12-1971

Interorder Relationships Among the Northeastern Federal Milk Marketing Orders

Yehoshua Tidhar
University of Connecticut - Storrs

Ian W. Hardie
University of Connecticut - Storrs

Bulletin 418, December 1971

Interorder Relationships Among the Northeastern Federal Milk Marketing Orders

By Yehoshua Tidhar and Ian W. Hardie
Department of Agricultural Economics

STORRS AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE AND NATURAL RESOURCES
THE UNIVERSITY OF CONNECTICUT, STORRS

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The Department of Agricultural Economics of the University of Maryland contributed to the completion of this study by making available to the Storrs Agricultural Experiment Station both professional time and computer facilities. Their cooperation made possible the publication of this bulletin.

The authors wish to express their appreciation to Stewart Johnson for suggestions during the course of the study and to S. K. Seaver for recommended revisions which were incorporated into the final manuscript.

Acknowledgement is also due the Computer Center of the University of Connecticut for providing its facility, which is financially supported by the National Science Foundation, Grant GJ-9.

INTERORDER RELATIONSHIPS AMONG THE NORTHEASTERN FEDERAL MILK MARKETING ORDERS*

*Yehoshua Tidhar and Ian W. Hardie***

INTRODUCTION

A. The Setting

Federal milk marketing orders are particularly important in the Northeastern United States. More than three quarters of the region's milk production is marketed under order provisions. In 1967, the 503 dealers who were controlled by the orders took delivery of 18.9 million pounds of milk from 51,368 producers. This amounted to a volume of milk worth about one billion dollars. The dealers in turn supplied approximately 36 million people with milk products. Hence, the federal milk marketing orders are the primary determinant of the incomes of the Northeast's dairy farmers, of the costs of milk for the area's milk dealers, and of the availability of milk to the region's population.

The federal milk marketing order program has several objectives. Three of the most important are:

1. Maintenance of an adequate supply of wholesome milk at reasonable consumer prices.
2. Promotion of orderly and efficient milk marketing.
3. Improvement of the long run incomes of dairy farmers.

The marketing order program accomplishes its goals by setting minimum prices which handlers must pay for milk purchased from producers. These prices are established for different classes of milk according to utilization. Class I milk, which is used in fluid milk products, and Class II milk, which is used in manufactured milk products, are the most usual classes. The various class prices and the percentage of milk utilized in each class serve as the basis for computing blend prices, which are the prices paid to producers.

As of January 1, 1968, there were six marketing orders in the Northeast. These orders included the Massachusetts-Rhode Island-New Hampshire Order (No. 1001), the Connecticut Order (No. 1015), the New York-New Jersey Order (No. 1002),

*The research on which this publication is based was made possible by funds provided under the Agricultural Research and Marketing Act of 1946 and is part of the Northeast Regional Milk Marketing Research Projects NEM-25 and NEM-40.

**Yehoshua Tidhar, Research Assistant, and Ian W. Hardie, Assistant Professor of Agricultural Economics, both formerly of the University of Connecticut.

Received for publication April 22, 1971.

FIGURE 1. — Milk marketing areas under federal orders, modified to coincide with county lines, Northeast United States, as of January 1, 1968.

TABLE 1: Selected Data on the Northeast Federal Milk Marketing Orders, 1967.

Marketing order	Population as of Dec. 31, 1967	No. of pool handlers regulated under order, Dec. 1967	No. of producers delivering milk to regulated handlers, Dec. 1967	Producer milk deliveries to regulated handlers, 1967	Percentage of milk deliveries used as Class I, 1967	Total value of milk marketed by producers at blend prices, 1967
				Thousand lbs.	Per cent	Thousand dollars
Connecticut	2,535,234	66	2,040	1,139,207	79	72,271
Delaware Valley	4,652,298	49	5,360	1,941,610	78	119,965
Mass.-R.I.-N.H.	6,040,558	137	8,834	3,219,250	61	175,079
New York-New Jersey	18,490,830	210	31,205	10,741,456	50	546,941
Upper Chesapeake Bay	2,093,277	23	1,999	855,189	70	50,240
Washington, D.C.	2,165,342	18	1,930	1,040,007	76	62,484
Total	35,977,539	503	51,368	18,936,719	--	1,026,980

Source: USDA, Consumer and Marketing Service, Dairy Division, *Federal Milk Market Statistics, Annual Summary for 1967*, (Washington, D.C.,: Government Printing Office, May 1968).

the Delaware Valley Order (No. 1004), the Upper Chesapeake Bay Order (No. 1016), and the Washington, D. C. Order (No. 1003). The geographical boundaries of the six orders are shown in Figure 1. Table 1 presents an order-by-order breakdown of some selected data which show the relative positions of the six orders included in the Northeast region. The New York-New Jersey Order was by far the largest, with the Massachusetts-Rhode Island-New Hampshire Order taking the number two position. The Upper Chesapeake Bay Order was the smallest order among the six. On August 1, 1970, the southernmost three orders were merged into a new order called the Middle Atlantic Order. As a result, the orders' relative positions shifted, with the New England orders becoming the smallest. The new order took the number of the old Delaware Valley Order (1004).

Fluid milk markets in the Northeast have been essentially local in nature. However, considerable growth in interaction among geographically separated fluid milk markets has been witnessed in recent years. Indeed, the merger of the three Middle Atlantic Orders was in response to their growing interdependence. This structural change has expressed itself in the increasing movement of bulk and packaged fluid milk between federal milk marketing orders. The data presented in Table 2 provide some evidence that interorder fluid sales have been an increasing percentage of the total fluid sales by handlers regulated under the Northeast orders.

The factors responsible for the rise in interorder milk movements include a variety of technological and economic forces. Advances in refrigeration, transportation, and packaging have made it possible to transport fluid milk over long distances at reduced costs and without affecting quality. Economies of scale in milk processing and handling have justified the construction of centralized bottling and processing plants which serve several markets. Consequently, milk moves more easily and markets which were separated become more interdependent.

Because milk can move between markets fairly easily, geographic price patterns

TABLE 2. Interorder Fluid Milk Sales (Bulk and Packaged) By Handlers Regulated Under Federal Milk Orders As Percentage Of Total Fluid Sales By Such Handlers 1965-67

Marketing Area	January 1965	January 1966	January 1967
	Percent	Percent	Percent
Massachusetts-Rhode Island-New Hampshire	4.4	4.3	5.3
Connecticut	4.4	11.0	14.8
Delaware Valley	6.6	6.8	4.1
Upper Chesapeake Bay	6.8	9.4	15.0
Washington, D. C.	2.6	3.3	6.8
New York-New Jersey	—	—	2.9

SOURCE: USDA, Consumer and Marketing Service, Dairy Division, *Federal Milk Order Market Statistics,* (Washington, D. C.: Government Printing Office), February 1965, February 1966, and unpublished data for October 1967.

with excessive price differentials will encourage unnecessary intermarket transfers of fluid milk products. Unneeded movements of fluid milk conflict with the objectives of the federal milk orders since they inflate market costs and cause less orderly marketing. Furthermore, milk handlers with different costs of obtaining fluid milk find themselves in competition, a situation which is inconsistent with the goal of equating handler costs of milk for the same use in the same market.

An order will experience a decline in its Class I utilization percentage and blend price when the Class I sales of locally regulated dealers are displaced by sales from dealers regulated under other orders. The decline in blend price will adversely affect the income of producers who deliver to the locally-regulated dealers, and enhance the income of other producers. Overall producer income may not fall, but, superfluous interorder movements cannot improve the incomes of all producers in the Northeast and such movements can lower marketing efficiency.

One way to minimize interorder milk flows is to periodically evaluate and adjust the Class I price differentials among the region's orders. Adjusting the price differentials to reflect differences in local supply and demand conditions and in transportation costs on a periodic basis would tend to keep milk flows beyond the real needs of each order at a minimum. It would, therefore, tend to promote the declared objectives of the federal program.

B. The Problem and the Approach

Adjustment of price differentials in the federal milk marketing orders is one of the functions performed by the Secretary of Agriculture. Evaluation of current and possible prices is a necessary antecedent to making rational adjustments. The purpose of this study is to formulate a useful method for evaluating the interorder effect of various sets of class prices.

The method of evaluating the class prices is to adhere to two basic conditions. One is that the method be relatively simple in concept, and easily solvable. The other is that the method used incorporate the major institutional factors present in the Northeastern milk marketing orders. Neither condition can be completely fulfilled for they tend to be in conflict, but both conditions guide the development of this study.

Because of the emphasis on these conditions, results are obtained only for short periods of time. No attempt is made in the study to provide once-and-for-all answers. Instead, the sought-after end is a mechanism for making evaluations of the effects of price proposals whenever these proposals arise.

Because the emphasis is not on long run answers, this report contains a single set of data. With the exception of some Class I prices, all figures are for August 1968. At the time of the project's initiation, complete and current data were available only up to this date. Since August is neither a flush production month nor a month of low production, the quantities of milk produced and consumed during the month should represent somewhat average values. Also, prior to 1968, the Delaware Valley Order was a handler pool order, so that August 1968 was the first August during which all six orders had similar marketing order regulations.

The short term nature of the results is illustrated by the merger of the three southernmost orders in 1970. Cognizance is taken of this merger in some solutions

by assigning the same Class I price to all three orders, but the value of the results will not compare with what could be obtained from a more recent set of data.

This study takes as given the goals of (a) promoting marketing efficiency (b) maintaining an adequate supply of milk to individual markets, (c) increasing the incomes of milk producers, and (d) placing all milk handlers operating in a given marketing area under the same external cost structure. The goal of eliminating excessive interorder shipments of milk is subsumed under (a).

Promotion of marketing efficiency in its general form is a rather vague concept. In the model formulated in the study, promotion of efficiency in marketing will be taken to mean minimization of the total marketing costs associated with meeting the fluid milk requirements of the six federal orders. Pursuit of this goal leads to a reduction in the overall marketing bill of the dairy industry in the Northeastern United States and to possible gains for both dairy farmers and consumers.

Maintenance of an adequate supply of milk in each market will be enforced in the model by demand constraints. Numerous attempts have been made to define what constitutes an adequate supply of milk, but a common acceptable definition is yet to be developed. In this study, an adequate supply of milk is defined to be the amount of fluid milk fulfilling Class I milk consumption in August 1968. This definition emphasizes short run considerations since it takes price as given and does not allow for simultaneous adjustment in prices, demand, and production.[1]

Enhancement of the income of dairy farmers will be given the same weight as the goal of minimizing total marketing costs. Both of these goals will appear in the objective function of the model. One goal can be weighted more heavily than the other, but unequal weights would represent a major policy change in the administration of the federal programs. The less important ends of minimizing interorder transfers and of equalizing the procurement costs of directly competing handlers will be implicit in the analysis. Minimizing marketing costs will minimize interorder transfers and this, in turn, will tend to minimize competition between handlers with different fluid milk costs. There will always be some handlers with different milk procurement costs if interorder shipments take place but such cases will be less when interorder transfers are minimized.

Four basic types of constraints limit the pursuit of the cost minimization and income maximization goals. One type is the already mentioned demand constraints which place a floor under the amount of fluid milk available for consumption in a market. A second type of constraint puts a ceiling on the supply of Class I milk available in each area of production. The third type limits intermarket transfers by forcing the handlers to sell the majority of their fluid milk in the markets of the order under which they are regulated. These constraints reflect the pooling restrictions written into most federal orders. The final constraint type (actually a combination of two constraints) is used to compute producer returns and to transfer these returns into the objective function. A more detailed account of these constraints, and of the rest of the model will be presented next.

[1] Partly compensating for this short run limitation, however, is the ability to easily change the consumption quantities which are entered in the model.

AN ECONOMIC MODEL OF THE SPATIAL ALLOCATION OF FLUID MILK IN THE NORTHEAST

An economic model is a simplified representation of a real world situation. By definition, it involves abstraction from the vast amount of detail and the many pecularities found in any economic system or situation. The model developed here emphasizes the *short run* effects of alternative Class I prices on the marketing costs of milk handlers, on producer incomes, on the least cost delivery pattern capable of providing adequate fluid milk supplies to the six northeastern orders, and on the interorder movement of fluid milk products in the Northeast. The short run refers to a time period during which the Class I, Class II, and blend prices remain relatively constant. (By implication, the Class I and Class II utilization percentages also remain constant.) Furthermore, production and consumption are represented as fixed quantities. In terms of real time, it is assumed that a month is equivalent to the short run.

A. Location and Nature Of Production, Consumption, And Processing Of Fluid Milk

Supplies of fluid milk are distinguished according to their location. For this purpose, the Northeast is divided into 17 production areas. Of the 17 areas, seven lie completely outside the marketing areas covered by the six federal orders. These seven areas are referred to as "distant" production areas. The remaining 10 production areas which lie inside the orders' marketing areas are called "near" production areas. It is assumed that each of the 17 areas is represented by a single fixed point at which all local production is concentrated, and from which fluid milk flows originate. The milk produced in the 17 areas is assumed to be homogeneous quality, and to meet the sanitary regulations for Class I use.[2] Monthly production of milk is taken as given datum and individual milk producers are assumed to have no influence over the blend prices they receive from milk handlers.[3]

The consumption of fluid milk products is also distinguished according to location. The Northeast is divided into 15 consumption areas, seven of which are the same as the distant production areas. Consumption of fluid milk products in these distant areas is used to determine whether a distant production area is a surplus or a deficit area. The remaining eight near consumption areas coincide with the marketing areas of the six federal orders. Each consumption area is represented by a single fixed point where all of the area's consumption of fluid milk products is assumed to be centered, and to which milk flows. For the distant consumption areas, the central point is the same as that for the distant production areas. However, the representative points of the near consumption areas are not necessarily the same as those of the near production areas. Monthly consumption of Class I products in each consumption area is exogeneously determined and is thus given datum to the model.

