year appears to be appropriate. Examples include annual interest charges, annual taxes, and annual salaries for management and key personnel.

In terms of total costs (fixed plus variable) per year, we visualize a surface corresponding to an equation of the type:

$$TC=a+bV_1+cV_2$$

in which a represents annual fixed costs, V_1 and V_2 the annual output of the two products, b the variable cost per unit of product 1, c the variable cost per unit of product 2, and so on—this may readily be expanded to accommodate more than two products. Note that this cost surface does not extend indefinitely, as V_1 and V_2 are limited by available raw product and plant capacity. Gross revenue for the plant is represented by product outputs multiplied by appropriate f. o. b. plant prices, or:

$$TR=P'_1V_1+P'_2V_2$$

Net returns—or net value of raw product in our earlier expressions—is represented by total revenue minus total costs, or:

$$NR=TR-TC=P'_1V_1+P'_2V_2-a-bV_1-cV_2.$$

If the manager wishes to maximize his net returns—and under perfect competition he has no alternative if he is to remain in business—he can do this by computing the additions to net revenue that will accompany the expansion of either product and selecting the product that yields the greater increase. Marginal net revenue functions are:

$$\frac{\partial NR}{\partial V_1}=P'_1-b$$

$$\frac{\partial NR}{\partial V_2}=P'_2-c$$

These marginal functions may be made directly comparable by expressing them in milk equivalent terms, in which y_1 and y_2 represent the respective yields per hundredweight of raw product:

$$\frac{\partial NR}{\partial y_1V_1}=(P'_1-b)y_1$$

$$\frac{\partial NR}{\partial y_2V_2}=(P'_2-c)y_2$$

By observing marginal net values per unit of raw product, the manager can determine which product to ship. Remember that total output is limited by the available supply of raw product, and that we have assumed capacities adequate to handle this supply in either product. With given at-plant prices and constant marginal costs, the marginal net value comparisons will indicate an advantage in one or the other product, and net revenue will be maximized by diverting the entire milk supply to the advantageous product.

In algebraic terms, we state the following rules for the manager:

if $(P'_1-b)y_1>(P'_2-c)y_2$, ship only product 1;
if $(P'_1-b)y_1<(P'_2-c)y_2$, ship only product 2;
if $(P'_1-b)y_1=(P'_2-c)y_2$, ship either 1 or 2.

These assume, of course, that prices exceed marginal costs; if marginal net revenues should be negative for all products, the optimum short-run program would be to discontinue operations entirely, but normally long-run considerations would dictate a program based on the product with least disadvantage. The third rule simply covers the chance case in which marginal net revenues per unit of raw product are exactly equal in the two lines of production, and so the choice of product is a matter of indifference.[3] Note that these optimum decisions in no way depend on fixed costs or on any arbitrary allocation of fixed costs.

We have stated that prices f. o. b. the plant will vary seasonally, with milk prices fluctuating over a wider range than cream prices. As these prices change, marginal net revenues will change—marginal net revenues from milk shipment will increase relative to marginal net revenues from cream shipments during low-production months and will decrease during months of high production. The manager will watch these changes in marginal net revenue. If $(P'_1-b)y_1$ always exceeds $(P'_2-c)y_2$, then the plant will always ship whole milk, and therefore must be in the specialized milk area. But if marginal net revenue from milk shipment is always lower than marginal net revenue from cream shipment, optimum plant operation will always call for cream shipment and the plant will be in the specialized cream zone.

[3] Under these conditions, the plant might ship both products simultaneously. Under other conditions, such simultaneous diversification would be optimum only if (a) capacity for a particular product is not adequate to permit complete diversion of the raw product, or (b) either marginal costs or marginal revenues change with changes in plant output. These appear to be unrealistic under the conditions stated, and so are disregarded.

