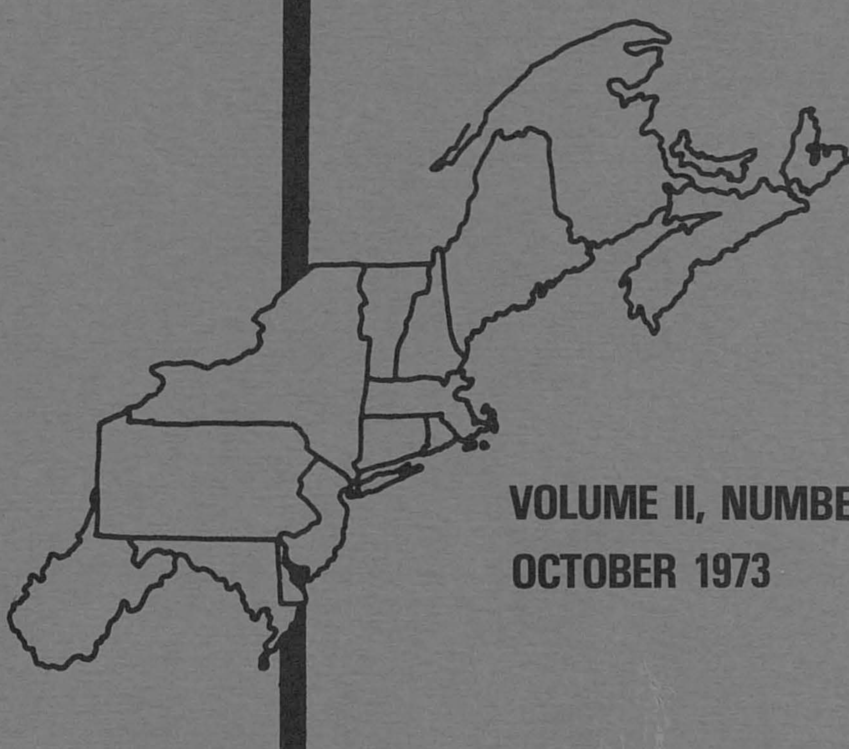
JOURNAL OF THE Northeastern Agricultural Economics Council



VOLUME II, NUMBER 2
OCTOBER 1973

AN INTERORDER PRICE ALIGNMENT MODEL FOR THE NORTHEAST FEDERAL MILK MARKETING ORDERS

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Introduction

Advances in storage, transportation, packaging and management have removed many of the old barriers between the Northeast's fluid milk markets. As the barriers disappear, the resulting market interdependence increases the importance of carefully aligning the minimum base prices set for unprocessed milk in the Northeastern federal milk marketing orders. For if these prices should get out of line, the lack of spatial barriers can encourage intermarket transfers which run counter to the orders' objectives.

Milk shipments between the markets in the Northeastern federal orders can conflict with the orders' provisions in several ways. They can go against the provision for efficient and orderly marketing of dairy products. They can increase the number of milk handlers competing in a market who have paid different prices for their raw milk. Or, if the intermarket milk shipments unnecessarily raise the total marketing bill in the Northeast region, they can adversely affect either the incomes of the milk producers or the prices of the packaged products.

As the need increases for careful alignment of base prices, so does the need for methods of evaluating interorder price differentials. One such method will be described and evaluated in this paper. It consists of a transshipment type of linear programing transportation model which has been modified to incorporate the main institutional factors present in the Northeast fluid milk markets.

Early in the development of the method, a decision was made to stay within the linear programing framework. It was recognized that this decision would rule out demand and supply responses. This was a limiting assumption in view of the work of the Northeast Dairy Adjustment Committee.[2] The simple framework also meant that all milk handlers would be assumed to have the same linear homogeneous variable cost function. Such an assumption is hardly encouraged by Babb's work [1] or by the Devino, et.al. study [3] on the economies of size in fluid milk processing plants. Nevertheless, the decision was made to stay with the simple model and to concentrate on building in the institution aspects of the Northeastern federal milk marketing orders.

