Optimum Market Organizations of The Fluid Milk Industry in the United States Under Alternative Marketing Strategies

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Milk is produced in nearby areas for practically all markets in the United States. In previous decades, institutional restraints combined with high transfer costs and perishability of the raw and processed products were effective in stimulating local production for local markets and encouraging the continuation of single-plant firms. They were also effective in keeping large quantities of milk from moving between markets except when actual shortages existed. Concurrently a basing-point pricing system emerged which reflected prices in the most concentrated milk production area plus transfer costs for outlying markets.

The fluid milk industry has undergone drastic changes during the past 25 years. Though total milk production has remained relatively stable, the economic environment has not ben static. More milk is marketed in fluid form, and new technologies have affected the number, size, and methods of operation of marketing firms.

New technologies within the transportation system are especially noteworthy. Improved highway systems, bulk handling of raw milk, large capacity transports, and improved in-route refrigeration have greatly enhanced the flexibility of milk assembly and its distribution. Today, locally produced fluid milk can be used to serve almost any other market in the region or nation. Since the costs of moving this milk have been reduced, there are pressures to change the pricing system.

The processing sector has adapted to changes occurring in the industry. Fewer but larger firms are serving multiple markets. A 72 percent reduction in fluid milk processing plants occurred between 1948 and 1965 and the downward trend has continued.[1] However, excess or obsolete capacity continues to be a problem in the industry. At the same time, incentives exist for firms to penetrate new markets in order to increase plant volume and achieve higher operating efficiency.

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Objectives

The objectives of the study were to (1) construct a model which would aid in determining the most efficient organization of the dairy industry under alternative assumptions, (2) use the model to assess the effects on total costs and interregional flows of milk under alternative degrees of market concentration when economies of size in processing plants were permitted, and (3) use the model to analyze the effects on market areas, local market shares, and interregional flows of milk under alternative basing-point pricing structures.

The Model

In recent years, researchers have made use of mathematical programming techniques to handle the various complex decision alternatives in determining an optimum outcome. Both linear programming and transportation models are techniques which have been used in such determinations.

Linear programming involves an analysis of problems in which a linear function of a number of variables is to be minimized (or maximized) when those variables are subject to a number of restraints in the form of linear inequilities[2] The problem can be described generally as given a set of m linear inequalities or equations in n variables, the objective is to find non-negative values of these variables which will satisfy the constraints and minimize (or maximize) some linear function of the variables.[3] The model used in this study is based on the production-distribution model formulated by Martin[4]. Mathematically, the statement for the intermarket assembly and distribution cost (C_{A+D}) portion of the analysis is as follows:

$$C_{A+D} = \sum_{j=1}^{n} \sum_{i=1}^{m} C_{ij} X_{ij} + \sum_{k=1}^{p} \sum_{i=1}^{m} T_{ki} X_{ki} \qquad (1)$$

subject to the constraints:

$$\sum_{i} X_{ij} = D_j$$

$$\sum_{i} X_{ki} \leqslant S_k$$

$$\sum_{k} S_k \geqslant \sum_{j} D_j$$

$$X_{ij} \text{ and } X_{ki} \geqslant 0$$

where

C_{A+D} = total costs for the assembly and distribution of milk for fluid consumption,

X_{ij} = quantity of processed milk shipped from processing area i to demand area j,
C_{ij} = per unit distribution cost of shipping processed milk from processing area i to demand area j,
D_j = quantity of processed milk consumed in demand area j,
X_{ki} = quantity of raw milk shipped from supply area k to processing area i,
T_{ki} = per unit assembly cost of shipping raw milk from supply area k to processing area i,
S_k = quantity of raw milk available in supply area k.

Average cost curves reported for processing milk typically reflect decreasing costs associated with economies of size. Including the processing function in cost minimization, therefore, involves procedures to handle non-linearities. Separable programming is one technique for handling certain types of nonlinear functions within the framework of a general linear programming format. Crowder used this technique in a study of a closed Oklahoma dairy economy.[5]

The basic procedures in separable programming are to: (1) represent a polygonal function by means of linear equations coupled with logical restrictions, and (2) to use the simplex method on these equations, modifying the method in order to impose the restrictions.[6] The key element is the representation of a nonlinear function by piecewise linear segments. As an example, assume that the objective is to minimize the function:

$$F = \sum_{i=1}^{m} f(X_i) \qquad (2)$$

subject to:

$$\sum_{i=1}^{m} f(X_i) = \sum_{i=1}^{m} \sum_{h=1}^{u} X_{ih}\,\theta_h$$

where

X_{ih} = h^{th} variable of processing area i to enter the analysis, measured in terms of the quantity of milk in the h^{th} interval,
θ_h = average processing cost associated with the quantity of milk in the h^{th} interval.