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If this plant is in fact located in the diversified milk-cream zone, then during some of the fall and winter months the marginal net revenue from milk will exceed the marginal net revenue from cream and the plant will ship only milk. But during some of the spring and summer months, these marginal net revenues will be reversed, and the plant will ship only cream. Day-by-day and week-by-week the manager will make these decisions, and the result will be a particular pattern of milk and cream shipments. If the plant is located near the inner boundary of the transition zone, it will ship milk during most of the year and cream during only a few weeks or even days at the peak production period. Conversely, a plant near the outer boundary of this zone will ship cream during most of the year and milk only for a few days at the very-low-production period.

Specialized Milk Versus Milk-Cream Plants

It may be protested that the foregoing analysis is incorrect because a plant that utilizes its separating equipment for only a few days must have very high cream costs. This is a common misunderstanding; it arises from the practice of allocating fixed costs to particular products. Nevertheless, a grain of truth is involved, and it can be correctly interpreted by considering the alternatives of specialized milk plant or milk-cream diversification near the milk and milk-cream boundary.

We have seen that the net value of raw product for the diversified plant can be represented by:

$$NR_{12}=P'_1V_1+P'_2V_2-a-bV_1-cV_2$$

In a similar way, we represent net values for the specialized milk plant as:

$$NR_1=P'_1V-d-bV$$

in which d represents the fixed costs for a specialized milk plant and b the variable costs—we assume variable costs of shipping milk as the same in the two types of plant, although this may not be true and is not essential to our argument.

In our equations prices are given in terms of the milk equivalent of the whole milk or cream, and expressed at country-plant location. Remembering that the at-plant price is market price less transportation cost to market and that transportation costs are functions of distance, these costs can be used to define the economic boundary between the specialized milk plant zone and the transition milk-cream zone. For simplicity, we represent the transportation costs by t_1D and t_2D, and give the expression for the distance to the boundary of indifference below:

$$D=\frac{(P_1-b)-(P_2-c)+\frac{a-d}{V_2}}{t_1-t_2}$$

Note that this boundary is long-run in nature—it defines the distance within which it will not be economical to provide separating facilities but beyond which plants will be built with such facilities.[4] The short-run situation would be represented by the margin between specialized milk shipment and diversified milk-cream shipments *where all plants are already equipped to handle both products.* From the material given earlier, it is clear that the equation for the short-run boundary will be exactly the same as the long-run equation, *except* that the fixed costs term $\frac{a-d}{V_2}$ will be eliminated. From this it follows that the long-run boundary will be farther from market than the short-run boundary. If a market has reached stable equilibrium, separating facilities will not be provided until a substantial volume of milk can be separated.

The actual determination of these boundaries will depend on the specific magnitudes of the several fixed and variable cost coefficients, the patterns of seasonal production, the relative transfer costs, and the patterns of seasonal price changes. Ideally, these all interact to give a total equilibrium for the market. We may illustrate the solution, however, by assuming some values for the various parameters and seasonal patterns. This has been done, with the results shown in figure 7. Here we have assumed that fluid milk prices change seasonally—the prices minus unit variable costs at country points are represented by line AB

[4] We assume that equipment will have adequate capacity to handle total plant volume. There remains the possibility that a plant would provide some equipment for a particular product, but less than enough to permit complete diversion. As equipment investments and operating costs normally increase less rapidly than capacity, it usually will pay to provide equipment to permit complete diversion of plant volume if it pays to diversify at all.

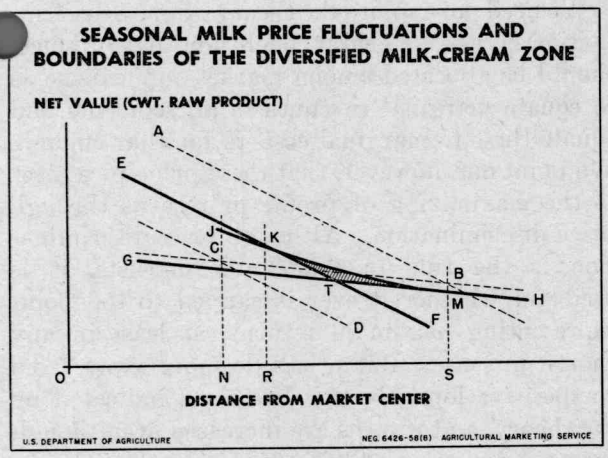


Figure 7.

for the high-price season and line CD for the low-price season. We have assumed that cream prices are constant. Although this is not strictly correct, it will permit us to indicate the final solution in somewhat less complicated form than otherwise would be necessary. The geographic structure of cream prices less direct variable costs is represented by line CB. Apparently, the short-run boundary between the specialized milk zone and the milk-cream zone would be at distance ON, for at point C net raw product values would be equal in either alternative. Similarly, the outer short-run margin between the milk-cream zone and the specialized cream zone would be at distance OS.