Model Description

A federal order is a multi-purpose device, so four objectives had to be incorporated into the interorder price model. One of these objectives -- that of maintaining an adequate supply of milk in the federal order markets -- was only partly fulfilled by the model's set of demand and supply constraints. Adequate supply had to be defined exogenously before the constraints could be used to enforce this definition. Two of the other objectives -- that of promoting marketing efficiency and that of increasing milk producer incomes -- were explicitly molded into the model's objective equation. The fourth goal -- that of placing all handlers in a federal order market under the same external cost structure -- was implicitly introduced into the model by a-priori choice of allowable milk shipment activities.

Milk shipments could involve either class 1 or class 2 milk and could be either bulk shipments of unprocessed milk, packaged milk shipments or shipments of manufactured milk products. Of these various types, two were incorporated in the model. Bulk shipments of class 1 milk from the supply areas to the federal order markets made up the main type of transfer activity. Shipments of packaged milk between markets within the orders were also included. All other types of milk shipments were left out of the modified transportation model.

The line of reasoning supporting the exclusion of class 2 milk shipments from the model follows in general the approach taken by Stitts and Hammond [9]. The Northeast is assumed to be in a single large market for manufacturing milk which is dominated by the Minnesota - Wisconsin milkshed. The absence of market barriers means class 2 milk prices in the Northeast are set primarily by the North-Central region's prices and by transportation charges. As long as milk produced in the Northeast is of relatively homogeneous quality, one can reasonably assume that the Northeastern handlers' fluid milk demands will take precedence over milk sold for manufacturing. Northeast class 2 milk production can consequently be treated as a residual supply with an exogenously determined price, and can be disposed of in a transportation model through slack activities. This is how the class 2 milk was handled in the interorder price alignment model.

The concepts of spatially perfect markets and uniformly efficient dealers lead to the conclusion that there should be only one type of class 1 milk shipment in the Northeast. This optimum type of shipment is the bulk transfer of unprocessed milk from the supply source to the market area. The argument for the dominance of this shipment type goes as follows. Imagine a group of equally efficient fluid milk handlers in a set of spatially perfect markets. Each handler services one or more markets and every handler has a processing plant at each market he services. This situation allows all dealers to take full advantage of the transportation rate advantage that exists for bulk shipments[6] because each dealer's milk shipments would consist exclusively of deliveries of raw milk from the production areas. In such a situation, intermarket shipments of either bulk or packaged milk would put a dealer at a competitive disadvantage. He would have to pay for two milk shipments while his competitors paid for one. Consequently the only way a dealer would enter a new market is by building a new plant, and the only type of milk shipment which would be evident in the region would be bulk shipments of unprocessed milk.

If either the uniform handler efficiency assumption or the perfect spatial market assumption are relaxed, other types of milk shipments can become economically rational. A transportation model by its nature treats all handlers as though they were equally good at minimizing costs. The only way this assumption could be relaxed, at least within the context of the transportation model, is to specify the shipments of individual handlers. This, of course, is highly impractical from a model size and data confidentiality standpoint, and is also rife with the possibility of inadvertently favoring some milk handlers over others. The assumption of uniform handler efficiently was therefore not relaxed. In contrast, the assumption of perfect spatial markets was obviously never made, for to do so would assume away the problem being studied.

The introduction into the model of packaged milk shipments between federal order markets was done to provide a signal that class 1 prices were out of line. Such shipments would appear in the model's solution only if handlers with plants in one federal order market had a class 1 price advantage over handlers regulated by another order, and only if this price advantage was large enough to more than compensate for the additional costs of the intermarket milk shipments. The appearance of intermarket shipments signals that there is competition in a single market between handlers who have paid different prices for their raw milk. It also indicates that the given class 1 prices are not promoting marketing efficiency. Thus, intermarket shipments are associated with sets of prices which are highly likely to be in conflict with the provisions of a federal order.

The elimination of intermarket milk shipments in the model provides one criterion for judging the interorder price differentials. But it is not a complete criterion because more than one bulk milk shipment pattern could satisfy both it and the supply-demand constraints of the modified transportation model. Additional criteria were needed, and these criteria came from the goals of promoting efficient marketing and of increasing producer incomes which were included in the model's objective function.