If function F can be written as equation 2, then the function f (and, hence, F) can be approximated by piecewise linear functionals.[7] Consider for illustration the average cost function shown in Section A of Figure 1. The function and the implicit total cost function represented in Section B are curvilinear. The separable programming procedure permits the estimation of the total cost function in Section B by linear segments.

Ten points on the quantity scale in Figure 1 are arbitrarily defined in terms of X_o through x_{10}. The quantity intervals, h_1 through h_{10}, de-

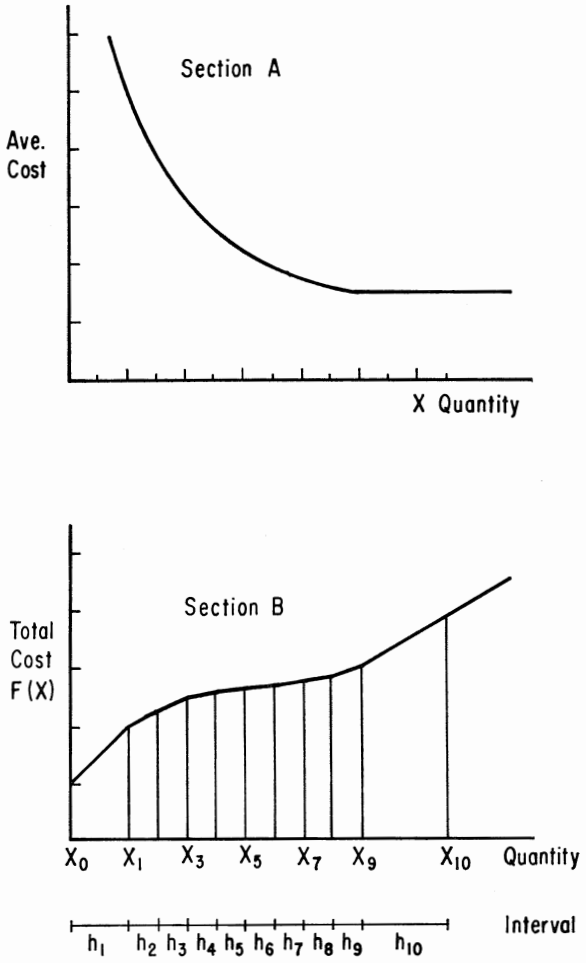


Figure 1 Hypothetical Average Cost and Linearly Segmented Total Cost Functions.

fined by the points on the quantity scale may be of variable lengths. Associated with each interval is a schedule of average costs; however, it is assumed that one average cost per unit, θ_i, is applicable for all units in the interval. That is the relationship is linear within the interval.

In the separable program, h_1 is the first variable to enter the analysis. The maximum total cost at this point is $(x_1 - x_0)\,\theta_1$. h_2 is the second variable to enter the analysis but can do so only after h_1 has

reached the maximum or upper limit. The cost for processing in the second interval is $(x_i - x_1)\,\theta_2$, where $x_1 > x_i \leqslant x_2$. The same conditions apply for subsequent variables. The cost function in Figure 1, therefore, is equivalent to a cumulative distribution function. Greater accuracy in representing a given function can be achieved by using a larger number of points which define shorter intervals over which each average cost is applied.

In determining minimum total costs for the optimum industry organization, the complete model must combine the linear transportation functions of raw milk assembly and processed milk distribution with the nonlinear processing cost function. The result is equation (1) plus equation (2) as follows:

$$TC = \sum_{j=1}^{n}\sum_{i=1}^{m} C_{ij}X_{ij} + \sum_{i=1}^{m} f(X_i) + \sum_{k=1}^{p}\sum_{i=1}^{m} T_{ki}X_{ki} \qquad (3)$$

where

TC = total industry cost and all other factors are as previously defined.

A special case of equation 3 was specified for an approximation of the current plant size environment. From the estimated number of firms by sizes, average processing costs for markets were estimated. The optimum organization was then determined on the basis of the transportation cost functions and the fixed processing cost coefficients. The solution for this case was a straight-forward linear programming solution without use of the separable function.