[2]Class I milk is milk used in fluid products such as whole milk, skim milk, buttermilk, flavored whole and skim milk, fluid cream, and mixtures of milk and cream.

[3]A handler is a person who purchases milk in a production area and transfers it to the city for sales in fluid products. This definition is more limited than the one in the orders.

This study locates the city plants at each of the representative points of the consumption areas. Two factors favor the location of fluid milk processing operations near the major markets. The first factor is the substantial savings in transportation costs which result from shipping fluid milk in bulk rather than as packaged milk.[4] The second factor is the economies of scale which have been shown to exist in fluid milk processing.[5] A city plant which serves a large marketing area and which draws its supplies from several production areas can achieve the operational size required to take advantage of these economies of scale. Whatever diseconomies of scale such a plant incurs in distributing the milk seem to be more than offset by the inplant economies of scale.

The model also postulates that where direct delivery of milk from farm to city plant is infeasible (because of the distance between production and consumption areas) fluid milk must be first assembled at a country plant. Country plants are located, by assumption, at each of the representative points of the production areas. Whether a shipment requires the use of a country plant or is a direct delivery shipment was decided on an area-by-area basis.[6]

On-the-farm milk consumption is treated as negligible so that the monthly quantity of milk produced in each of the production areas is assumed to be the monthly quantity available for delivery to milk handlers. Since fluid milk inventories are ruled out, such producer deliveries are the only source of milk to dealers. In a distant area, the local production is assumed to be used first to meet local Class I consumption. Only the excess over local demand is available for marketing as Class I milk in the near consumption areas and for diversion to other uses and markets.[7] If the distant area is a deficit area (production is smaller than Class I consumption), it is eliminated from further consideration. In a near production area, all producer deliveries are assumed available for marketing as Class I products in the near consumption areas and for diversion to other uses and markets.

The reasons for distinguishing between distant and near production areas should now be apparent. The model is formulated to study the movement of milk for Class I use between northeastern production areas and the marketing areas of the six orders. It is not intended as an explanation of Class I sales outside these marketing areas. By assuming that distant areas become an active component of the model only if they are surplus areas, one avoids having to deal with flows into distant deficit areas. At the same time, the requirement that local Class I needs be met first guarantees that a distant area does not become a supplier of the Northeast

[4] Orval Kerchner, *Cost of Transportating Bulk and Packaged Milk By Truck*, Marketing Research Report No. 791, ERS, USDA, (Washington, D. C.: Government Printing Office, May 1967), p. 18.

[5] Emerson M. Babb, "Changing Marketing Patterns and Competition of Fluid Milk," *Journal of Farm Economics*, Volume 48, No. 3, Part II, (August 1966), p. 57.

[6] Stewart Johnson of the University of Connecticut Agricultural Economics Department gave guidance in specifying the types of shipments.

[7] Diversions to other uses and other markets include fluid milk converted into manufactured products, plus Class I products marketed in federal orders outside the Northeast and in nonregulated markets.

orders unless its own fluid milk demand is adequately satisfied. The same conditions need not be placed, however, on the near production areas since their consumption of fluid milk products is part and parcel of the total fluid milk consumption of the six orders.

The model allows the use of different representative points for consumption and production areas which have the same (or almost the same) boundaries, and which lie within the limits of the six orders. This reflects the geographical separation between the milk production and consumption within the federal order areas.

B. Restrictions on Class I Milk Flows

One of the terms contained in the regulations of a federal milk order is the definition of the order's marketing area. A marketing area is defined as a geographic area in which the same milk handlers compete for milk sales. Handlers who purchase milk for sales in a designated marketing area must pay the minimum prices established by the order. This condition would be sufficient for regulatory purposes if every handler sold his milk in only one marketing area. However, many handlers distribute Class I products in several marketing areas, so that a question arises as to the order under which they should be regulated. To account for such situations, the federal orders contain a pooling requirement. Handlers are classified as fully regulated, partially regulated, or exempt primarily on the basis of the percentage of handler's milk receipts sold as Class I milk in an order's marketing area.

This pooling requirement can be approximated in a simplified form by what is commonly known as the majority rule. The approximation states that a handler regulated under a particular order must sell at least 51 percent of his total Class I sales in the six orders within the regulating order. Since the pooling requirement applies to every handler regulated under a given order, it is not unreasonable to assume that 51 percent or more of the total Class I sales regulated by an order will be in the regulating order's marketing area(s). This simplified and aggregate formulation of the pooling requirements is the form incorporated into the model.[8] Its inclusion restricts intraregional Class I milk under any one of the orders. Each of the six northeastern orders has a pooling requirement.

Demand constraints are a second kind of restriction which is placed on the Class I shipments. This type of restriction maintains an adequate supply of fluid milk products by specifying that the sum of all monthly Class I deliveries into a single consumption area must at least equal the monthly quantity of Class I products consumed in the area. There is one demand constraint for each of the near consumption areas.

In addition to the pooling and demand restrictions the model has a third type of restriction on Class I flows. The supply constraint states that the total Class I milk shipped from a production area cannot exceed the monthly supplies of fluid

[8]This aggregate representation of the pooling requirement does not carry precisely the same implications as the order's regulations. However, more precise formulations require that the model distinguish between handlers. Since only total milk shipments are specified in the model, the aggregate representation of the pooling requirement is used.

milk in the area. Where the total of such fluid milk shipments is less than available supplies the excess milk is assumed to be diverted to plants producing manufactured milk products and to Class I sales outside the Northeast Orders. The specific uses of this excess milk are not explained in the model. Only the total excess milk in a given production area is indicated. There is one supply constraint for each of the production areas in the region.

C. Computation of Producer Income

The fourth class of constraints does not restrict milk shipments. Instead, these constraints compute the total producer income (ignoring zone and location differentials) for each order. These producer return constraints work hand in hand with the objective function in which producer income is maximized so that the milk producer returns are simultaneously calculated and optimized.

The producer return constraints are a modified form of the blend price formulas. An order's blend price is a weighted average of the order's Class I and Class II milk prices. Each Class price is weighted by the proportion of milk utilized in the class and the weighted prices are summed. After adjustment for cooperative service payments, seasonal incentive plans, etc., the blend price is obtained.

The Class I utilization proportion for a given order is defined as the ratio between the order's Class I usage and the total producer deliveries to handlers regulated under the order. The order's Class I usage refers in turn to producer deliveries used as Class I milk by handlers regulated under the order; thus, Class I usage includes both sales in the six orders and sales in any market outside of the orders. The Class II utilization proportion is defined in a similar manner, except that Class II usage replaces Class I usage in the proportion.

Total producer deliveries to handlers regulated under each of the six orders, and Class I sales made outside the Northeast orders by the regulated handlers, are assumed to be predetermined parameters. Treatment of these two items as given values is somewhat unrealistic, but a model which includes them as variables would be too complicated and demanding of data. Any change in milk flows due to changes in these items will have to be tested for parametrically.

An order's total producer returns (before adjustment by zone and location differentials) are found by multiplying the total producer deliveries by the order's base blend price. In order to show how the producer return constraints are derived, a formula for the blend price and for the total deliveries is needed. The required formula for computing the base blend price of each order is:

(1) $b_h = u_h p_h + (1-u_h) m_h + a_h$

where

h = 1, 2, . . ., 6 is a number assigned to each order

b_h = blend price of order h

p_h = Class I price of order h

m_h = Class II price of order h

u_h = Proportion of producer deliveries regulated under order h which are utilized as Class I milk

a_h = An adjustment for cooperative service payments, seasonal incentive plans, etc.

The Class II utilization proportions do not show up explicitly in this formula: since the Class I and Class II utilization proportions add up to 1, Class II proportions are represented implicitly as $(1-u_h)$.

A Class I utilization proportion has three components: (1) milk regulated under an order which is sold as Class I within the six orders (denoted as Z_h), (2) Class I milk sales regulated under order h and made outside the six orders (represented by e_h), and (3) total producer deliveries regulated under order h (symbolized as v_h). To get the Class I utilization proportion, the two types of milk sales are summed and the result is divided by the total deliveries:

$$(2)\quad u_h = (Z_h+e_h)/v_h$$

Total producer returns (W_h) are the total producer deliveries times the blend price:

$$(3)\quad W_h = b_h v_h$$

The blend price formula given in equation (1) can be substituted into equation (3). Equation (2) can be solved for the total producer deliveries, v_h, and the result also substituted into (3). Then total producer returns would be:

$$W_h = [u_h p_h+(1-u_h)m_h+a_h][(Z_h+e_h)/u_h]$$

$$(4)\quad = (p_h-m_h)Z_h+(p_h-m_h)e_h+(m_h+a_h)v_h$$

The constraints used in the model are rearrangements of equation (4):

$$(5)\quad W_h-(p_h-m_h)Z_h = (p_h-m_h)e_h+(m_h+a_h)v_h$$

Note that W_h, the total producer returns, and Z_h, the Class I sales within the orders, are variables whose values are determined by solving the model. The other item's values are assumed to be given data.

D. Marketing Costs

Marketing costs are taken to be those expenses incurred by the handlers in assembling, processing and distributing the fluid milk products. Handler costs are by no means the only charges which could be termed milk marketing costs but they are the only charges which are included in the model. The model's costs are related to the marketing functions handlers perform, to the location of milk supplies relative to the Class I markets, and to the order under which a handler is regulated. The types of costs distinguished are:

(1) purchases of fluid milk
(2) costs of assembling and cooling the milk (country plant costs)
(3) costs of transporting milk from a production area to a processing plant
(4) costs of processing milk into fluid milk products (city plant costs)
(5) costs of selling the Class I milk products
(6) costs of transporting milk from a processing facility to a market area
(7) costs of distributing the fluid milk products in a marketing area

Although costs are classified according to the marketing functions performed by the handlers, costs of individual handlers are not used. This is because the types of shipments incorporated in the model are (1) the aggregate transfers of Class I milk between production and market areas, and (2) total transfers of fluid milk products between different market areas. Handler shipments are aggregated because data for individual handlers is lacking and because the number of such individual

transfers is large. Consequently, the effect of dealers operating with varying degrees of efficiency cannot be isolated in the model.

Every unit of fluid milk is charged the same cost unless the cost varies between areas or between orders. Costs which are assumed not to vary by area or by order are deleted from the model. All handlers are assumed to have the same assembly costs, processing costs, selling costs, and costs of final distribution. These are the costs which are left out of the model. The model includes country plant costs, transportation costs, and raw milk purchase costs. Handlers who have country plants are assumed to have similar country plant costs; of course, this cost is zero for those handlers who do not need a country plant.[9] Handlers shipping from a common production area to a common market, or between two given markets, are presumed to pay the same transportation charges. Finally, handlers regulated by a particular order are assumed to pay the same zone prices for their raw milk.

Specifying costs to be the same for all handlers covers a multitude of errors. Yet, accepting the assumption serves two purposes. It implies that handlers do not have to be identified and that the study can deal with aggregate milk flows between geographic points. Furthermore, the supposition reflects a division of decision making present in federally regulated markets. Administrators of orders are interested in the factors which affect the total flows of milk because they set prices, zone differentials, etc. But these prices and differentials should not be responsive to changes in the situations of individual handlers. Concentration on costs which are systematically related to differences in locations or in orders, therefore, fits the particular needs of the federal order administrators.

Milk Purchasing Costs. The specific schedules of zone differentials currently included in the orders result in Class I zone prices which are low for plants far from the order's basing point and high for plants close to the basing point.[10] From a handler's viewpoint, the zone price is a cost which must be met. Thus, dealers whose plants are located in the far away zones enjoy a cost advantage over handlers whose plants are located closer to the base point of the order, a cost advantage offset by greater transport costs.

Class II and blend prices are also adjusted by zone differentials. In the model, the blend price zone differential may cancel out the Class I price zone differential. A hypothetical illustration may show how this happens. Suppose a milk producer eight zones away from an order's base point delivers to a country plant in the eighth zone and that the dealer who owns the plant is regulated by the order. Suppose also that both the Class I and blend price zone differentials are 5 cents per zone, that the base Class I price is $7, and that the base blend price is $6.50.[11] Then the zone Class I price would be $6.60 and the zone blend price would be

[9] These costs are included because they depend on the distance between the milk production area, and the market area.

[10] If producer deliveries are shipped directly from farm to city plant, the Class I zone price is determined by the location of the city plant. If the milk is routed through a country receiving station to a city plant, the zone price is set by the location of the country plant.

[11] One final assumption is also needed: location differentials and other adjustments do not apply.

$6.10. The model subtracts total market costs from the objective value and adds total producer returns. The 5-cent zone differential would lower costs 40 cents in the above example, but it would also lower total producer returns 40 cents. Hence, the two zone differentials would cancel each other out, and would not affect the model's solution.

Class I and blend price zone differentials cancel each other only if they are equal. To allow for the possibility of unequal differentials, and to account for location differentials (which are used in special cases to modify the value of zone blend prices), the model allows for the explicit incorporation of the Class I and blend differentials. However, these differentials are kept separate from the base Class I and blend prices, and are entered as a remainder obtained by subtracting the blend price zone and location differentials, if any, from the Class I zone differential.