Consider the long-run situation where decisions as to plant and equipment are involved. For convenience, express all net values in terms of the averages for the entire year. The net value of raw product from specialized milk plants is represented by line EF. This line is a weighted average of such lines as AB and CD—each weighted by the quantity of milk handled at that particular price—the line represents the seasonal weighted average price minus direct variable cost *and minus* annual average fixed costs d/v per unit of raw product. In other words, this net value line is long-run in that it shows the effects of fixed costs as well as variable costs and seasonal price and production changes. Similarly line GH represents long-run net value of raw product in specialized cream plants differing from CB by the subtraction of average fixed costs a/v. Apparently, the economic boundary between specialized milk and specialized cream plants would be at point T *if we prohibited diversified operations.* But we know that plants equipped with separators would find it economical to diversify seasonally in zone NS.

The increase in net value realized by cream plants through seasonal milk shipments is represented by the curved line JKM in the diagram. As we start at point M on the outer boundary of the diversified zone and move to plants located closer to market, an increasing proportion of the raw product during any given year will be shipped to market as whole milk. These milk shipments occur during the low-production season, as milk prices are then at their highest levels. Observe that these plants are covering total costs—including the costs for fixed separating equipment, even though a smaller and smaller volume of milk is separated. That is, the dominant consideration in this situation is the opportunity for higher net values through milk shipments—and not higher costs based on an arbitrary allocation of certain fixed costs to a diminishing volume of cream. Notice also that, under competitive conditions, plants must make this shift to milk shipment. Otherwise, they could not compete for raw product and so would be forced out of business.

Although plants equipped with separating equipment would find it economical to ship small volumes of cream in the low-price period even from the zone NR, the gains would not be adequate to cover the long-run costs of supplying separating equipment. This means that specialized milk plants—without separating equipment and so with lower fixed costs—are more economical in this zone. This is indicated by the fact that line JKM falls below the net value line EF for specialized milk plants in the JK segment. The boundary specified by our long-run equation is found at distance OR, where net long-run values are equal for specialized milk plants and for diversified plants—RK. Plants at this boundary would find it economical to ship cream for a month or two each year if they shipped cream at all. This abrupt change from specialized milk plants to plants shipping a fairly substantial volume of cream is a reflection of the added fixed costs, and this represents the previously mentioned grain of truth in the usual statements about the high plant costs involved in shipping low volumes of cream or similar products.

Noncompetitive Markets

Price Discrimination and the Classified Price System

No matter how revealing the theory of competitive markets may be, it is clear that it cannot apply directly to modern milk markets. Milk, cream, and the several manufactured dairy products serve different uses, and are characterized by different (although to some extent interrelated) demands. Moreover, bulkiness of product and high transportation costs segregate fluid milk markets, and this segregation is at times enhanced by differences in sanitary regulations. In any market, as a consequence, there will be a relatively inelastic demand for fluid milk and a somewhat more elastic demand for cream. Most of the manufactured products produced in the local milkshed must be sold in direct competition with the output of the major dairy areas, and so the demands for these products in the local market normally appear to be quite elastic to local producers. It should be recognized, however, that some manufactured products are rather bulky and perishable, and so may have a local market somewhat differentiated and segregated from national markets.