Markets and Basic Data

Production and Consumption Areas

The area of study is the 48 coterminous states in the continental United States. The area was divided into 105 consuming markets and 92 areas of production. The specific markets are depicted in Figures 2 and 3. Codes used in identifying demand (distribution points) areas and supply (assembly points) areas are given in Appendix Table I.

Boundaries selected for consuming markets are defined on the basis of three criteria. First, in Federal order areas, the area covered by the order is considered in determining the market area. Second, and closely related to the first, a market as defined in this study is closely related to population centers in the regions.

Within each consuming area, a central distribution point is selected on the basis of population and geographical location within the area. In

most instances, the most populous city near the center of the market area is selected; however, population is weighted heavier in the determination of the distribution center than the geographical location.

Figure 2 Demarcation of Market Areas Used in the Study.

Figure 3 Demarcation of Production Areas Used in the Study.

Third, a market was limited in coverage to a radius from an assembly point to the outside perimeter of less than 200 miles. This allows for realistic distribution functions serving the market from the base point. The only exception to this restriction was in the very sparsely populated areas of the continental United States.

In defining the production areas, consideration was given to the existing market orders and the sources of supply to these orders. Population is not a consideration in determining the central assembly point within an area but concentration of production is considered. In many instances the production is concentrated in the milkshed areas of the larger populated areas; and, as a result, many central assembly points are identical to consuming area distribution points. In addition, the outer perimeter of a production region is generally within 200 miles of the central assembly point.

To present a more concise description of the analysis of six models in this study, the United States was divided into five major regions and eight sub-regions. Individual market participation in the organizations were aggregated for each of the major regions and sub-regions as exhibited in Figure 4.

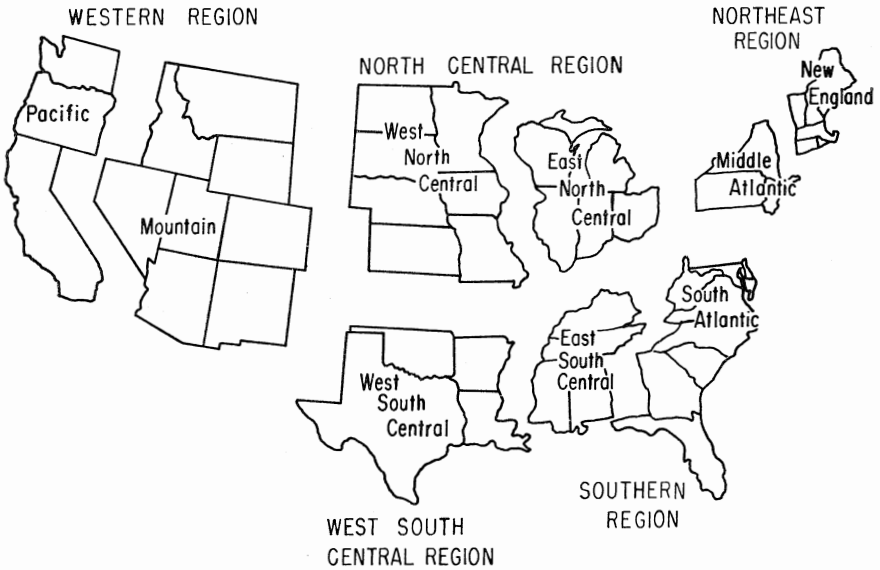


Figure 4 Regional and Sub-Regional Demarcation for Aggregated Summary Statistics.

The spatial dimension used in this analysis involves the mileage from point of production to points of processing to points of distribution. The distances used are obtained from the mileage chart of the Rand McNally Road Atlas and for those cities not listed on the mileage chart, the most direct route is selected on the appropriate map (s) from which the mileage between origin and destination are determined.[8]

Consumption Estimates

The dairy industry is regulated in many areas of the United States by state and federal agencies, and data are available on the amounts of fluid milk for human consumption in many of the markets. Coverage of markets is incomplete and in some cases it is difficult to determine the amount of overlay or duplication between markets. For this reason, consumption for each market included in the study was estimated.

Consumption estimates should reflect the influences of the size and characteristics of the population, income of consumers, price of product, tastes and preferences for the product, racial and ethnic influences, and other factors that determine demand. The size of the population is the most important variable determining the quantity of milk consumed in a market. For some of the subsequent variables, the size of the population is also used to obtain per capita estimates. The population estimates for each given market consisted of the aggregation of the population estimates for all counties within that market. Population estimates by county were obtained from the United States Population Census of July 1,1966.[9]

One of the factors influencing the consumption of fluid milk is the level of consumer income. Per capita disposable income was selected as the income variable, and data for each market were estimated from data reported in *Sales Management,* a publication which annually estimates various economic variables and business activity by state and county for the United States.[10]. The per capita disposable income level for each market was computed as the weighted average of per capita income estimates of the counties included in the market.