Country Plant Cost. The per unit cost of operating a milk receiving station is assumed to be constant over the whole range of plant operation. Whatever economies of scale exist are ignored. Moreover, this cost is considered to be the same for all country plants regardless of their location in the Northeast. Where production areas are near a major market, direct delivery is the most efficient method of milk delivery to a city plant. Thus, dealers are assumed to bypass the operation of a country plant whenever possible. Only where the distance between production and consumption areas is relatively long are milk handlers presumed to incur the cost of operating a country plant.

Transportation Costs. Besides the costs of purchasing the milk supply and the costs of operating a country plant, handlers also have transportation costs. The transportation rates which connect any pair of producing and consuming areas applies to the shipping of bulk fluid milk. These rates are assumed to be independent of the volume shipped and a linear function of the distance covered. Thus, the farther away supply is located from a market, the greater the handler's transportation cost. Those transportation rates applying to shipments between markets are rates for shipments of processed milk products. The finished milk product rates are also considered to be independent of the volume shipped and a linear function of the distance covered.

E. Interorder Shipments

Shipments of Class I milk from a production area to a market are presumed to be of unprocessed milk. All city plants are assumed to be located at the markets, and the majority of milk processed in each city plant is considered to be sold in the market in which the plant is located. The order regulating the plant is, therefore, the order of the market containing the plant.

Country plants are assumed to be located in the production areas. A country plant shipping milk to two or more city plants in different markets is hypothetically split into two or more "splinter" plants by the model. Each hypothetical "splinter" plant is consequently regulated by the same order as the city plant to which it ships. Of course, if a country plant ships to only one market, it is regulated by that market's order and does not need to be conceptually split up. The hypothetical division of a country plant cannot affect country plant costs in

the model because these costs are considered to be a constant per unit figure. But the splitting procedure can bias the costs of purchasing milk. If a given country plant in a given production area ships milk to city plants in two different orders, both of the country plants' milk shipments will, in actuality, be regulated by whichever order has the larger shipment. In the model, however, each shipment would be regulated by the order controlling the city plant receiving the milk. Thus, the Class I and blend price for the milk which is computed by the model would be an average of the two orders' prices, while the actual Class I and blend prices would come from one of the orders.

The purpose of the assumptions in the previous two paragraphs is to specify the type of production-to-market shipments contained in the model. These assumptions rule out Class I milk regulated by one order being shipped from a production area to a market in a second order. Instead, interorder shipments are assumed to be intermarket shipments.

All intermarket shipments are assumed to be of processed milk. This situation is not always true in actuality, yet it greatly simplifies the model.[12] The justification for the set of assumptions is as follows. Large milk processing plants are more efficient than smaller plants.[13] To gain this efficiency a dealer needs to consolidate his processing into one operation. A large plant is best located at a major market, since unprocessed milk transportation rates are cheapest. The cost of transporting processed milk products is higher than bulk transportation rates, but is not high enough to offset the economies of centralized processing. Consequently, a dealer who sells most of his Class I milk in one market will find it advantageous to process all of his Class I milk in a plant located at that market and to ship finished milk products to any other market in which he sells.

Dealers who sell Class I milk in large quantities in more than one market might have more than one city plant. In most instances, each of the dealer's plants will supply the majority of its milk to the market in which it is located. The plant will, therefore, be regulated under that market's order. Since the model does not identify dealers, each plant of a multiple-plant dealer can, therefore, be treated as though it were owned by a different handler.

The growth of large city plants in the Northeast lends support to the type of shipment incorporated in the model. Also supporting the assumed type of shipment is the fact that most interorder shipments are made by larger handlers.

F. The Formal Model

Presentation of the model in a more formal manner will serve two purposes. It will pull together and summarize the foregoing description, and it will provide a concise symbolic statement of the assumptions, objectives, and constraints of the study. Since the linear programming technique is used to solve the model, the formal

[12] For example, the assumptions allow the number of shipments incorporated in the model to be reduced from 816 to 200. They also lead to unique solutions in cases where the 816 shipment model does not. The larger model is explored in an unpublished master's theses by Yehoshua Tidhar (University of Connecticut, 1969).

[13] Babb, Emerson. *Op. Cit.*

presentation will be as a linear programming problem. First an objective equation will be specified, and then a series of linear side conditions will be given which must be met by the objective equation.

The studies' objective is to maximize:

$$\Sigma_h W_h - \Sigma_i \Sigma_j (c_{ij} + t_{ij} + d_{ij}) X_{ij} - \Sigma_j \Sigma_k (p_j + S_{jk}) Y_{jk} \qquad (1)$$

where

- i = 1, . . ., 17 represents the production areas
- j,k = 1, . . ., 8 represents the markets
- h = 1, . . ., 6 represents the orders
- c_{ij} = per unit country plant cost
- t_{ij} = per unit cost of transporting raw milk from i to j
- d_{ij} = difference between: (1) Class I zone differentials plus any Class I location differentials, and (2) blend price zone differentials plus any blend price location differentials
- p_j = Class I base price (nearby zone) for market j
- s_{jk} = per unit cost of transporting processed milk from market j to market k
- X_{ij} = units of raw milk at source i to be shipped to market j
- Y_{jk} = units of processed milk at market j to be shipped to market k
- W_h = total producer returns (equals blend price of order h multiplied by the total producer deliveries regulated under order h)

Marketing costs are minimized and producer returns (W_h) are maximized in equation (1). Three costs are associated with shipments from the production areas to the markets. They are the country plant cost (c_{ij}), the transportation cost (t_{ij}), and a "net" zone differential (d_{ij}). With each market is associated a Class I fluid milk price (p_j). In addition, if an intermarket transfer of bottled milk is made, a second transportation cost is charged (s_{jk}). The objective equation treats the costs as items to be subtracted from each order's total producer returns.

Class I prices at the plant zone where the milk is first delivered are considered to be the relevant purchase prices for the raw milk. Blend prices adjusted by zone and location differentials are the average producer returns which are to be maximized. The plant zone prices are separated in the objective equation into (1) Class I and blend prices quoted at the basing points of the orders, and (2) Class I and blend zone and location differentials.

Two types of shipments are included in the study. One type denoted by X_{ij} is from a production area (i) to a market (j). These type one shipments cannot exceed the supplies of milk available at each production point:

$$\sum_{j=1}^{8} X_{ij} \leqslant S_i \qquad i=1, \ldots, 17 \qquad (2)$$

S_i is the total supply of raw milk at source i.

The second type of shipment denoted by Y_{jk} is an intermarket shipment. Enough of these shipments must take place to satisfy the demands at each market:

$$\sum_{j=1}^{8} Y_{jk} \geqslant D_k \qquad k=1, \ldots, 8 \qquad (3)$$

D_k is the total Class I milk demanded in market k. Note that psuedo-shipments

from each market to itself are included in equation (3) so that milk can be consumed in the market in which it is processed.

One additional set of supply-demand constraints is needed. These constraints insist that all milk shipped from the production areas be consumed as Class I milk:

$$\sum_{i=1}^{17} X_{ij} - \sum_{k=1}^{8} Y_{jk} = 0 \qquad j=1, \ldots, 8 \tag{4}$$

Thus, milk to be used in manufactured products is left at the point of production.

A simple majority rule is used to determine the order under which a handler is regulated: a handler regulated under an order must dispose of at least 51 percent of his total Class I sales (ie., of the sales in all six orders) within the markets of the regulating order. The remaining 49 percent of the milk can be distributed in any market. The majority rule's macro counterpart is that 51 percent of the Class I sales regulated under an order must be sold in the order's marketing areas. This simplified and aggregated formulation is used in the study to approximate the federal order's pooling requirements.

The markets in each order are:

Order 1 - Markets 1 and 2
Order 2 - Market 3
Order 3 - Markets 4 and 5
Order 4 - Market 6
Order 5 - Market 7
Order 6 - Market 8

The majority rule for Order 1 is:

$$\sum_{j=1}^{2} \sum_{k=1}^{2} Y_{jk} \leqslant .51 \sum_{j=1}^{2} \sum_{k=1}^{8} Y_{jk} \tag{5}$$

The first pooling constraint, which is an alternative form of the majority rule, is:

$$.51 \sum_{j=1}^{2} \sum_{k=3}^{8} Y_{jk} - .49 \sum_{j=1}^{2} \sum_{k=1}^{2} Y_{jk} \leqslant 0 \tag{6}$$

The first set of terms in equation (6) is the sum of all shipments regulated under the first order into markets outside the order. Shipments to markets within the order appear in the second set of terms. As can be seen, at least 51 percent of the sales must be within the order.

Similar pooling constraints are developed for the other orders.
For Order 2, the constraint is:

$$.51 \sum_{\substack{k=1 \\ k \neq 3}}^{8} Y_{3k} - .49\, Y_{33} \leqslant 0 \tag{7}$$

For Order 3, it is:

$$.51 \sum_{j=4}^{5} \left(\sum_{k=1}^{3} Y_{jk} + \sum_{k=6}^{8} Y_{jk} \right) - .49 \sum_{j=4}^{5} \sum_{k=4}^{5} Y_{jk} \leqslant 0 \tag{8}$$

While for Order's 4, 5, and 6, the pooling constraints are:

$$.51 \sum_{\substack{k=1 \\ k\neq j}}^{8} Y_{jk} - .49Y_{jj} \leq 0 \qquad j=6, 7, 8 \tag{9}$$

Total producer returns (before adjustment by zone and location differentials) are computed by a series of equations. The derivation of these equations was shown earlier in Subsection C, titled "Computation of Producer Income." The constraints used to compute the producer returns in the model were shown there to be:

$$W_h-(p_h-m_h)Z_h = (p_h-m_h)e_h+(m_h+a_h)v_h \tag{10}$$

W_h and Z_h are the variables in these constraints. The other coefficients are assumed to be data. Z_h is computed by a set of "regulated deliveries" conditions. The regulated deliveries constraints are:

For Order 1

$$\sum_{j=1}^{2} \sum_{k=1}^{8} Y_{jh}-Z_1 = 0 \tag{11}$$

For Order 2

$$\sum_{k=1}^{8} Y_{3k}-Z_2 = 0 \tag{12}$$

For Order 3

$$\sum_{j=3}^{4} \sum_{k=1}^{8} Y_{jk}-Z_3 = 0 \tag{13}$$

For Orders 4, 5, and 6

$$\sum_{k=1}^{8} Y_{jk}-Z_{j-2} = 0 \qquad j=6, 7, 8 \tag{14}$$

Once Z_h is known, the producer return constraints determine W_h.

THE DATA

The data requirements of the model and the methods used to derive and estimate this data are presented in this section.

A. Area Delineation

Production Areas

The study divides the Northeast into 17 dairy production areas. These areas are modifications of the 20 areas developed by the NEDA Committee.[14] The twenty production areas have been recombined and adjusted so that area boundaries coincide with county lines and with borders of the Northeastern Federal Milk

[14] *Dairy Adjustments in the Northeast, An Analysis of Potential Production and Market Equilibrium.* New Hampshire Agricultural Experiment Station, Bulletin 498, June 1968, p. 11-12.

Orders.[15] The NEDA Committee based its stratification of areas on climate, topography, soils, and marketing outlets. Most of these considerations still apply to the current redivision. Of the 17 production areas, seven are distant areas: they lie outside the boundaries of the orders. The other 10 areas are near production areas.

For each production area, a representative point is selected. The points which have been chosen approximate the "center of gravity" of milk production in the area. These points are also at large enough population centers so that there exists information on distances between them. The northeastern dairy production areas and their representative points are presented in tabular form in Table 3, and in map form in Figure 2.

TABLE 3. Northeastern Dairy Production Areas

Area Number	Production Area	Central Point	Type Of Area
1	Central and Southern Maine	Augusta, Maine	Distant
2	Southern New Hampshire	Concord, N. H.	Near
3	Northern Vermont-Northwestern New Hampshire	Hyde Park, Vermont	Distant
4	Southern Vermont-Southwestern New Hampshire	Rutland, Vermont	Distant
5	Southeastern Massachusetts-Rhode Island	Boston, Massachusetts	Near
6	Western Massachusetts	Northhampton, Mass.	Near
7	Connecticut	Hartford, Conn.	Near
8	Hudson Valley-New York	Poughkeepsie, N. Y.	Near
9	Northern New York	Ogdensburg, N. Y.	Distant
10	Oneida, Mohawk and Black River Valleys-Eastern Plateau of New York	Oneonta, New York	Near
11	Central Plain of New York-Southern New York-Northern Pennsylvania	Hornell, New York	Distant
12	Western Pennsylvania-Northern West Virginia-Western Maryland	Pittsburgh, Pennsylvania	Distant
13	Northern New Jersey-Eastern New York	Middletown, New York	Near
14	Southern Pennsylvania-Northern Delaware-Southern New Jersey	Norristown, Pennsylvania	Near
15	Central Pennsylvania-Western Maryland-Eastern West Virginia	Lewistown, Pennsylvania	Distant
16	Eastern Maryland-Southern Delaware	Baltimore, Maryland	Near
17	Central Maryland-District of Columbia-Eastern Virginia	Frederick, Maryland	Near

[15]A complete listing the production areas and of the counties in each of them appears in Appendix A.