Differing demand elasticities for alternative dairy products long ago gave rise to systems of price discrimination. Here we refer to differences in f. o. b. market prices that are greater than, and unrelated to, the differences resulting from differences in processing costs, transfer costs, and the costs of meeting any higher sanitary requirements. In addition, producers in most markets have developed collective bargaining arrangements in dealing with milk distributors. These have commonly resulted in some form of classified pricing, under which handlers pay producers according to a schedule with different prices based on the final use made of the raw product. Whatever else may be said about classified pricing plans, it is clear that they involve price discrimination in several segments of a market. Thus, a completely homogeneous raw product may be priced at different levels according to the use made of the product. Because of the nature of available substitutes and so of demand elasticities, these classified or use prices are normally highest for fluid milk, lower for milk used as fluid cream, and lower still (and approximating competitive market levels) for the major manufactured dairy products.

We need not explore the theory of price discrimination here—its general conclusion that product should be allocated among market segments so as to equate marginal revenues in all segments and equate these to marginal costs is familiar enough. We point out, however, that these principles refer to the maximizing of profits or returns through price discrimination. Although price discrimination is the rule in fluid milk markets, it is doubtful whether it ever is carried to the point representing maximum returns, at least in any short-run sense. But prices do move away from competitive levels in the directions indicated by the theory, and returns are increased even though they are not necessarily maximized.

To avoid misunderstanding, we emphasize that considerations of supply as well as demand are involved in milk pricing. We have already pointed out that the demands for the major manufactured products appear to be perfectly or nearly perfectly elastic to sellers in the local market. Supply diversions to and from the national market keep prices in line in the local market, and the impact of local supplies is relatively insignificant in the national market. These diversions and the impracticability of market exclusion prevent significant price discrimination.

Similar diversions are physically possible for fluid milk, although at relatively higher transportation costs, and in a perfect multiple-market system all prices would be interdependent through supply and demand interactions. But here market exclusion is both practical and practiced, through such devices as differences in sanitary regulations, refusal to inspect farms beyond the normal milkshed, refusal to certify farms as "Grade A" unless they have a fluid milk market, and provisions of a variety of pooling plans and base or quota arrangements.

The classified price system itself is an effective barrier to entry if it is enforced by an agency with power extending across State lines, for this plan effectively eliminates the incentives for milk dealers to reach out and buy milk from low-priced and unregulated sources. Even in the absence of complete jurisdiction, classified prices may make market entry difficult through general acceptance of the pricing plan by dealers in any given market.

These and other market exclusion devices may be far from perfect, however, especially over a period of time. Class I prices at discriminatory levels may encourage expanded production by present and new producers within the existing milkshed and so may dilute composite prices through a growing proportion of surplus milk. High prices may encourage consumers to seek substitutes and thus increase the elasticity of long-run demands. Fear of popular rejection of pricing schemes, plus concern of the regulating agency for the public interest, may place effective ceilings on class I prices, even though short-run demands are inelastic.

All of these and other considerations influence and limit the operation of classified pricing plans. But extreme differences between class I and surplus prices, between prices in alternative markets, and between prices paid to neighboring farmers provide evidence that barriers to market entry are important in fluid milk markets and that discriminatory prices for fluid milk exploit these effective barriers. This evidence is bolstered by reports of attempts to restrain increases in production and supply, and of shifts to milk pricing under Federal authority when State price regulation becomes ineffective.

From our present standpoint, the important aspect of classified pricing is that this system establishes a schedule of prices *to be paid to farmers* by handlers, and that these prices refer to specific alternative uses for the raw product. We add a second aspect that is appropriate for the New York market, although not for all fluid markets: the market is operated on the basis of a marketwide pool. This means that the classified prices paid by handlers do not go directly to their producers but in essence are paid into a pool. All producers are then paid from the pool on an uniform basis, after appropriate adjustments for butterfat test and for location.

Three important modifications are thus required in our foregoing theory: (1) At-market prices will no longer represent competitive equilibrium levels; (2) returns to producers in any locality are not directly influenced by the particular use made of their milk—prices paid producers by two plants will be uniform pool prices even though the plants process and ship quite different products; and (3) the analysis in terms of net values of raw product must now reflect firm decisions when raw product is priced by a central agency—where raw product costs are determined by classified prices rather than directly by competition.