The retail prices of the fluid milk used in estimating consumption were the prevailing prices paid by consumers for the most common grade of whole milk sold at stores. The prices were for milk in one-half gallon paper containers and were obtained from the monthly series of *Fluid Milk and Cream Report.*[11] Although in many instances the retail markets reported in the *Fluid Milk and Cream Report* and the markets as defined in this study are not identical, they were sufficiently similar that the retail price reported for a given urban or metropolitan concentration was used for the market defined for this study. When two or more

major population centers were located in a given market, a weighted average retail price based on population in the centers was computed and used. In a market which was characterized by sparse population and no major metropolitan centers located in the market for which retail prices were available, the retail price reported for a nearby metropolitan center was used.

Taste and preferences, ethnic factors, geographical location, and racial structure influence milk consumption, but empirical estimates of the effects of some of these factors are limited. For one of the variables, Purcell found that southern Negro families consume approximately 3.64 quarts of fluid milk products per week less than Caucasian families, but no estimates were made for the rest of the United States.[12] In an effort to account for these factors in some manner, an attempt was made to determine a consumption estimate which reflected consumption habits in four major geographical regions of the United States. The beginning phase of the estimating procedure utilized estimates of consumption by Federal market order as published each year in the May issue of the *Fluid Milk and Cream Report.* Estimates of per capita consumption and population data in this publication were used to determine a weighted average per capita consumption for each of four regions. The regions are the South (Southern and West South Central Regions of Fig. 4) West, North Central and Northeast. These estimates of per capita region consumption of fluid milk reflected the composite effects of locatiin, income, price, racial, and other factors. The next phase of the estimating procedure involved establishing the basis for adjustment of the regional estimate of per capita consumption to remove the effects of regional income, regional prices and regional racial composition. The aim was to obtain an estimate of a constant term which reflected other factors affecting regional consumption. The basic form of equation 4 which follows was used to estimate Z_k, the constant term representing regional consumption. Data for the regions rather than the individual markets were used in the estimating procedure.

Per capita consumption estimates for fluid milk are estimated for each market in this analysis by the following equation.

$$C_i = Z_k + (Z_k)\ (.16)\ (\Delta I_i) + (Z_k)\ (-.285)\ (\Delta P_i) \pm \left[Z_i + \frac{-(f_1)\ (Z_k)\ (.16)\ (NWP_i) + (f_2)\ (Z_k)\ (WP_i)}{TP_i} \right] \quad (4)$$

where

C_i = estimated per capita consumption for market i

Z_k = estimated average per capita consumption in region K corrected for regional variations in income, price and racial factors

.16 = the estimated income elasticity for fluid milk[13]

ΔI_i = the percentage difference in per capita disposable income in market i and the national average per capita disposable income.

—.285 = the estimated price elasticity of demand for fluid milk.[14]

P_i = the percentage difference in the retail price of fluid milk sold in half gallon containers in market i and the national average price for milk sold in half gallon containers

f_1 = a conversion factor depicting the difference of consumption of non-white Americans from the national average per capita consumption.

NWP_i = estimate of the non-white population in market i.

f_2 = conversion factor representing the difference in consumption of the Caucasion population from the national average per capita consumption.

WP_i = estimate of Caucasion population in market i.

TP_i = the estimate of total population in market i.

Production Data

Production estimates for fluid-eligible milk were computed for all counties in the United States with the exception of counties in some southern states. Production for the month of October, 1965 was selected for the study. A fall month of normally low production was chosen in preference to an annual average or flush production period because October is considered a representative month for a conservative determination of the availability of excess supplies of milk.[15]

In most instances, the major source of production data was state agricultural agencies which had total production estimates by month and year for all counties within the state. Even though data on total production could be developed from state and federal statistics, the quantity of fluid milk available for human consumption was not available. For raw milk to be eligible for human consumption, certain sanitary requirements must be met by the producer. If these requirements

are met, the producer is allowed to market his milk as Grade A or Class I. Since surplus production is characteristic of many areas, a producer may not be able to sell his entire production at the Class I price. In this case, a certain proportion is defined as Class II (Class III in some markets) and used for manufacturing purposes. The producer would receive a blend price for his production made up of the proportion of his sales being utilized as Class I and Class II.