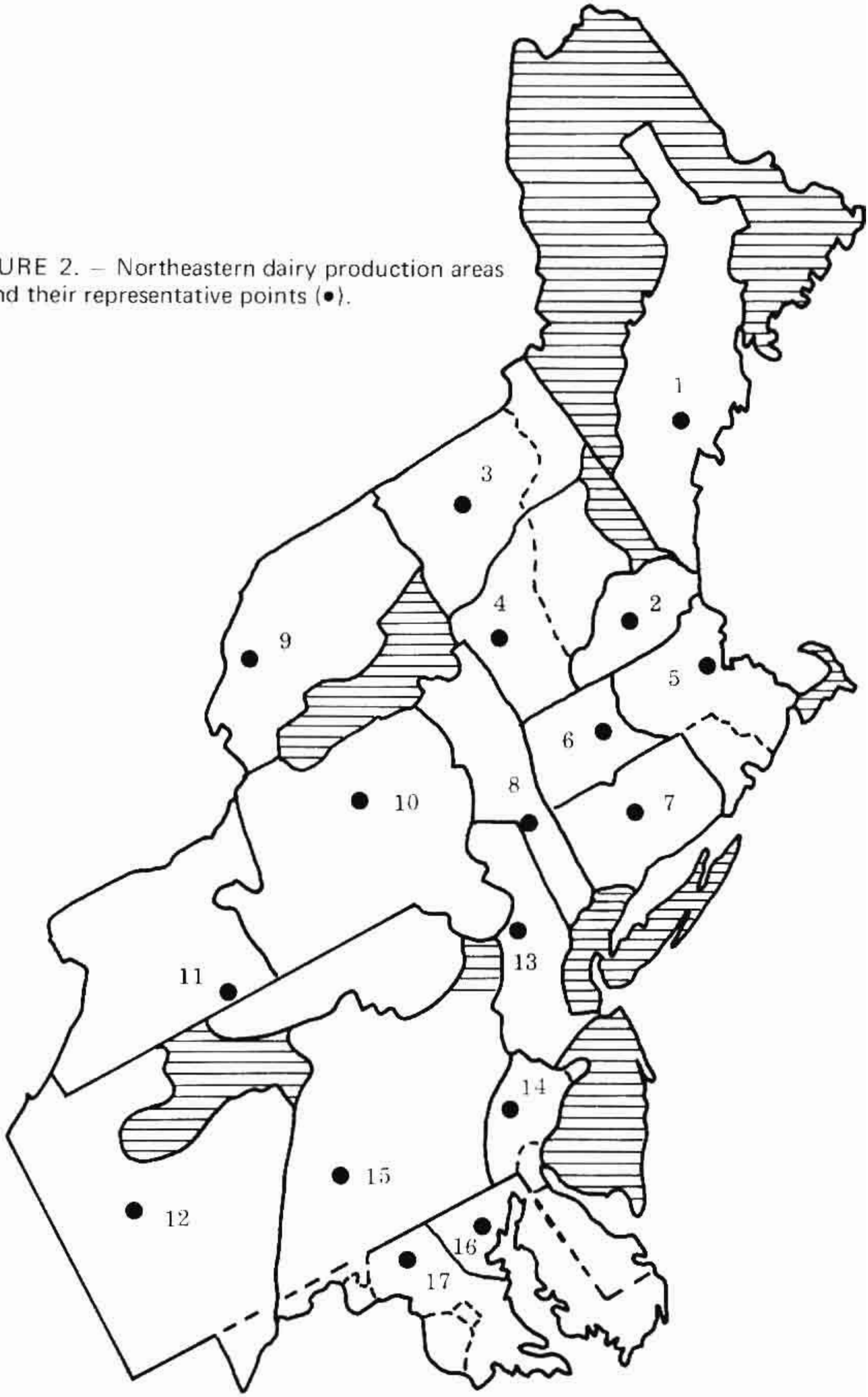


FIGURE 2. — Northeastern dairy production areas and their representative points (•).

Consumption Areas

The Northeast is partitioned into 15 fluid milk consumption areas which are shown together with their representative points in Table 4 and Figure 3. Seven of these areas coincide with the seven distant production areas. The remaining eight consumption areas cover the marketing areas of the six northeastern orders. They are the near consumption areas. The boundaries of all consumption areas also follow county lines and no overlapping exists. Usually, only one near consumption area corresponds to a federal order's marketing area. However, in the case of the Massachusetts-Rhode Island-New Hampshire and the New York-New Jersey orders, the marketing area of each order is represented by two consumption areas. This is done to more realistically take into account the spatial dispersion of consumers.

The largest population center in each of the near consumption areas is chosen as the representative point for that area. For the distant areas, the representative points are the same as those of the corresponding distant production areas.

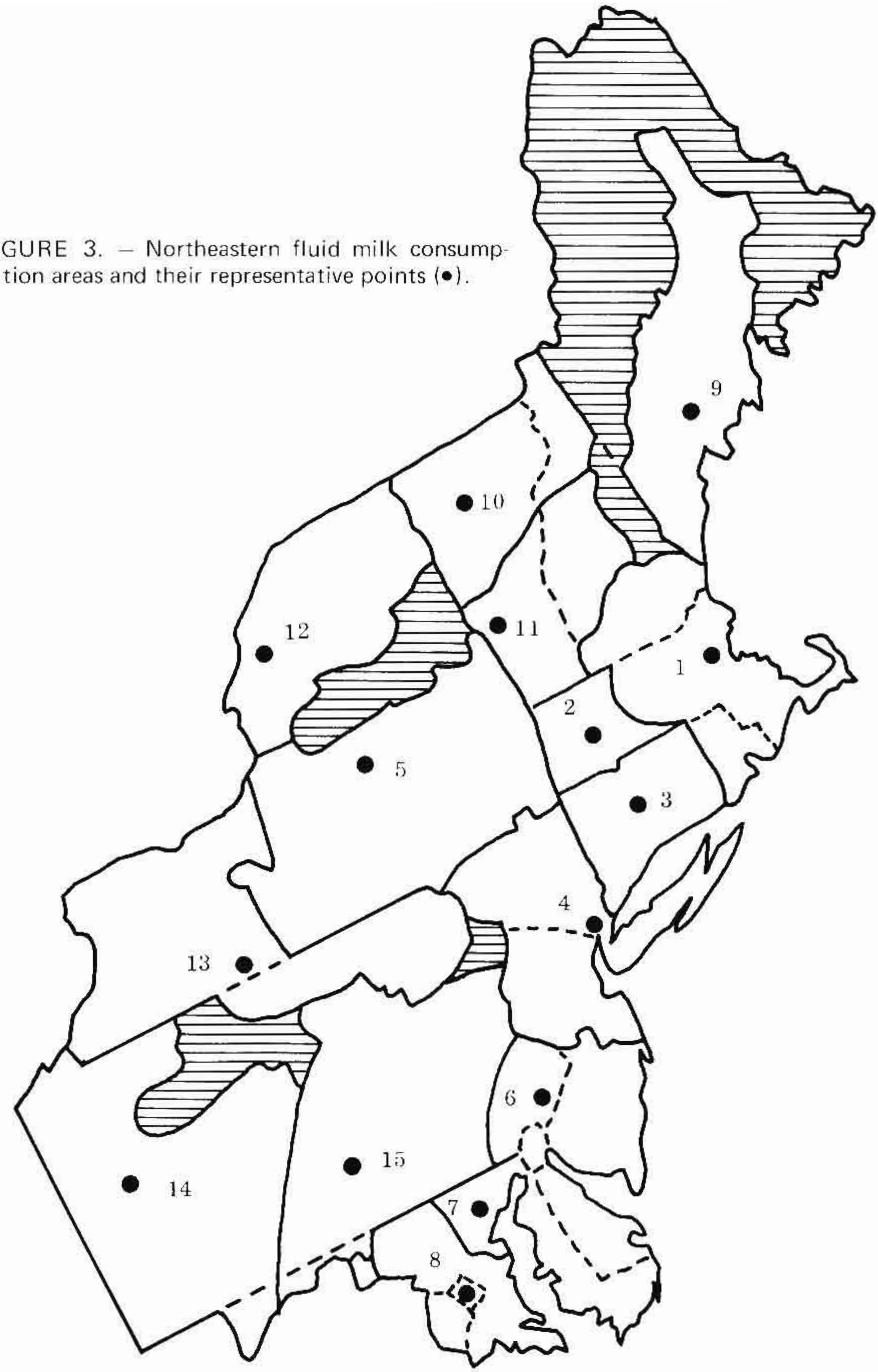
Federal Orders

Marketing areas of the six federal orders which were operating in the Northeast in August 1968, adjusted to county lines are shown in Figure 1.

TABLE 4. Northeastern Fluid Milk Consumption Areas

Area Number	Consumption Area	Central Point	Type Of Area
1	Southern New Hampshire-Eastern Massachusetts-Rhode Island	Boston, Massachusetts	Near
2	Western Massachusetts	Springfield, Mass.	Near
3	Connecticut	Hartford, Conn.	Near
4	Eastern New York-New Jersey	New York, New York	Near
5	Central New York	Utica, New York	Near
6	Delaware Valley: Southern New Jersey, Eastern Pennsylvania, Northern Delaware	Philadelphia, Pennsylvania	Near
7	Upper Chesapeake Bay: Delaware, Eastern Maryland	Baltimore, Maryland	Near
8	Washington, D. C.; Central Maryland, Northern Virginia	Washington, D. C.	Near
9	Central and Southern Maine	Augusta, Maine	Distant
10	Northern Vermont-Northwestern New Hampshire	Hyde Park, Vermont	Distant
11	Southern Vermont-Southwestern New Hampshire	Rutland, Vermont	Distant
12	Northern New York	Ogdensburg, N. Y.	Distant
13	Central Plain of New York-Southern New York-Northern Pennsylvania	Hornell, New York	Distant
14	Western Pennsylvania-Northern West Virginia Western Maryland	Pittsburgh, Pennsylvania	Distant
15	Central Pennsylvania-Western Maryland-Eastern West Virginia	Lewistown, Pennsylvania	Distant

FIGURE 3. – Northeastern fluid milk consumption areas and their representative points (•).



Each federal order has one or more basing points for determining Class I, Class II, and blend prices. This study uses only one basing point for each order. The basing points for the six orders in the Northeast are given in Table 5, which also includes an internal identification system for the orders, and a list of the consumption areas corresponding to each order's marketing area.

TABLE 5. Northeastern Federal Orders And Their Basing Points

Federal Marketing Order	Federal Identification Number	Internal Identification Number	Basing Point	Consumption Areas Included In Order
Massachusetts-Rhode Island-New Hampshire	1001	1	Boston, Mass.	1, 2
Connecticut	1015	2	Hartford, Conn.	3
New York-New Jersey	1002	3	New York, N. Y.	4, 5
Delaware Valley	1004	4	Philadelphia, Penn.	6
Upper Chesapeake Bay	1016	5	Baltimore, Md.	7
Washington, D. C.	1003	6	Washington, D. C.	8

B. Milk Production

Monthly milk production in each of the 17 production areas for August 1968 was estimated as follows:

(1) Total milk production for each of the northeastern states was determined for August 1968.[16]

(2) The amount of milk sold as whole milk in 1964 was obtained for each of the northeastern states, and for the counties within the 17 production areas.[17]

(3) Each county's 1964 whole milk sales were expressed as a proportion of the total whole milk sold in the state in which the county is located.

(4) Each state's total milk production in August 1968 was multiplied by the corresponding proportions derived in Step 3. The result is the estimate of milk production in each county for August 1968.

(5) The estimates of milk production obtained in Step 4 were summed for all counties composing a production area. The resulting August 1968 milk production estimates are presented in Table 6.

C. Fluid Milk Consumption

Two approaches are used to estimate fluid milk consumption for August 1968. In the near consumption areas, fluid milk consumption is estimated from data on Class I sales under the six federal orders. In the distant areas, population and per capita

[16] USDA, SRS, CRB, *Milk Production*. (Washington, D. C.: Government Printing Office, September 11, 1968), p. 3.

[17] The amount of milk sold as whole milk is the closest available approximation to actual milk production on a county basis. 1964 figures are the latest figures available on these county sales. U. S. Bureau of the Census. *Census of Agriculture, 1964, Statistics for the State and Counties*. (Washington, D. C.: Government Printing Office, 1967).

TABLE 6. Estimated Total Milk Production, Northeastern Production Areas, August 1968

Production Area Number	Total Milk Production (1,000 Pounds)
1	50,066
2	16,566
3	116,502
4	49,074
5	41,492
6	20,994
7	52,035
8	85,855
9	100,870
10	343,497
11	311,216
12	142,413
13	71,991
14	43,839
15	266,509
16	73,433
17	47,474
TOTAL	1,833,826

consumption figures provide the basis for ascertaining the August 1968 fluid milk consumption.

Class I sales in August 1968 provide an accurate estimate of the fluid consumption in the near areas. Consumption Areas 3, 6, 7, and 8 are within a single federal order; the fluid milk consumption in these areas is the same as consumption of Class I milk in the order's marketing area. Consumption Areas 1 and 2 are in Federal Order 1 and Areas 4 and 5 are in Order 3. Class I milk marketed in each of these order's must, therefore, be divided between the two consumption areas making up the order. This division is done according to the proportion of the order's population which is in each consumption area.[18] In the case of Order 1, the proportion of the order's total population in Area 1 is 89 percent, while that in Area 2 is 11 percent. Hence, the total Class I milk marketed in Order 1 is apportioned on an 89-11 basis between Consumption Area 1 and 2 respectively. Similarly, 87 percent of the total population of Order 3 is located in Area 4, and 13 percent is located in Area 5. Thus, Area 4 accounts for 87 percent of the Class I milk marketed in Order 3 and the rest is consumed in Area 5. Table 7 presents the estimated fluid milk consumption in each of the eight near consumption areas.

Estimates of fluid milk consumption for the distant consumption areas are shown in Table 8. Data is not available on Class I sales in the distant consumption areas. Therefore, estimates for these areas are derived using the following procedure:

(1) The total population in August 1968 was determined for each of the

[18]Population figures were obtained from each state in the Northeast. They constituted the latest available estimates, and gave in addition to state totals a breakdown by counties in each state.