Classified Prices and Managerial Decisions

We have seen that, under competitive conditions, plant managers would tend to utilize milk in optimum outlets in order to meet competition and so survive, and that these optimum use patterns would depend on market prices and on transport costs. With classified prices and market pooling, however, the raw product cost to a plant is determined by the particular use pattern, while payments to producers from a market pool are a reflection of the total market utilization. As a consequence, producer payments will be fixed for any location regardless of utilization; they cannot be effective in encouraging optimum use patterns. The plant manager is now faced with the problem of maximizing his returns when faced on one hand with a set of market prices for products and on the other by a set of classified prices for raw product.

Suppose we begin our examination of this problem by assuming that market prices and transportation costs are given and fixed—thus fixing the particular set of product prices f. o. b. the country plant at any specified location. Assume also that classified prices are established to reflect as closely as possible the net values of the raw product in any use. This means that the gross value of products of a hundredweight of milk will be reduced to net value basis by subtracting the efficient processing costs, and that these net values will be further reduced by subtracting appropriate transfer costs. In short, the net value curves in the previous diagrams will now represent classified prices for any particular use and at any specified location.

Although this might appear to be an ideal arrangement at first glance, further consideration will indicate that such a system would completely eliminate the economic incentives that could be expected to yield optimum use and geographic patterns. We have indicated that actual payments to producers are divorced from the particular plant utilization under marketwide pooling, and so there is no incentive for a producer to shift

from one plant to another. By the same token, the threat of losing producers because of low producer payments is no longer a problem for the plant manager.

Moreover, if processing and transportation costs are reflected accurately in the structure of classified prices, the manager will find that he can earn only normal profits, but that he will earn these normal profits regardless of the use he makes of the raw product. Under these assumptions, then, utilization patterns through the milkshed will be more or less random and chance.

This can be made clear by considering the plant profit function. We have defined net values for the raw product in terms of product prices at the market, transfer costs, and plant operating costs. Now we subtract raw product costs as specified by classified prices, and for a diversified plant we define profits as follows:

$$\text{Profit} = (P_1 - t_1 D) V_1 + (P_2 - t_2 D) V_2 - a - bV_1 - cV_2 - C_1 V_1 - C_2 V_2$$

in which C_1 and C_2 are the established class prices at this plant location. These are defined perfectly to reflect net values, as noted above, or:

$$C_1 = P_1 - t_1 D - b - d/V_1$$

$$C_2 = P_2 - t_2 D - c - (a-d)/V_2$$

Notice that the last terms in these equations refer to fixed costs—d for specialized milk plants, and a for diversified plants. If these values for the classified prices are substituted in the profit equation, the result is zero excess profits (normal profits, of course, are included as a part of plant operating costs). In short, with these perfectly calibrated classified prices, there would be no abnormal profits, but normal profits could be earned with any product combination and at any location.

Significantly, marketwide pooling makes this a stable situation by removing any direct impact of a plant's utilization pattern on payments to the producers who deliver to this plant. Suppose we assume that the market pool is replaced by individual plant pools (these would differ from the familiar individual handler pools if handlers operate more than one plant). Maintain all of the above assumptions, so that the manager will still earn only normal profits regardless of location or product mix. The product mix or utilization pattern would now have a direct bearing on producer payments, however, and this would modify the situation.

Consider two neighboring plants in what would normally be the milk shipping zone. Assume that, as profits would be equivalent, one manager elects to ship milk and the other cream. As the classified price for milk will be higher than the classified price for cream use in this zone, the first plant will pay its producers a substantially higher price than the second. This creates producer dissatisfaction, and some transfer of producers and volume from the second plant to the first. The individual plant pool, therefore, would provide a real incentive through the level of producer payments to bring about the optimum utilization of the raw product.

Let us now make our models more realistic by admitting that market prices for the several products are determined by supply and demand rather than being given and fixed. Classified prices are fixed by the appropriate agency. In some instances, they are tied to market product prices through formulas. To fix ideas, assume that the price for fluid milk delivered to the market is free to vary in response to changes in supply and demand; that the class I price is fixed at some predetermined level and with location differentials accurately reflecting transfer costs; that other product prices (cream, butter, . . .) respond primarily to supply and demand conditions in a national or regional market and so may be considered as given in the market in question, but subject to variation through time; and that class II and other classified prices are tied to product prices as accurately as possible through net value formulas and transfer cost differentials.