The federal order objective of promoting efficient and orderly marketing was reinterpreted in the study to mean minimization of the Northeast region's total marketing cost. In this form, the federal orders' objective could easily replace the minimum total transportation cost objective found in a standard transportation model. However, the introduction of the federal order goal of increased milk producer incomes required extensive modification of the transportation model. This modification, when allied with the a-priori selection of milk shipment types, constituted the basic difference between the standard linear programing transportation model and the interorder price alignment model.

The objective function in the interorder price alignment model simultaneously minimizes total marketing costs and maximizes total milk producers' income. But marketing costs and producer incomes are linked in a federal milk marketing order by the way blend prices are calculated. Consequently, blend price formulas had to be introduced into the interorder price model in order to link the two parts of the model's objective function. An orders' blend price is a weighted average of the orders' classified milk prices. The weights depend on the end use of the milk deliveries regulated under the order. Each time the milk shipment pattern changes in the Northeast, the class 1 milk utilization proportions of the orders may also change. If they do, the weights in the blend price formula shift and new blend prices occur. New blend prices obviously mean changed producer incomes, so shifts in the milk shipment patterns affect both marketing costs and producer incomes.

Revised forms of the federal order blend price formulas were included in the interorder price model's set of constraints. These derived forms expressed the total returns to the group of milk producers regulated under an order as a linear function of the total class 1 milk sales within the order. The total class 1 milk sales in an order is also calculated within the model's constraint set, so the interdependence between the cost-minimizing shipment pattern and the receipts of the milk producers is endogenous to the model. This is perhaps the most attractive attribute of the price alignment model with regard to its usefulness either as a component in a simulation model or as a tool in setting minimum class prices.

Model Performance

The most important attribute of any model is how it performs. The interorder price alignment model just discussed was used to analyze the effect of the 1970 merger of the three southernmost federal orders of the Northeast region. A detailed description of this analysis, and of the model itself, is presented in the Bulletin by Tidhar and Hardie[11]. However, a brief discussion of the main findings will be presented here to indicate the type of results which come out of the price-alignment model.

The model was set up with six federal orders, eight federal order market areas, and 17 milk production areas. The set of class 1 and class 2 prices which actually existed in August 1968 -- about the time the impetus came to merge the southernmost three of the six orders -- was put into the model. When it was solved, two interorder shipments appeared. One of these was a 20.4 million pound shipment from Springfield, Massachusetts (Order 1001) to Hartford, Connecticut (Order 1015). The other was a 10.3 million pound shipment from Baltimore, Maryland (Order 1016) to Philadelphia, Pennsylvania (Order 1004). After the solution for the actual prices was obtained, the class 1 prices in the southernmost three orders were set equal to each other. This was done to simulate the price effect of the merger. When the model was solved again, the interorder shipment between Baltimore and Philadelphia disappeared. Since interorder shipments in the model's solution are considered to be a signal of possible price misalignments between the orders, this disappearance suggested the merger was justified, at least from a price-setting standpoint. A further comparison of the two solutions showed that:

(1) some of the bulk shipments from the Maryland producing areas shifted between the Baltimore, Washington, D.C., and Philadelphia markets.

(2) the blend prices in the northernmost three orders were not affected by the price change.

(3) the price equalization in the southernmost three orders decreased the total marketing costs of the Northeast region by $85,000.

Thus all of the model's criteria supported the merger.

The 20.4 million pound shipment from Springfield to Hartford encouraged the trial of a third price alternative. It had been suggested in a December 1967 hearing that the interorder price differential between the Connecticut and New York-New Jersey Orders be reduced from 18¢ per hundredweight to 10¢ per hundredweight. Since this price realignment would be an indirect way to adjust to the Springfield - Hartford shipment and since this interorder shipment should be relatively insensitive to price changes (the shipping distance is only 23 miles), it was felt that more could be learned about how the model functioned by analyzing this price change. After the change was made and the model solved, a comparison of the second and third solutions revealed that:

(1) the Springfield - Hartford shipment was eliminated

(2) more milk was purchased from producers in the New York milk production areas but class 1 sales were lost by the production areas of Hyde Park, Vermont and Lewistown, Pennsylvania.