TABLE 7. Estimated Total Fluid Milk Consumption, By Near Consumption Areas, August 1968

Consumption Area Number	Total Fluid Milk Consumption (1,000 Pounds)
1	162,555[a]
2	20,091[a]
3	72,470[b]
4	393,923[c]
5	60,953[c]
6	106,876[d]
7	37,129[c]
8	50,037[f]
TOTAL	904,034

[a]Total Class I milk in marketing area of Order 1 includes 4,538,000 lbs. reported as disposed in non-regulated markets in Massachusetts, and 83,000 lbs. reported sold in Rhode Island non-regulated markets.

SOURCE: Market Administrator - Massachusetts-Rhode Island-New Hampshire Marketing Area, *Monthly Statistical Report,* August 1968 (September 25, 1968), p. 1.

[b]SOURCE: Market Administrator - Connecticut Marketing Area, *Monthly Statistical Report for August 1968,* (September 25, 1968), p. 1.

[c]Total Class I milk in Order 3's marketing area includes 11,359,000 lbs. of Class I receipts from Order 4.

SOURCES: Market Administrator, New York-New Jersey Milk Marketing Area, *August 1968 Uniform Price Announcement* (September 13, 1968), and unpublished report received from the market administrators' offices in Orders 3 and 4.

[d]Total Class I milk in marketing area includes 9,303,000 lbs. of Class I receipts from Orders 3 and 5.

SOURCES: "Announcement of Uniform Price for Order 4 Producer Milk, August 1968," Inter-State Milk Producers Review (Philadelphia, Pa., September 1968), p. 6, and unpublished report obtained from Order 4 market administrator office.

[e]SOURCE: Unpublished tabulation received from market administrator's office in Order 5.

[f]SOURCE: Unpublished information from market administrator's office in Order 6.

counties composing the distant consumption areas.[19]

(2) These population figures were multiplied by the per capita consumption of fluid milk in the state (or the part of the state) in which the county is located.[20]

[19]The counties included are the same as those in the distant production areas, a list of which appears in Appendix B. Population data are taken from the latest available estimates for the northeastern states.

[20]Per capita fluid milk consumption values were provided by Stewart Johnson, Department of Agricultural Economics, University of Connecticut, Storrs, Connecticut. These values vary among states and parts of states in the Northeast because of the influence that income, residential location, and general consumption habits have on the consumption of fluid milk products. Specific values used in the estimation procedure are given in Table 8.

TABLE 8. Population, Per Capita Consumption of Fluid Milk, And Estimated Total Fluid Milk Consumption, Distant Consumption Areas, August 1968

Consumption Area Number	Population In Area	Per Capita Consumption Of Fluid Milk (Pounds/Month)	Total Fluid Milk Consumption (1,000 Pounds)
9	827,028	26.5	21,916
10	266,550	26.5	7,064
11	238,292	26.5	6,315
12	328,970	26.5	8,718
13	3,498,997	26.5 for New York 24.7 for Pennsylvania	91,334
14	4,155,870	24.7 for Pennsylvania 23.3 for West Virginia and Maryland	102,495
15	3,087,320	24.7 for Pennsylvania 23.3 for West Virginia and Maryland	75,903

The product of this multiplication is the estimate of fluid milk consumption for the county in August 1968.

(3) The estimates of milk consumption were added together for all the counties in a distant consumption area, to yield the August 1968 estimates of the areas fluid milk consumption.

D. Potential Supply Sources And Net Supplies Of Milk

Only distant production areas that have surplus production can be considered as potential supply sources for the near consumption areas. All seven distant production areas turned out to be surplus areas, and are thus considered potential supply sources.

The net supplies of milk in each of these areas are calculated by subtracting local fluid milk consumption from local production. These net supplies constitute the milk available in the distant areas to handlers regulated under the six orders. For the near production areas, the net supply is the total milk production in the area. August 1968 net supplies of milk by production areas are presented in Table 9.

E. Total Producer Deliveries, Class I Usage, And Class I Sales Outside The Six Marketing Areas, For Northeastern Orders

Total producer deliveries to handlers regulated under each order, Class I usage in each order, and Class I sales outside the northeast orders by regulated handlers are presented in Table 10. Producer deliveries and Class I usage are available from USDA publications.[21] Class I sales outside the six marketing areas are more

[21] USDA, CMS, Dairy Division. *Federal Milk Order Market Statistics, August 1968 Summary*, (Washington, D. C.: Government Printing Office, October 1968), p. 8 and 10.

TABLE 9. Net Supply Of Milk, Production Areas, August 1968

Production Area Number	Net Supply Of Milk (1,000 Pounds)
1	28,150
2	16,566
3	109,438
4	42,759
5	41,492
6	20,994
7	52,035
8	85,855
9	92,152
10	343,497
11	219,882
12	39,918
13	71,991
14	43,839
15	190,606
16	73,433
17	47,474
TOTAL	1,520,081

TABLE 10. Total Producer Deliveries, Class I Usage, And Class I Sales Outside The Six Marketing Areas, By Federal Orders, August 1968

Federal Order Number	Total Producer Deliveries (1,000 Pounds)	Class I Usage (1,000 Pounds)	Class I Sales Outside Six Marketing Areas (1,000 Pounds)
1	289,011	179,307	3,119[a]
2	91,915	72,152	445[b]
3	781,828	454,822	4,555[c]
4	184,175	128,682	18,349[d]
5	76,884	47,694	8,802[e]
6	93,392	61,315	4,668
TOTAL	1,517,205	943,972	39,938

[a]Market Administrator - Massachusetts-Rhode Island-New Hampshire Marketing Area, *Monthly Statistical Report, August 1968.* (September 25, 1968), p. 1.

[b]Market Administrator - Connecticut Marketing Area, *Monthly Statistical Report for August 1968.* (September 25, 1968), p. 1.

[c]Market Administrator, New York-New Jersey Milk Marketing Area, *August 1968 Uniform Price Announcement.* (September 13, 1968).

[d]Unpublished report obtained from Order 4's market administrators' office.

[e]Unpublished tabulation from market administrator's office in Order 5.

[f]Unpublished tabulation from market administrator's office in Order 6.

difficult to obtain, and requests for detailed information directed to the market administrators of several orders encountered the problem of confidentiality. Therefore, the values of this parameter are approximations only.

F. Class Prices

Class I Prices

This study examines three alternative schedules of interorder Class I prices for the northeastern orders. Proposal 1 contains the values prevailing in August 1968 while Proposals 2 and 3 suggest reductions in certain of the interorder price differentials of Proposal 1. Price differentials can be altered either by lowering the high price or by raising the low price. The approach chosen here is to change the differentials by raising the low prices. Class I prices have been going up consistently. Dairy farmers favor the high prices, and will probably oppose any attempt to change differentials by lowering Class I prices. Therefore, changes in differentials seem more likely to come in the form of price rises.

New interorder price differentials mean that the Class I prices in the six orders will be different for each of the three proposals. Table 11 presents the three sets of Class I prices used in the study. The prices that appear under the heading of Proposal 1 are the actual Class I prices existing in August 1968. In Proposal 2, the differential between Orders 4, 5 and 6 is eliminated. This is done by raising the nearby price of Orders 5 and 6 from $6.83 to $6.93. Thus, Proposal 2 reflects the 1970 merger of the southernmost three orders. Proposal 3 reduces the 18 cent differential between Order 3 and Orders 1 and 2 to 10 cents. The reduction is made by raising the 201-210 mile zone price in Order 3 from $6.49 to $6.57. In addition, prices in Orders 5 and 6 are readjusted so as to maintain the same differentials as those embodied in Proposal 2. Consequently, Proposal 3 also accounts for the merger.

Class II Prices

The Class II prices which existed in August 1968 are taken to hold for all three

TABLE 11. Class I Prices In Distant And Nearby Zones, By Northeastern Orders, And By Proposals

	Proposal 1[a]		Proposal 2		Proposal 3	
Order Number	201-210 Mile Zone ($/cwt.)	Nearby Zone ($/cwt.)	201-210 Mile Zone ($/cwt.)	Nearby Zone ($/cwt.)	201-210 Mile Zone ($/cwt.)	Nearby Zone ($/cwt.)
1	6.67	7.07	6.67	7.07	6.67	7.07
2	6.67	7.07	6.67	7.07	6.67	7.07
3	6.49	6.73	6.49	6.73	6.57	6.81
4[b]	6.46	6.93	6.46	6.93	6.54	7.01
5[b]	6.51	6.83	6.61	6.93	6.69	7.01
6[b]	6.51	6.83	6.61	6.93	6.69	7.01

[a]SOURCE: USDA, CMS, *Federal Milk Order Market Statistics, August 1968 Summary*, (Washington, D. C.: Government Printing Office, October 1968), p. 4.

[b]In the three southern orders, the distant zone is actually the 196-205 mile zone, not the 201-210 mile zone.

TABLE 12. Class II Prices Nearby Zone, By Federal Orders, August 1968

Order Number	Class II Price ($/cwt.)
1	$4.36
2	4.36
3	4.39
4	4.38
5	4.32
6	4.32

SOURCE: USDA, CMS *Federal Milk Order Market Statistics, August 1968 Summary*, (Washington, D. C.: Government Printing Office, October 1968), p. 10.

proposals. Table 12 given these prices for each federal order.

G. Country Plant Costs

Information about the operating costs of country plants in the Northeast is very limited. Available estimates show the costs to vary over a wide range. David Arms of the Cooperative Dairy Economics Service reports a range of 9-14 cents/cwt.[22] According to Arms, these costs cover both fixed and variable operating cost. Another source suggests 18 cents/cwt. as a reasonable cost.[23] Until more data become available it seems appropriate to use a cost which falls in between the extremes cited above. The cost which represents country plant operating costs in this study is 15 cents/cwt.

H. Distances Between Plants and Basing Points In The Northeastern Orders

Knowledge of the distances between all production areas (where country plants are located), near consumption areas (where city plants are located), and the basing points of the six northeastern orders is required in order to correctly determine the plant zones, and thus the zone differentials which apply to any plant regulated under any of the orders. These distances are given in Table 13. They are the shortest practical truck routes and they are taken from the mileage guide used by the market administrators.[24]

Direct Delivery Shipments

Specification of the shipments which are direct delivery shipments is based on observations of the actual milk flows in the Northeast.[25] Only 30 routes are

[22]David Arms, "Class I and Blended Zone Price Differentials," Cooperative Dairy Economics Service (Boston, Massachusetts: June 27, 1966) p. 3.

[23]USDA, CMS, Dairy Division, *Proposed Amendments to Connecticut and Massachusetts-Rhode Island Federal Order Markets (Hearing from June 20 through July 1, 1966)*, Brief of September 16, 1966, p. 5.

[24]Household Goods Carriers Bureau, Agent, *Mileage Guide No. 8*, (Washington, D. C.: September 20, 1966).

[25]Stewart Johnson, University of Connecticut, Storrs, Connecticut, provided the list of direct shipment areas.

TABLE 13. Distances In Miles Between Production Areas, Near Consumption Areas, And Basing Points Of The Northeastern Orders

Area	Boston (1)	Hartford (2)	New York City (3)	Philadelphia (4)	Baltimore (5)	Washington, D.C. (6)
Production Area 1	164	262	375	465	562	601
Production Area 2	70	139	252	342	439	478
Production Area 3	213	222	338	416	505	544
Production Area 4	159	151	242	320	409	448
Production Area 5	0	98	211	301	398	437
Production Area 6	104	42	158	248	345	384
Production Area 7	98	0	117	207	304	343
Production Area 8	182	84	83	165	261	300
Production Area 9	360	319	369	387	444	483
Production Area 10	239	165	189	218	303	342
Production Area 11	409	335	302	275	268	307
Production Area 12	570	476	373	289	218	223
Production Area 13	227	127	63	140	225	264
Production Area 14	305	211	106	22	99	138
Production Area 15	435	337	239	160	132	156
Production Area 16	398	304	199	97	0	39
Production Area 17	443	349	244	142	45	48
Near Consumption Area 1	0	98	211	301	398	437
Near Consumption Area 2	85	23	140	230	327	366
Near Consumption Area 3	98	0	117	207	304	343
Near Consumption Area 4	211	117	0	90	199	225
Near Consumption Area 5	251	187	219	270	343	382
Near Consumption Area 6	301	207	90	0	97	142
Near Consumption Area 7	398	304	199	97	0	39
Near Consumption Area 8	437	343	225	142	39	0

considered to be direct delivery routes. Table 14 indicates which shipments are direct deliveries.

Transportation Costs of Unprocessed Milk

The costs of transporting the unprocessed milk are assumed to be independent of volume shipped, and a linear function of distance. A rate of 1.5 cents per 10 miles is considered representative of this transportation cost.[26] This rate is close to rates recently used in other location studies of milk. It covers the cost of moving milk by bulk truck from a country plant to city plant. It also is comparable to costs of shipping direct delivery from farm to city plant.[27] The 1.5 cents per 10 miles rate does not include the terminal cost. Terminal costs are taken to be included in the country plant operating cost and in the handling cost of city plants. The transportation costs per cwt. of milk between all 17 production areas and eight near consumption areas are presented in Table 15. The reader will note that some of the transportation costs are zero. This is a result of the deletion of local distribution and assembly costs from the model.

[26] *Federal Register*, Volume 33, No. 199 (Washington, D. C.: Government Printing Office, October 11, 1968), p. 15216.

[27] Ibid.