In an attempt to estimate the amount of fluid milk eligible for human consumption, class prices, average prices, and average butterfat contents of milk sold at the respective 1965 prices as reported in *Fluid Milk and Cream Report* were used. The butterfat content was used to adjust the various prices to a standard fat level.

As an example of the estimating procedure, assume that Oklahoma farmers are paid an average price of $4.80 per hundred pounds of milk eligible for the fluid markets for milk with an average butterfat test of 3.63 percent. The average price for manufacturing grade milk is $3.42 for an average butterfat test of 3.89 percent, and the average price of all milk sold in the market is $4.64 with an average butterfat test of 3.66 percent. The average price of all fluid milk converted to an equivalent price per point of butterfat test (0.1 percent) is $0.1268. Using the equivalent price for all milk, the standardized price of milk eligible for fluid markets is the quoted price adjusted upward for 0.3 points (from 3.63 to 3.66 percent butterfat) or $0.0380 (0.3 x 0.1268 = 0.0380). The manufacturing price can be adjusted down by 2.3 points in a similar manner. The standardized price of manufacturing milk would decrease by $0.2916 (2.3 x 0.1268).

The adjusted prices were used in the following equation:

$$Q_j\hat{P}_{1j} + (1.0 - Q_j)\ \hat{P}_{2j} = \hat{P}a_j \qquad (5)$$

where

Q_j = the proportion of total production eligible for human consumption.

P_{ij} = the fat test adjusted Class I price for production area j.

P_{2j} = the fat test adjusted Class II price (manufacturing milk) for production area j.

P_{aj} = the average price for all fluid milk sold in market j.

The proportion determined from equation 5 was then used to determine the amount of fluid milk eligible for fluid consumption from total production.

Assembly Costs

Assembly cost generally is a term which is associated with the cost involved in performing the functions of transporting milk from the farm to a processing facility. In this study, however, assembly costs are defined more narrowly as those costs associated with the movement of raw fluid milk from a specified assembly point within a production area to any location where a processing facility may be established. Costs involved in moving milk from farms to the specified assembly point are excluded.

Costs for long distance movements of bulk milk were developed by Kerchner for the East, Midwest, and Western regions of the United States.[16] Using information from trucking firms, milk equipment dealers, and specific input-output data, a synthetic method of analysis was used to develop transportation cost functions for hauling bulk milk. Both fixed and variable costs were developed. The fixed costs included administrative costs, depreciation, federal highway use tax, insurance, interest, license, miscellaneous tax, and management and office salaries. The fixed costs for a 49,000 pound pay load truck amounted to 11.405¢ per hundredweight for average annual volume and distance levels. Variable costs included fuel, labor, tires, maintenance, and miscellaneous items and amounted to 0.1126 cents per hundredweight pe rmile for the 49,000 pound pay load truck. In addition to the fixed and variable costs for the truck, the bulk transport cost function included a transfer cost of 4 cents per hundredweight. This cost was to represent the cost of transferring milk to a large transport at a reload station.

The bulk milk transportation cost function used in this study is based on Kerchner's aggregate function for the 49,000 pound pay load unit. The equation is:

$$T_{ki} = 11.405 + 0.1126\ M_{ki} \qquad (6)$$

where

T_{ki} = Assembly costs in cents per hundredweight for transporting raw milk from production area k to processing area i,

M_{ki} = one-way mileage from k to i.

.11260 = estimate of the variable cost in cents per hundredweight per mile.

Distribution Costs

Distribution costs are defined in this study as costs incurred in the movement of packaged fluid milk from the processing facility to the centrally located distribution outlet of any market area. This involves the movement of the finished product to the central distribution point of the market area and gives no consideration to the particular distribution method in any of the markets. Costs involved in moving the product from a single distribution outlet to the consumer are not considered.

As with the assembly cost function, Kerchner's cost functions for packaged fluid milk are used. Basically, Kerchner's transportation costs for packaged milk are derived by adjusting the bulk milk transportation costs. The major adjustment consisted of the replacement of the bulk semitrailer with a 40-foot refrigerated trailer. The adjustment lowers the capacity of the trailer from 49,000 pounds to 35,000 pounds, permitting 8100 one-half gallon cartons to be transported in wire cases. The costs were derived under the assumption of no backhaul activities. The only other major cost variation was for the time involved in loading and unloading activities. Packaged milk placed in palletized cases could be loaded with a forklift in 1 hour and unloaded in 1.5 hours compared with the bulk hauling operation requiring 2 hours for loading and 1.5 hours for unloading.