Under these conditions, plant profits in nonfluid milk operations would be uniform regardless of specific use or location. Product prices would move with national market conditions, but class prices would change in perfect adjustment to product prices. Prices of fluid milk, however, would move up or down relative to the established class I price, sometimes making fluid milk shipment more profitable and at other times less profitable than the nonfluid outlets. Under the assumed conditions, moreover, all of the available raw product would be attracted into or moved out of class I—there would be no graduated supply curve with prices adjusting until the quantities demanded just equaled the quantities offered.

Without going further, it should be clear that efficient utilization of raw product under a system of classified prices can be expected only if the pricing provisions put premiums on optimum uses. These premiums may take the form of larger profits from plant operations, or competitive losses in plant volume, or both. The pricing system must make the manager "feel" the advantages (profits and available raw product) of efficient utilization, and the disadvantages (losses and diminishing raw product supply) of inefficient use, so that his responses and adjustments will lead toward the optimum organization for the entire market. In the following section, we explore several methods of providing such incentives.

Pricing for Efficient Utilization

At the start of this section, we should make clear what we mean by efficient utilization. Earlier, we pointed out that a competitive system of product zones and equilibrium market prices mean aggregate transportation costs as low as possible. This will be true of such zones even if product prices are determined monopolistically—the most efficient organization of product zones will be consistent with competitive prices. Stated in another way, if we disregard market prices and simply determine the organization of processing throughout a milkshed that will minimize the transfer costs of obtaining specified quantities of the several products, the resulting zones will be the same as would characterize a market with competitive prices.

In the language of the linear programer, we say that the solution of the system of competitive prices among products and markets involves a *dual* solution in terms of minimum transfer costs. In the same sense, the solution of the problem of minimizing transfer costs involves a dual solution in terms of competitive prices—but these are *shadow* prices and need not correspond to actual prices. In the latter instance, of course, the allocations of producing areas will be consistent with the set of competitive shadow prices; they will not represent the free choice areas consistent with the noncompetitive prices.

This dual efficiency solution extends far beyond the minimizing of transportation costs. Suppose we have given the geographic location of production, processing costs, transportation rates, and quantities of the several products required at the market. Given this information, it is possible (though often involved) to develop a program that will supply the market with these quantities, allocate products by zones in the milkshed, minimize the combined aggregate costs of transportation and processing, and *return the highest aggregate net value* to the raw product.

If in this model we have specified efficient levels of processing costs, the resulting allocation will represent the ideal "long-run"solution with plants perfectly organized with respect to type and location. But we can enter specific plant sizes, locations, and types in the model, and obtain the best possible solution within these restraints—the optimum short-run solution. In our present context, however, we take efficient utilization to mean the optimum long-run pattern as described above, and we emphasize that this will mean the largest possible aggregate return to the raw product within the restraints imposed.

We have suggested a modification to the pricing system that might make plant managers feel the consequences of inefficient utilization—the elimination of marketwide pooling and the substitution of plant pools. This modification would be effective if the high-use plants had outlets for more and more fluid milk, but this is patently unrealistic on a total market basis. Under most circumstances, there would be little incentive under classified prices and plant pools for a plant to take on additional producers. Often, more producers would only add to the nonclass I volume of milk in the plant and so would lower the blend price to all producers. It is common observation that marked differences between the blend prices received by producers can exist and persist for long periods of time. Therefore, this is not a very dependable way to obtain improved efficiency in utilization, and it has serious deficiencies from the standpoint of equity of individual producers.