TABLE 14. List of Direct Delivery Shipments

Origin Production Area	Destination Near Consumption Area
2	1
2	2
2	3
4	2
5	1
5	2
5	3
6	1
6	2
6	3
7	1
7	2
7	3
7	4
8	2
8	3
8	4
8	5
10	5
13	4
13	6
14	4
14	6
14	7
14	8
16	6
16	7
16	8
17	7
17	8

Transportation Costs of Processed Milk

The model limits interorder milk shipments to shipments of processed milk. The cost of these intermarket shipments is also assumed to be a linear function of distance. Processed milk transportation rates are specified to be 1.8 cents per 10 miles for all intermarket transfers. This figure was chosen as representative on a judgement basis after scanning the rates published in a marketing research report by the United States Department of Agriculture.[28] The chosen figure of 1.8 cents lies between the highest and lowest of the published rates. Table 16 gives the distances between the near consumption areas, while Table 17 gives the intermarket transportation costs.

THE RESULTS

The milk marketing model presented earlier set out a combined objective of minimum marketing costs and maximum producer returns. This objective was met

[28] *Costs of Transportating Bulk and Packaged Milk,* Marketing Research Report 791, Economic Research Service, United States Department of Agriculture.

TABLE 15. Transportation Costs, In Cents/Cwt., Between Production Areas And Near Consumption Areas*

Production Area	Near Consumption Area 1	2	3	4	5	6	7	8
1	24.60	37.35	39.30	56.25	57.00	69.75	84.30	90.15
2	10.50	18.60	20.85	37.80	36.15	51.30	65.85	71.70
3	31.95	30.00	33.30	50.70	37.35	62.40	75.75	81.60
4	23.85	19.35	22.65	36.30	22.95	48.00	61.35	67.20
5	0.00	12.75	14.70	31.65	37.65	45.15	59.70	65.55
6	15.60	2.85	6.30	23.70	28.50	37.20	51.75	57.60
7	14.70	3.45	0.00	17.55	28.05	31.05	45.60	51.45
8	27.30	15.00	12.60	12.45	21.90	24.75	39.15	45.00
9	54.00	44.55	47.85	55.35	21.15	58.05	66.60	72.45
10	35.85	23.85	24.75	28.35	9.45	32.70	45.45	51.30
11	61.35	49.35	50.25	46.80	25.35	41.25	40.20	46.05
12	85.50	74.70	71.40	55.95	58.35	43.35	32.70	33.45
13	34.05	21.30	19.05	9.45	21.60	21.00	33.75	39.60
14	45.75	34.95	31.65	15.90	37.20	3.30	14.85	20.70
15	65.25	52.80	50.55	35.85	40.80	24.00	19.80	23.40
16	59.70	48.90	45.60	29.85	51.45	14.55	0.00	5.85
17	66.45	55.65	52.35	36.60	58.20	21.30	6.75	7.20

*Each element in the table is the product of multiplying 0.15 cents by the distance between a production area and a near consumption area. The source for the distances is: Household Goods Carriers Bureau, Agents, *Mileage Guide No. 8*, (Washington, D. C.: September 20, 1966).

TABLE 16. Distances In Miles Between Near Consumption Areas

	1 Boston	2 Springfield	3 Hartford	4 New York	5 Utica	6 Philadelphia	7 Baltimore	8 Wash., D.C.
1 Boston	0	85	98	211	251	301	398	437
2 Springfield		0	23	140	164	230	327	366
3 Hartford			0	117	187	207	304	343
4 New York				0	219	90	199	225
5 Utica					0	270	343	382
6 Philadelphia						0	97	142
7 Baltimore							0	39
8 Washington								0

for each of the sets of Class I prices[29] by solving three linear programming problems.[30] From the three solutions were obtained the optimum patterns of fluid milk transfers associated with each of the price sets, blend prices, implicit costs of deviating from the optimum shipment patterns, and total marketing costs of the type defined earlier in the objective equation. The results of the three solutions are

[29] These were: Price Set 1 Existing prices; Price Set 2 No 10¢ differential among three southernmost orders; Price Set 3 A reduction from 18¢ to 10¢ between New England and New York-New Jersey order.

[30] Funds for computer time were provided by the University of Maryland Computer Center.

TABLE 17. Transportation Costs In Cents Per Hundredweight Between Near Consumption Areas*

	1 Boston	2 Springfield	3 Hartford	4 New York	5 Utica	6 Philadelphia	7 Baltimore	8 Wash., D.C.
1 Boston		.153	.176	.380	.452	.542	.716	.787
2 Springfield			.041	.252	.295	.414	.589	.659
3 Hartford				.211	.337	.373	.547	.617
4 New York					.394	.162	.358	.405
5 Utica						.486	.617	.668
6 Philadelphia							.175	.256
7 Baltimore								.070
8 Washington								

*Based on an assumed rate of 1.8c per ten miles.

presented in this section. These results have meaning only within the assumptions and limitations of the economic model and the data used in this analysis.

Several other linear programming problems were solved in addition to those for the three price sets. These auxiliary solutions were used to test the validity of treating total producer deliveries as predetermined constants. August 1968 producer deliveries to each order were successively increased and decreased by approximately 5 percent. Neither the optimum shipment pattern nor the implicit solution values were affected by these changes. Consequently, the figures used for the producer deliveries could be off as much as 5 percent in either direction without affecting the results presented here.

A. Optimum Patterns of Class I Milk Shipments

Tables 18 and 19 give the optimum shipment pattern for the set of prices which actually existed in August 1968. Transfers of Class I milk from the production areas to the points of processing are shown in Table 18. Shipments from the city plants to the points of consumption are presented in Table 19. The two types of shipments are distinguished because of the assumption that all processing of fluid milk (other than cooling) takes place in the market areas. As a consequence, only unprocessed milk is shipped from the production areas to the consumption centers, and only processed milk products are transferred between the orders' consumption areas.

Approximately 904 million pounds of Class I milk is processed by the 1968 model. Fourteen production areas supplied this milk. All of the near production areas shipped to the Northeast Orders and of these near areas, only Oneonta, New York, had some surplus milk left for diversion to other uses. Two of the seven distant production areas shipped all of their net milk supplies (i.e., production in excess of local needs) to the Northeast Orders; these two were Augusta, Maine and Rutland, Vermont. The distant production areas centered at Hyde Park, Vermont and Lewistown, Pennsylvania, provided some but not all of their net milk supplies to the federal order markets. The remaining distant areas – Ogdensburg, New York, Hornell, New York, and Pittsburgh, Pennsylvania – marketed no milk at all in the

TABLE 18: Optimum Class I Shipments From Supply Areas To Processing Points For Price Set I

Million Pound Units

Supply Area ↓ / Processing Point →	1 Boston	2 Springfield	3 Hartford	4 N.Y.	5 Utica	6 Phil.	7 Baltimore	8 Wash.,D.C.	Total Delivered From Supply Area	Quantity Left At Supply Point
1 Augusta, Me.	28.2								28.2	
2 Concord, N.H.	16.6								16.6	
3 Hyde Park, Vt.	53.1								53.1	56.3
4 Rutland, Vt.		42.8							42.8	
5 Boston, Mass.	41.5								41.5	
6 Northhampton, Mass.	21.0								21.0	
7 Hartford, Conn.			52.0						52.0	
8 Poughkeepsie, N.Y.				85.9					85.9	
9 Ogdensburg, N.Y.										92.2
10 Oneonta, N.Y.				236.1	61.0				297.0	46.5
11 Hornell, N.Y.										219.9
12 Pittsburgh, Penn.										39.9
13 Middletown, N.Y.				72.0					72.0	
14 Norristown, Penn.						43.8			43.8	
15 Lewistown, Penn.						29.3			29.3	161.3
16 Baltimore, Md.						23.4		50.0	73.4	
17 Frederick, Md.							47.5		47.5	
TOTAL DELIVERED TO PROCESSING POINT	160.4	42.8	52.0	394.0	61.0	96.5	47.5	50.0	905.1	616.1

TABLE 19: Optimum Class I Shipments From Processing Points To Markets For Price Set 1

Million Pound Units

Processing Point ↓ / Market →	1 Boston	2 Springfield	3 Hartford	4 N. Y.	5 Utica	6 Phil.	7 Baltimore	8 Wash., D.C.	Quantity Of Milk Processed
1 Boston	160.3								160.3
2 Springfield	2.2	20.1	20.4						42.7
3 Hartford			52.0						52.0
4 New York				393.9					393.9
5 Utica					61.0				61.0
6 Philadelphia						96.5			96.5
7 Baltimore						10.3	37.1		47.4
8 Washington, D.C.								50.0	50.0
QUANTITY OF MILK CONSUMED	162.5	20.1	72.4	393.9	61.0	106.8	37.1	50.0	903.8

Northeast Federal Order Marketing Areas.

The shipment pattern just described illustrates one of the properties of a linear programming model. An actual production area with a 100 percent Class I milk utilization is unlikely. Yet, such utilizations are common in the solution of the study's model due to its inherent assumptions of frictionless markets and uniformly efficient dealers. Adjustments to compensate for these assumptions could be made by subtracting some milk from the net supplies of each production area (cf., Table 9.). The subtracted milk is presumed to be utilized as Class II milk. Less Class I milk is then available to be transferred to the orders from a particular production area and the model will compensate by shipping milk from more production areas. Such adjustments were not made in this study because their purpose is to approximate what has actually occurred. The study's purpose is instead to evaluate price sets under uniformly optimum efficiency.

Table 18 shows that the Boston, New York, and Philadelphia processing points draw milk from more than one production area. This is to be expected because of the way the model is constructed. Similar processing costs are assumed in all markets, and transfer costs for processed products are high, relative to raw milk shipping costs. Consequently, the least costly place to process milk is at a consumption point. This, plus the fact that consumption of Class I milk in the Boston, New York, and Philadelphia orders is large relative to the supply in the production areas, leads to the three orders being serviced from several supply sources.

Similar processing costs and high intermarket transfer costs also lead to another conclusion: interorder milk shipments are associated with market inefficiency. Such shipments can be optimum only if the gain from processing Class I milk at the point of consumption is offset by the price differentials between orders. But such price differentials do not fulfill the objectives of the Federal milk program because they foster an unnecessarily large number of milk shipments. Thus, interorder shipments turn out to be one criterion for evaluating sets of Class I prices.

A second criterion for evaluating price differentials is the total marketing costs associated with each price proposal. This criterion will be explained later.

Table 19 gives the intermarket and interorder shipments for Price Set 1. These prices actually occurred in 1968 so the differences between Table 19 and that year's historical shipment pattern are due to the assumptions of optimality and uniform dealer efficiency. Table 19 provides a benchmark for evaluating the changed price differentials embodied in Price Sets 2 and 3. As can be seen, the 1968 price differentials are close to optimum as only two interorder shipments occur. Approximately 20 million pounds of milk is transferred from Springfield to Hartford, but with only 23 miles separating the two consumption points (Table 16 and Table 17), total marketing costs are not greatly affected by this interorder transfer. Springfield also ships about 2¼ million pounds of milk to Boston. However, this intermarket shipment is within the New England order, so both markets are subject to the same minimum Class I price. The second interorder transfer is between Baltimore and Philadelphia, where about 10 million pounds of milk are shipped 97 miles.

Price Set 2 eliminates the price differential between the southernmost three

orders. The nearby Class I price of $6.83 in Orders 5 and 6 is raised 10 cents to match Order 4's price of $6.93. As Table 20 shows, the effect of Price Proposal 2 is to dispose of the interorder shipment from Baltimore to Philadelphia. The other intermarket and interorder shipments remain unchanged.

A change in the transfer pattern of processed milk obviously implies a change in the shipments of unprocessed milk. Table 21 gives the new shipment pattern between the production and processing points for Price Set 2. Baltimore and Frederick, Maryland are the only supply areas affected by the change in the differentials and the total quantity of Class I milk they ship is not influenced. The Baltimore production area increases shipments to Philadelphia by 10 million pounds; this milk was processed in Baltimore but is now processed in Philadelphia. Since the Baltimore producers can no longer supply 10 million pounds to Washington, the Frederick producers increase their Washington shipments to fill the gap. Overall, the model's milk producers and dealers experience only minor changes when the price differentials between Orders 4, 5 and 6 are eliminated.

Tables 22 and 23 present the shipment patterns associated with Price Set 3. This set is a modification of Price Proposal 2 in which the 201-210 mile zone price differential between the New York and Connecticut orders is reduced from 18 cents to 10 cents. As Table 22 indicates, Price Set 3 eliminates the interorder shipment between Springfield, Massachusetts and Hartford, Connecticut. Springfield still processes approximately 43 million pounds of Class I milk, but now ships Boston all of the excess above the 20 million pounds needed for local consumption. Boston processes approximately 20 million pounds less milk since Springfield shifts this much from Hartford to Boston and Hartford increases its processing by the 20 million pounds needed for local consumption.

Contrary to Price Set 2, Table 23 shows that the third price proposal causes extensive shifts in Class I shipments from production areas. The rather complicated change in the unprocessed milk shipment pattern is summarized in Figure 4. This rearrangement of milk transfers favors producers in New York State. Oneonta increases its utilization rate to 100 percent and Ogdensburg begins to supply some Class I milk. On the other hand, Hyde Park, Vermont and Lewistown, Pennsylvania are forced out of the Northeast Federal Order Markets. While the rise in the New York Class I base price should obviously favor the New York milk producers, the production areas which lose their comparative advantage are less obvious.