(3) the Connecticut order's blend price was increased by 60¢ per hundredweight, but the Massachusetts - Rhode Island - New Hampshire order's blend price decreased 10¢.

(4) total marketing costs in the Northeast region went up $667,000.

Thus, the criteria of the model were in conflict over the third pricing alternative and it was left open to judgement whether or not the price proposal would improve the operation of the Northeast federal milk marketing orders.

Conclusion

The results of the runs made with the interorder price alignment model were encouraging. They seemed to pass the test of reasonableness, both in the direction of the changes resulting from the class 1 price realignments and in the magnitude of these changes. This is not to say that the method is without problems. Besides the restrictive assumptions introduced by the reliance on the transportation model, there are some internal problems yet to be resolved. Some question also remains about whether or not the right type of intermarket shipment was used, and whether or not it is wise to suppress all class 2 shipments. Nevertheless, the model seems to account fairly well for the institutional factors present in the Northeast fluid milk markets and on that point alone it may be of some interest.

APPENDIX

The interorder price alignment model is summarized below. A detailed description of this model can be found in the Bulletin "Interorder Relationships Among the Northeastern Federal Milk Marketing Orders" which is cited as [13] in the reference list.

Objective Function:

Minimize: $\sum_{i}\sum_{j}(c_{ij}+t_{ij}+d_{ij})\,X_{ij}+\sum_{j}\sum_{k}(p_{j}+s_{jk})\,Y_{jk}-\sum_{h}W_{h}$

Where: i = represents production areas

j,k = represents market areas

h = represents federal orders.

The parameters in the function are:

c_{ij} = per unit country plant cost

t_{ij} = per unit cost of transporting milk from production area i to market j

d_{ij} = difference between: (1) class 1 zone differentials plus any class 1 location differentials, and (2) blend price zone differentials plus any blend price location differentials

p_{j} = class 1 base price (nearby zone) for market j

s_{jk} = per unit cost of transporting milk from market j to market k.

The variables are:

X_{ij} = units of raw milk at source i to be shipped to market j

Y_{jk} = units of milk at market j to be shipped to market k

W_{h} = base blend price of order h multiplied by total producer deliveries regulated under order h.

Marketing costs are minimized and producer returns are maximized in the objective function. Total producer returns are defined as the product of the average zone blend prices and total producer deliveries. The objective function separates basing point prices from zone and location differentials. Hence both W_h and d_{ij} must be used to find total producer returns.

Demand-Supply Constraints:

$$\sum_j X_{ij} \leq S_i$$

$$\sum_j Y_{jk} \geq D_k$$

$$\sum_i X_{ij} - \sum_k Y_{jk} = 0.$$

Where:

S_j = total supply of milk at production area i.

D_k = total class 1 milk demanded in market k.

These constraints guarantee that the market demands are met, that available supplies are not exceeded, and that the quantity shipped equals the quantity demanded.

Majority Rule Constraints:

$$.51 \sum_{Jk}\sum Y_{Jk} - .49 \sum_{JK}\sum Y_{JK} \geq 0$$

Where:

J,K = markets within order h

k = markets outside order h

The majority rule constraints are simplified and aggregated formulations of the federal order pooling requirements. They force 51 percent of the class 1 sales regulated under an order to be sold in the order's marketing areas. One of these constraints is constructed for each of the h orders.

Total Producer Return Constraints:

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

where the parameters are:

p_h = class 1 price of order h

m_h = class 2 price of order h

e_h = milk sales regulated under order h and made outside the Northeast region's federal order market areas

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

v_h = total producer deliveries regulated under order h.

The variable Z_h is the total class 1 sales made within the federal order marketing areas and regulated under order h. The Z_h are computed by a set of <u>regulated delivery constraints</u>:

$$\sum_{J}\sum_{k} Y_{Jk} - Z_h = 0$$

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

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