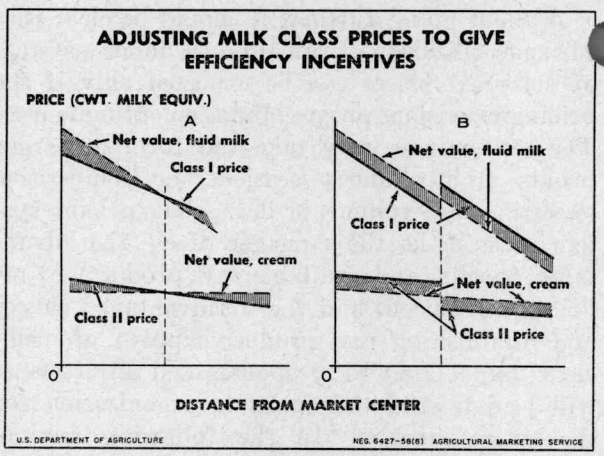
The real answer to this problem is to establish a pricing system that permits handlers to participate in the gains from efficient utilization. This means that class prices throughout the milkshed must depart somewhat from the perfect net values of raw product discussed earlier—some of the higher net values resulting from optimum utilization and location must go to handlers. Perhaps

this should be called the principle of efficient pricing. We shall not attempt to guess at the magnitude of the required incentives, other than to express an opinion that reasonably small incentives should bring fairly substantial improvements in utilization.[5] Neither shall we attempt to spell out the detailed modifications to a classified pricing system that would provide such incentives. But in the paragraphs that follow we do note some types of adjustments that appear to be consistent with this principle.

1. If products are ranked according to at-market equivalent values, the at-market allowances to cover processing costs should exceed efficient levels for the high-value products but be less than cost for the low-value products. Furthermore, the geographic structure of class prices should decline with distance from market less rapidly than transportation costs for low-value product. Note that these work together to give an incentive structure favoring high-value (and bulky) products near the market and low-value (and concentrated) products at a distance from market.

Handlers shipping fluid milk from plants located in the nearby zone receive a "premium" in the form of the difference between the net value in fluid use and the class I price. If these same plants elect to ship cream, the class II price will exceed the net value of cream and so a "penalty" will result from this inefficient use of milk supplies. The converse would be the case for plants located in the more remote parts of the milkshed. Ideally, these incentives should be equal at a distance consistent with the efficient milk-cream boundary, and similar zone boundaries for other product combinations. This is suggested by the construction in figure 8–A.

2. As an alternative to the blending together of incentives as suggested above, a more effective device might be one that provides the desired incentives through a uniform combination of "premiums" and "penalties." These would favor efficient production in any specified zone, making the incentive effective by a reduction in the appropriate class price for the specified zone and an increase in class prices in alternative "nonefficient" zones. The reduction in class prices is essentially similar to the provisions that permit an "incentive" reduction in the class III price for butter or cheese uses, but these specify the incentive for particular time periods while the above relate to specified distance zones (figure 8–B).



Figures 8–A and 8–B.

3. When several products are included in a single class for pricing, a class price that reflects a low margin on the lowest value (at-market) product will discourage its production and encourage utilization for the higher value products within the class. At the same time, this procedure can be expected to establish "subzones" within the major zone. In this way, relatively bulky, high-value, high-margin products will tend to be produced near the inner boundary of the manufacturing zone, while the more concentrated, low-value, low-margin products are confined to the more distant edges of the milkshed.

4. Corollary to (3), limiting surplus classes to one or two, with a number of alternative product uses in each class, will tend to improve utilization efficiency and also simplify administrative problems. It must be recognized, however, that this will reduce returns to producers if wide and persistent differences in product values exist within a given class. In short, the gain in efficiency may be offset (from producer standpoint) by failure to fully exploit product values.

[5] It should be clear that the increased efficiency induced by these incentives would, among other things, increase the net value of the milk in the production area by selecting the optimum use and by minimizing aggregate transfer cost. It would be possible, of course, to provide incentives of such magnitude that the amount "given away" to handlers could exceed the net gain by cost reduction. Therefore, these incentives will need to be calibrated so as to accomplish the desired objective without at the same time dissipating the benefits to be derived.

5. Except for discrepancies resulting from errors and imperfections of knowledge, the efficient utilization pattern for a milkshed would be achieved if the total market supplies were under the management of a single agency, dedicated, within the restraints of the established class prices, to maximizing returns to the raw product. In most situations, it would be unrealistic to consider consolidating all country facilities under a single firm. Nevertheless this general idea may have some application in the operation of a market. For example, the market administrator might assign utilization quotas for the several products to each plant, making these consistent with the efficiency model.