B. Blend Prices

Blend prices cannot be obtained directly from the solution of the linear programming models. However, the model does generate total producer returns for each order. Since the blend prices are average producer returns, they can be computed by dividing total producer returns by the total producer deliveries (cf., Table 10).

The blend prices associated with the optimum solution for each Class I price proposal are given in Table 24. Price Set 2 results in an increase of $0.14 per hundredweight for the producers of the old Upper Chesapeake Bay Order. Of course, the recent merger of these two orders into the Middle Atlantic Order will make these price differences academic, as both groups of producers will receive the

TABLE 20: Optimum Class I Shipments From Processing Points To Markets For Price Set 2

Million Pound Units

Markets → ↓	1 Boston	2 Springfield	3 Hartford	4 N. Y.	5 Utica	6 Phil.	7 Baltimore	8 Wash.,D.C.	Quantity Of Milk Processed
1 Boston	160.3								160.3
2 Springfield	2.2	20.0	20.4						42.6
3 Hartford			52.0						52.0
4 New York				393.9					393.9
5 Utica					61.0				61.0
6 Philadelphia						106.9			106.9
7 Baltimore							37.1		37.1
8 Washington, D.C.								50.0	50.0
QUANTITY DEMANDED	162.5	20.0	72.4	393.9	61.0	106.9	37.1	50.0	903.8

TABLE 21: Optimum Class I Shipments From Supply Areas To Processing Points For Price Set 2

Million Pound Units

Supply Area ↓ / Processing Point →	1 Boston	2 Springfield	3 Hartford	4 N.Y.	5 Utica	6 Phil.	7 Baltimore	8 Wash.,D.C.	Total Delivered From Supply Area	Quantity Left At Supply Point
1 Augusta, Me.	28.2								28.2	
2 Concord, N.H.	16.6								16.6	
3 Hyde Park, Vt.	53.1								53.1	56.3
4 Rutland, Vt.		42.8							42.8	
5 Boston, Mass.	41.5								41.5	
6 Northhampton, Mass.	21.0								21.0	
7 Hartford, Conn.			52.0						52.0	
8 Poughkeepsie, N.Y.				85.9					85.9	
9 Ogdensburg, N.Y.										92.2
10 Oneonta, N.Y.				236.1	61.0				297.1	46.5
11 Hornell, N.Y.										219.9
12 Pittsburgh, Penn.										39.9
13 Middletown, N.Y.				72.0					72.0	
14 Norristown, Penn.						43.8			43.8	
15 Lewistown, Penn.						29.3			29.3	161.3
16 Baltimore, Md.						33.7		39.7	73.4	
17 Frederick, Md.							37.1	10.4	47.5	
TOTAL DELIVERED TO PROCESSING POINT	160.4	42.8	52.0	394.0	61.0	106.8	37.1	50.1	904.2	616.1

TABLE 22: Optimum Class I Shipments From Processing Points To Markets For Price Set 3

Million Pound Units

Markets → / ↓	1 Boston	2 Springfield	3 Hartford	4 N. Y.	5 Utica	6 Phil.	7 Baltimore	8 Wash.,D.C.	Quantity Of Milk Processed
1 Boston	139.9								139.9
2 Springfield	22.7	20.1							42.8
3 Hartford			72.5						72.5
4 New York				393.9					393.9
5 Utica					61.0				61.0
6 Philadelphia						106.9			106.9
7 Baltimore							37.1		37.1
8 Washington, D.C.								50.0	50.0
QUANTITY DEMANDED	162.6	20.1	72.5	393.9	61.0	106.9	37.1	50.0	904.1

TABLE 23: Optimum Class I Shipments From Supply Areas To Processing Points For Price Set 3

Million Pound Units

Supply Area ↓ / Processing Point →	1 Boston	2 Springfield	3 Hartford	4 N. Y.	5 Utica	6 Phil.	7 Baltimore	8 Wash.,D.C.	Total Delivered From Supply Area	Quantity Left At Supply Point
1 Augusta, Me.	28.2								28.2	
2 Concord, N.H.	16.6								16.6	
3 Hyde Park, Vt.										109.4
4 Rutland, Vt.		42.8							42.8	
5 Boston, Mass.	41.5								41.5	
6 Northhampton, Mass.	21.0								21.0	
7 Hartford, Conn.	32.7		19.4						52.0	
8 Poughkeepsie, N.Y.			53.1	32.7					85.9	
9 Ogdensburg, N.Y.					36.0				36.0	56.2
10 Oneonta, N.Y.				318.5	25.0				343.5	
11 Hornell, N.Y.										219.9
12 Pittsburgh, Penn.										39.9
13 Middletown, N.Y.				42.7		29.3			72.0	
14 Norristown, Penn.						43.8			43.8	
15 Lewistown, Penn.										190.6
16 Baltimore, Md.						33.7		39.7	73.4	
17 Frederick, Md.							37.1	10.4	47.5	
TOTAL DELIVERED TO PROCESSING POINT	140.0	42.8	72.5	393.9	61.0	106.8	37.1	50.0	904.2	616.0

FIGURE 4: Changes In The Shipment Pattern Between Production Areas And Processing Points Due To Price Set 3

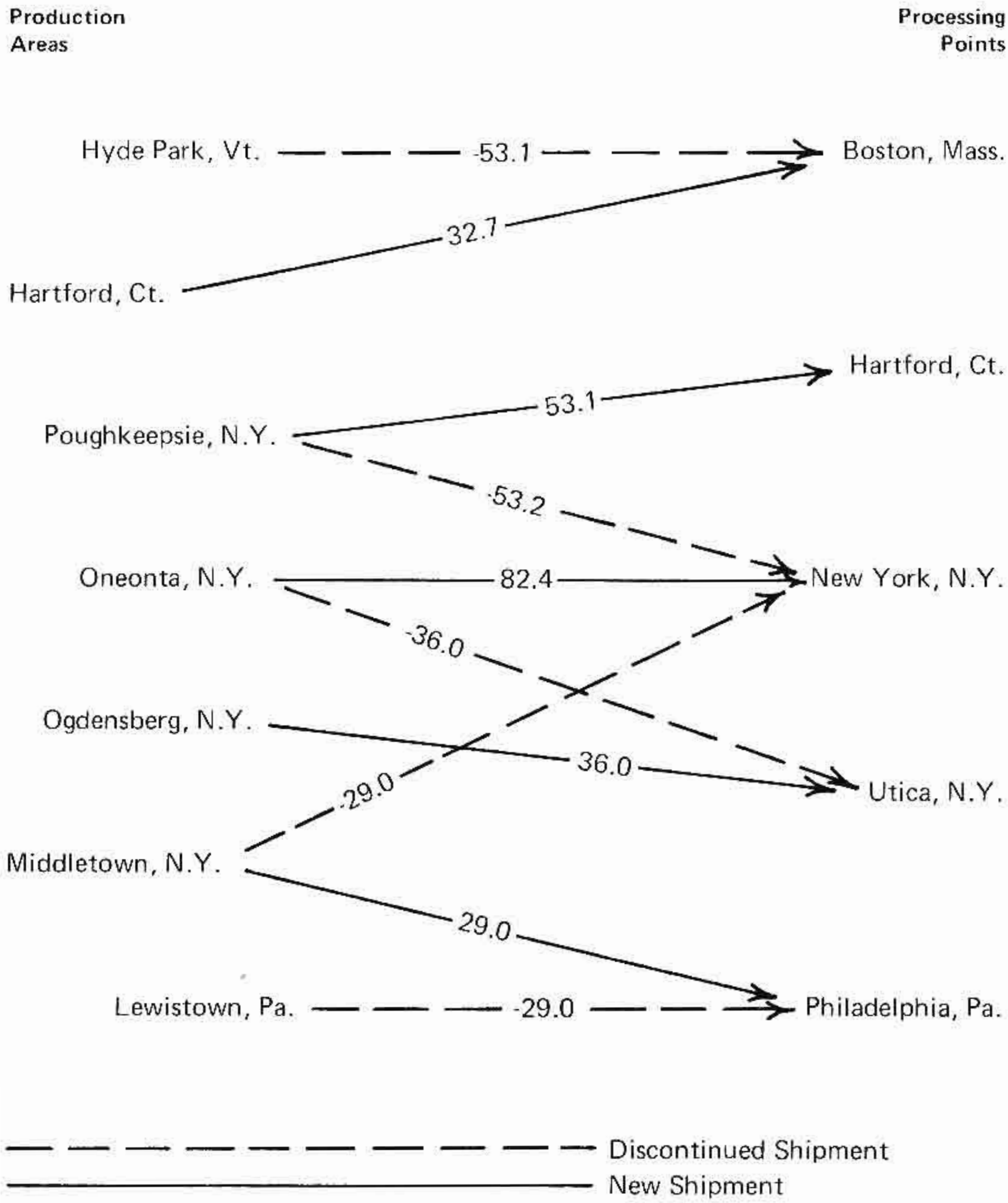


TABLE 24. Base Blend Prices Resulting From The Optimum Shipment Pattern For The Three Price Proposals

Dollars Per Hundredweight

Order Number and Name	Price Proposal 1	Price Proposal 2	Price Proposal 3
1 Mass.-R.I.-N.H.	6.42	6.42	6.23
2 Connecticut	6.32	6.32	6.92
3 New York-New Jersey	6.07	6.07	6.07
4 Delaware	5.96	6.10	6.10
5 Upper Chesapeake	6.15	5.81	5.81
6 Washington, D.C.	5.77	5.77	5.77

same base blend price. Price Proposal 3 affects the two New England Orders. Connecticut producers receive a $0.60 increase and the Massachusetts-New Hampshire-Rhode Island order producers suffer a $0.19 decrease in their base blend price. Interesting enough, the New York-New Jersey blend price does not change when Price Set 3 replaces Price Set 2.

C. Shadow Values

Four types of shadow values result from this study's model. These implicit or shadow values measure the costs of deviating slightly from the optimum solution. Unless the deviation from the optimum situation is very small, however, the shadow values obtained can be misleading. This is because a significant divergence from the optimum will yield quite different implicit values. As a consequence, changes in prices, institutional factors, etc. are better analyzed by changing and re-solving the model, rather than depending on shadow prices or shadow costs.

D. Total Marketing Costs

The total marketing costs[31] provide a second criterion for choosing the best set of Class I base prices, since they are a measure of the efficiency of the Northeast milk markets. These costs can be obtained by adding total producer returns to the objective value of the optimum solution of the model.[32]

Total marketing costs are comparable for the three price sets even though some prices were arbitrarily increased in Proposals 2 and 3. This is so because the Class I prices appear both as costs and as returns in the model's objective equation: a Class I price is charged as a cost for each intermarket shipment and a Class I price also implicitly appears in each order's total producer return.[33]

The two sets of prices do not exactly offset each other. The Class I prices entered as costs are zone prices taken at the consumption points while the Class I prices in the producer returns are base prices. Nevertheless, raising (or lowering) an

[31] As defined in this study, cf., Pages 16-18.

[32] This step is necessary because the objective function was defined to be the difference between total producer returns and total marketing costs.

order's Class I base price will not affect the differential between it and the Class I zone prices. Hence, the price change is offset and the marketing costs are comparable for different prices.

One source of error does creep into the comparisons of total marketing costs for the three price proposals. The Class I base price also appears in the constant term of the producer return constraints. Thus, some of the increase (decrease) in the producer returns is not offset by an increase (decrease) in costs. The magnitude of this increase (decrease) is so small, however, that it is not likely to affect cost comparisons. For Price Proposal 2, the non-offset increase in returns is approximately \$13,500. In the case of Price Proposal 3, it is approximately \$42,500. With total marketing costs in excess of 120 million dollars, these errors ought not significantly affect comparison of the price proposals.

Total marketing costs for the first set of Class I prices are \$121,792,000. This figure is based on the prices that actually held in August 1968. It provides a standard of comparison for the price proposals. Total costs resulting from Price Proposal 2 – in which a common price was established for the three southernmost orders – are \$121,705,000. Consequently, Proposal 2 both decreases total marketing costs and eliminates an interorder shipment: Proposal 2 thus has a clear-cut gain over Proposal 1. Price Proposal 3 eliminates an interorder shipment but it also leads to increased marketing costs of \$122,372,000. Hence, the two criteria conflict and a decrease in the price differential between the New England and New York-New Jersey orders does not lead to a clear cut gain. Judgement is required to evaluate the worth of Proposal 3. However, the elimination of the interorder shipment between Hartford, Connecticut and Springfield, Massachusetts does not seem worth the \$580,000 increase in the Northeast regional marketing costs.

[33] One part of the objective equation is (cf., Page 23).

$$\Sigma_j \Sigma_k p_j Y_{jk}$$

where

- j, k = 1, . . ., 8 represents consumption areas
- p_j = Class I price at market j
- Y_{jk} = processed fluid milk products shipped from market j to market k

The Class I prices are costs in this part of the objective function. Total producer returns also appear in the objective equation. These returns can be written from the producer return constraints as:

$$W_h - b_h = (p_h - m_h) Z_h$$

where

- h = 1, . . ., 6 represents the orders
- W_h = producer income from order h
- b_h = constant term in producer return constraint h
- p_h = Class I base price of order h
- m_h = Class II base price of order h
- Z_h = total Class I milk regulated under order h and consumed within the six orders.

Hence, the base Class I prices are implicitly incorporated in the total producer returns in the objective equation. Since the sum of the inter-market shipments originating from a given order is equal to the milk sales regulated under the order and sold within the eight federal order markets (cf., Page 27), the Class I prices which enter as costs tend to be offset by the Class I prices which enter into the returns.

SUMMARY AND CONCLUSIONS

A. Summary of Results

Approximately 904 million pounds of Class I milk were transferred by the model from the 17 production areas to the eight consumption areas of the Northeast orders. Total marketing costs for these transfers (excluding the costs of processing, assembly costs of supplies within production areas, and the selling and final distribution costs of processed milk products) were around 120 million dollars. Of the total fluid milk shipped, less than 4 percent was shipped as processed milk between orders, and this percentage was reduced to zero by the third set of Class I base prices.

Total producer returns of about 93 million dollars was generated by the model. The division of these returns among the six Northeast Federal Orders varied as different sets of Class I base prices were tried in the model. However, the total returns for all six orders were not affected by the price changes.

Both the interorder shipment and marketing cost criteria indicated that Price Set 2 would have been preferable to the Class I base prices which prevailed in August 1968. Thus, the results support the merger of the three middle Atlantic orders which took place in 1970. Price Proposal 3 yielded mixed results suggesting that, had the third set of prices held sway in 1968, interorder milk shipments between Hartford, Connecticut and Springfield, Massachusetts would have been eliminated but that total marketing costs would have increased by about 580 thousand dollars. The rise in costs was judged to be more critical than the elimination of the interorder milk transfers and the third price proposal was deemed undesirable.

B. Conclusions About The Model

A comparison of the effects of the three price proposals on the minimum total marketing cost and the interorder movements of milk made it possible to choose among the proposals. The choice is not always clear cut as the third price proposal has demonstrated. When the two criteria used in the study conflict, the worth of a proposed change in the interorder Class I price differentials becomes a matter of judgement. Nevertheless, the model makes the judgement an informed one.

An attempt was made to keep the model simple. The result was a short run construct based on a fairly large set of simplifying assumptions. As a consequence, a particular solution to the model yields results of limited value. To build a knowledge of the effect of interorder price differentials on market costs and Class I milk flows, the model would have to be repeated for several proposed price sets. Similarly, to know the consequences of the assumptions made during the construction of the model and during collection of the data, solutions for many different sets of parameters would be required.

The need of repeated runs to derive the full set of results from the model fits the philosophy in which it was conceived. The contrasting approach is to construct a more complicated structure which yields a fuller range of results from a single

solution.[34] Which approach is more valuable depends on the skill of the model builder and the use to which the model is to be put.

The presented model has several strengths. It solves in a computer in a matter of seconds. It is small enough that results (like errors in comparing marketing costs) which are not direct output from the computer can be easily generated. It does not require data which is difficult to obtain, or that is confidential, and it does not need sub-studies to manipulate the data into usable form. The model is simple enough that it can be changed without much effort if structural changes take place in the industry. Finally, and most important, the economic model used in the study seems to yield reasonable results.

C. Suggestions For Further Research

The present study considered only three price proposals. Many additional alternative proposals could be evaluated. In addition to testing and evaluating more proposals, the present model could also be used to test the effects of changes in transportation rates, country plant costs, and zone and location differentials.

Modifications of the model may be of value. The model assumed a pooling constraint of the "majority rule" type. This assumption could be changed to produce a pooling constraint which approximates more closely the actual pooling requirements. The model also ignored several provisions of the federal orders, such as the assignment sequence for determining the regulating order and the cooperative service payments. These factors could be incorporated into modifications of the model. Other constructive changes in the existing model may include: (1) the incorporation of Class II milk as a distinct spatially distributed product with its distinct marketing costs, a step that would permit the utilization percentages to fluctuate freely, and (2) the expansion of the model to encompass all United States Federal Orders and their supply sources.

Improvements can probably also be made in the data collection procedures used in this study. The procedures for estimating production of milk, fluid milk consumption, and Class I sales outside the six orders were based on secondary sources. In the future, ways could be developed to provide more accurate and reliable estimates of these parameters.

[34] For an example of this type of model, see:

Kottke, Marvin W. "Spatial, Temporal and Product-Use Allocation of Milk In An Imperfectly Competitive Dairy Industry." *American Journal of Agricultural Economics*, Volume 52, Number 1, (February 1970), pp. 31-40.

APPENDIX A

Northeastern Dairy Production Areas, and Counties Included in Each Area

TABLE 25. Northeastern Dairy Production Areas And Counties Included In Each Area

Area Number	State	Counties Included In Area
1	Maine	Androscoggin, Cumberland, Franklin, Kennebec, Knox, Lincoln, Oxford, Penobscot, Piscataquis, Sagadahoc, Somerset, Waldo, York
2	New Hampshire	Belknap, Cheshire, Hillsborough, Merrimack, Rockingham,
3	New Hampshire	Coos
	Vermont	Addison, Caledonia, Chittenden, Essex, Franklin, Grandisle, Lamoille, Orleans, Washington,
4	New Hampshire	Grafton, Sullivan
	Vermont	Bennington, Orange, Rutland, Windham, Windsor
5	Massachusetts	Bristol, Essex, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
	Rhode Island	Bristol, Kent, Newport, Providence, Washington
6	Massachusetts	Berkshire, Franklin, Hampden, Hampshire
7	Connecticut	Hartford, Litchfield, Middlesex, New Haven, New London, Tolland, Windham
8	New York	Albany, Columbia, Dutchess, Greene, Rensselaer, Saratoga, Schenectady, Washington
9	New York	Clinton, Franklin, Jefferson, St. Lawrence
10	New York	Broome, Cayuga, Chenango, Chemung, Cortland, Delaware, Fulton, Herkimer, Lewis, Madison, Montgomery, Oneida, Onondaga, Oswego, Otsego, Schoharie, Schuyler, Sullivan, Tioga, Tompkins, Yates
11	New York	Allegany, Cattaragus, Chautauqua, Erie, Genesee, Livingston, Monroe, Niagara, Ontario, Orleans, Seneca, Steuben, Wayne, Wyoming
	Pennsylvania	Bradford, Lackawanna, Luzerne, Potter, Sullivan, Susquehanna, Tioga, Wayne, Wyoming

TABLE 25 (Continued)

Area Number	State	Counties Included In Area
12	Pennsylvania	Allegheny, Armstrong, Beaver, Blair, Butler, Cambria, Clarion, Crawford, Clearfield, Erie, Fayette, Greene, Indiana, Jefferson, Lawrence, Mercer, Somerset, Warren, Washington, Westmoreland
	West Virginia	Monogalia, Preston
	Maryland	Garrett
13	New York	Orange, Ulster
	New Jersey	Hunterdon, Morris, Somerset, Sussex, Warren
14	Pennsylvania	Bucks, Chester, Delaware, Montgomery, Philadelphia
	New Jersey	Mercer
	Delaware	New Castle
15	Pennsylvania	Adams, Bedford, Berks, Centre, Carbon, Clinton, Columbia, Cumberland, Dauphin, Franklin, Fulton, Huntingdon, Juniata, Lancaster, Lebanon, Lehigh, Lycoming, Mifflin, Monroe, Montour, Northhampton, Northumberland, Perry, Schuylkill, Synder, Union, York
	Maryland	Allegany, Washington
	West Virginia	Berkeley, Jefferson
16	Maryland	Anne Arundel, Baltimore and Baltimore City, Caroline, Carroll, Cecil, Dorchester, Harford, Howard, Kent, Queen Anne's, Somerset, Talbot, Wicomico, Worcester
	Delaware	Kent, Sussex
17	Maryland	Calvert, Charles, Frederick, Montgomery, Prince George's, St. Mary's
	Virginia	Arlington, Fairfax, Prince William
	District of Columbia	

BIBLIOGRAPHY

REFERENCES

Babb, Emerson M. "Changing Marketing Patterns and Competition of Fluid Milk". *Journal of Farm Economics,* Volume 48, No. 3, Part II (August, 1966), 53-68.

Dantzig, George B. *Linear Programming and Extensions,* Princeton, New Jersey: Princeton University Press, 1963.

Hsiao, James C. "A Quadratic Programming Approach to Spatial Equilibrium Analysis for the Dairy Industry in the Northeast Region". Unpublished Ph.D. dissertation, University of Connecticut, 1967.

Hsiao, James C., and Kottke, Marvin W. *Spatial Equilibrium Analysis of the Northeast Region—An Application of Quadratic Programming,* Bulletin 405, Storrs Agricultural Experiment Station, College of Agriculture and Natural Resources, The University of Connecticut, Storrs, July, 1968.

IBM. Mathematical Programming System/360 (360A - CO - 14X). *Linear and Separable Programming—User's Manual.* First Edition, 1967.

Johnson, Stewart. Professor of Agricultural Economics. Statement for presentation at public hearing beginning December 5, 1967 to consider proposed amendments to federal milk orders 2, 1 and 15. University of Connecticut, Storrs, Connecticut.

Kottke, Marvin W. "Spatial, Temporal and Product-Use Allocation of Milk in an Imperfectly Competitive Dairy Industry" *American Journal of Agricultural Economics,* Volume 52, No. 1 (February 1970), 33-40.

Report by Mid-Atlantic Class I Milk Price Committee, June, 1968.

Tidhar, Yehoshua. "Class I Price Differentials Among the Northeastern Federal Milk Marketing Order: A Linear Programming Application." Unpublished M.Sc. thesis, University of Connecticut, 1969.

UNIVAC Data Processing Division, Programmers Reference Manual UP-4138, *Linear Programming* First Edition 1966.

U. S. Department of Agriculture. Consumer and Marketing Service. *The Federal Milk Marketing Order Program.* Marketing Bulletin No. 27. Washington, D. C.: Government Printing Office, Revised April, 1968.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division, *Federal Milk Order Market Statistics,* July, 1963. Washington, D. C.: Government Printing Office.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Federal Milk Order Market Statistics,* February, 1964. Washington, D. C.: Government Printing Office.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Federal Milk Order Market Statistics,* February, 1965. Washington, D. C.: Government Printing Office.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Federal Milk Order Market Statistics,* February, 1966. Washington, D. C.: Government Printing Office.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Federal Milk Order Market Statistics,* Annual Summary for 1967. Washington, D.C.: Government Printing Office, May, 1968.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Federal Milk Order Market Statistics,* August 1967 Summary. Washington, D. C.: Government Printing Office, October, 1967.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Interorder Movements of Milk for October,* 1967. Unpublished tabulation obtained by special request.

U. S. Department of Agriculture. Economic Research Service. *Cost of Transporting Bulk and Packaged Milk by Truck,* by Orval Kerchner. Marketing Research Report No. 791. Washington, D. C.: Government Printing Office, May, 1967.

SOURCES OF DATA

Arms, David. *Class I and Blended Zone Price Differentials.* Cooperative Dairy Economics Service. Boston, Massachusetts, June 27, 1966.

"Announcement of Uniform Price for Order 4 Producer Milk, August 1968". *Inter-State Milk Producers Review,* Philadelphia, Pennsylvania, (September, 1968), 6.

Dairy Adjustment in the Northeast, An Analysis of Potential Production and Market Equilibrium. Bulletin 498. New Hampshire Agricultural Experiment Station, June, 1968.

Delaware Valley Order, Market Administrator's Office. Unpublished correspondence, December 27, 1968.

Federal Register, Volume 33, No. 199, October 11, 1968, 15216.

Household Goods Carriers Bureau, Agent. *Mileage Guide No. 8.* Washington, D. C., September 20, 1966.

Market Administrator, Connecticut Marketing Area. *Monthly Statistical Report for August 1968.* September 25, 1968.

Market Administrator, Massachusetts-Rhode Island-New Hampshire Marketing Area. *Monthly Statistical Report, August 1968.* September 25, 1968.

Market Administrator, New York-New Jersey Milk Marketing Area. *August 1968 Uniform Price Announcement.* September 13, 1968.

Upper Chesapeake Bay, Market Administrator's Office. Unpublished correspondence, January 3, 1969.

U. S. Bureau of the Census. Census of Agriculture, 1964, *Statistics for the State and Counties.* Washington, D. C.: Government Printing Office, 1967.

U. S. Department of Agriculture. Agricultural Marketing Service. *Order No. 2 Regulating the Handling of Milk in the New York-New Jersey Marketing Area.* Washington, D. C.: Government Printing Office, January 1, 1964.

U. S. Department of Agriculture. Agricultural Marketing Service. *Federal Order No. 16. Order Regulating the Handling of Milk in the Upper Chesapeake Bay Marketing Area.* Washington, D. C.: Government Printing Office, August 1964.

U. S. Department of Agriculture. Consumer and Marketing Service. *Order No. 1, Amendment No. 5.* Washington, D. C.: Government Printing Office, December 1, 1967.

U. S. Department of Agriculture. Consumer and Marketing Service. *Order No. 3, Compilation.* Washington, D. C.: Government Printing Office, May 1, 1967.

U. S. Department of Agriculture. Consumer and Marketing Service. *Order No. 4, Amendment No. 3.* Washington, D. C.: Government Printing Office, June, 1967.

U. S. Department of Agriculture. Consumer and Marketing Service. *Order No. 15, Compilation.* Washington, D. C.: Government Printing Office, December 1, 1967.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. *Federal Milk Order Market Statistics, August 1968 Summary.* Washington, D. C.: Government Printing Office, October, 1968.

U. S. Department of Agriculture. Consumer and Marketing Service, Dairy Division. Proposed Amendments to Connecticut and Massachusetts-Rhode Island Federal Order Markets (Hearing from June 20 through July 1, 1966). Brief of September 16, 1966.

U. S. Department of Agriculture. Statistical Reporting Service, Crop Reporting Board. *Milk Production.* Washington, D. C.: Government Printing Office, September 11, 1968.

Washington, D. C. Order. Market Administrator's Office. Unpublished correspondence, January 17, 1969.