Some Comments on the New York Study

The Use of Efficiency Models

This paper was written to summarize principles developed and used in the conduct of parts of the present study of the New York milk market. Specifically, the theoretical models provide a framework for the organization of empirical research work. By discussing the attributes of efficiency models, we point to various types of information essential to the empirical study of this market and its operation. Major focus is on decision making by individual firms, for this is the mechanism that activates the whole market. From the theory, it is clear that specific information is needed on such items as product prices at the metropolitan market, processing costs for the various products and joint products in the milkshed, transfer costs, and past and present patterns of actual utilization by product, location, and season.

With these data and the efficiency models, the market can be "programmed" to indicate the optimum situation and changes in this optimum through time. By contrasting these synthetic results with actual utilization patterns, it is possible to judge the operating efficiency of the whole market. These comparisons can be made specific in terms of savings in costs and increases in net values that could result from efficient operation. Moreover, specific subphases of the research can appraise the efficiency of such operations as the combination of ingredients in an optimum or low-cost ice cream mix—and so provide useful management guides to operating firms.

By adding the specific provisions of the classified pricing system to the efficiency model, and relating it to the actual distribution of plants and facilities, a modified short-run efficiency model results. This should more nearly resemble the actual situation, although discrepancies are still to be expected. The model would be especially useful in checking the effects of changes in product prices, cost rates and allowances, and classified prices on the market, and on its aggregate efficiency. Note also that this model can be applied to the operation of any actual firm—taking as given its total utilization pattern and its endownment of plants and facilities, and checking optimum utilization. Again, results may indicate inefficiencies but it is expected that its application will be of more value in indicating the impact of classified prices and other factors on the firm decision making.

Finally, these research results can be combined with the results of management interviews to determine as accurately as possible the way in which firms and the market adjust to changing prices, costs, and classified prices of raw product. This should permit a final appraisal of the market, and suggest specific modifications and changes that would improve efficiency.

Secondary and Competing Markets

As an epilogue, we point to the perhaps obvious simplifications of our theoretical models, and the need for elaboration in actual operation. Some of these have been suggested by the addition of a number of products and byproducts, the treating of plant alternatives rather than individual products, and the insertion of more realistic (and more complicated) cost relationships. These represent merely an elaboration of the model, but some aspects are in the nature of major additions. They include the consideration of competition between New York and other major markets, and the relationships between New York and various "upstate" secondary markets completely surrounded by the major milkshed (and now subject to the New York market order).

Our models relate to a single central market with product zones in the milkshed surrounding this market. Alternative utilization thus involves processing costs, prices for products at the major market, and transfer costs from country points to

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the major market center. With the addition of other markets—major or secondary—the analysis must be repeated for each market, and alternative market outlets as well as product outlets given specific consideration. The major principles involved remain as we have stated them in the previous pages, but the final complex model describes the efficient organization for an entire region, and the consistent structure of intermarket prices (or shadow prices) and market-product zones.

From the viewpoint of the present study, it seems probable that limitations of time will force major emphasis on the New York metropolitan market. This will be accomplished by accepting the actual geographic pattern of farm production, plants, and plant-to-market shipments, and inquiring as to efficient operation within these given patterns. This is done with the realization that the specific inclusion of such secondary markets as Albany, Syracuse, Buffalo and Rochester, and such major markets as Boston, Philadelphia, and Pittsburgh would no doubt reveal inefficiencies in the present among-market allocations, and yield valuable information about the problem of pricing in competing markets. But so long as this appears to be impracticable in the present study, it seems appropriate to eliminate all shipments to other markets, and to concentrate attention on the remaining volumes pertinent to the New York market. In this connection, it is recognized that many plants within the New York milkshed serve local markets and are not covered by the New York market operation—thus are not included in the market statistics. Thus the elimination of the pool milk that goes to nonmajor markets means that all supplies for these secondary markets are eliminated from consideration.

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