Using the adjusted data, Kerchner developed the following distribution cost function:

$$C_{ij} = 6.513 + 0.16025\ M_{ij} \qquad (7)$$

where

C_{ij} = distribution cost in cents per hundredweight for transporting packaged milk from processing area i to demand area j

M_{ij} = one-way mileage from i to j.

Processing Costs

Processing costs are defined in this study as costs associated with the transformation of raw milk into the final packaged product ready for delivery. There are several studies which have reported estimates of processing costs. Cobia and Babb used these studies to approximate a planning curve for fluid milk processing plants.[17] Both synthetic and statistical studies were involved in the development of planning curves with input prices being adjusted by the appropriate price indices.

Several planning curves were developed by Cobia and Babb to reflecting various product mixes, container sizes, and types of containers. The planning curve selected for this analysis represents a firm processing milk in one-half gallon paper containers. Based on recent trends toward paper containers and the voume of milk sold in the one-half gallon size, this type of firm was considered to be representative of an efficient operation in the processing industry.

The function developed by Cobia and Babb for this organization is as follows:

$$PC_{gi} = 11.763\ X_{gi}^{\ -0.11507} \qquad (8)$$

where

PC_{gi} = processing cost in cents per quart for plant g in area i,

X_{gi} = quantity of milk processed in quarts per day for plant g in area i.

Equation 8 was defined only for daily volumes up to 130,000 quarts per day and it was necessary to extend the function for this study. However, the extended planning curve fails to reach a minimum point and turn up as might be expected for large processing facilities if diseconomies were present. At least a minimum point should be attained since certain costs per unit are constant and must be met. Such costs include container, variable labor, and some portion of administrative costs. Crowder had the same problem in a similar study of the Oklahoma dairy industry. After obtaining various sized container costs and interviewing fluid milk processors, Crowder determined that the minimum costs per quart were 1.3 cents for containers (one-half gallon paper) and .5 cents for labor and administrative functions.[18] Crowder's combined estimates of 1.8 cents per quart were selected for use in this analysis. Equation 8 was used for determining average processing costs for all volumes where $PC \geqslant K$ and K is equal to 1.8 cents per quart. The constant K is the lower limit for equation 8 and represents the average processing costs used for facilities with volumes which would yield $PC < K$ if equation 8 were used.

In addition to the adjustments above, the function should reflect the 1965 price level considered as a base for the study. Since the planning curve was formulated using 1961 price indices, use of the function could be in error by the difference in the price levels in the two years. However, price increases could be offset by cost saving advances in technology affecting the processing of milk. It is assumed that such effects are offsetting and the function in equation 8 is used to represent processing costs.

Single Firm Market Organizations

The models in this section are formulated to determine the minimum cost flow of fluid milk from production assembly points to retail distribution points in an unrestricted market environment. The general assumptions are as follows: (1) barriers to free flow of fluid milk which might be created by State and Federal Market agencies are non existent, (2) sanitation and health requirements are met by all producers, processors, transporters and handlers of the resource and final product, and (3) fluid milk marketing firms are assumed to have management with equal ability and perfect knowledge of economic conditions. In general, the industry is assumed to be involved in an economic environment in which maximum efficiency is the goal.

Processing activities are specified for each consuming market. It is assumed that the processor is initiating the action in obtaining adequate resource supplies. The cost of transferring milk from a production area to a processing facility is charged to the receiver. Costs associated with transportation of the final product is charged to processors at points of origin under the assumption that processors initiate the movements to other markets in an effort to increase their market shares.

Each market is permitted to have one processing plant. Plant sizes are variable between markets and each market is faced with the selection from among 10 plants of different sizes. Plant size I is specified as the smallest alternative size and generally represents a facility with enough capacity to process approximately seven percent of the local needs. Each additional expansion in the firm's size is based on a percentage of the local market consumption. Plant sizes II through VII represent 15, 35, 50, 115, 150, 200 and 250 percent of the local demand.

Beyond these incremental sizes associated with each market, two additional plant sizes are specified. Plant size IX, next to the largest, represents a firm operating at 10 million quarts per day, approximately the size where the average cost curve flattens and becomes horizontal. Plant size X, the largest, has the capacity to meet the demand required for all markets in the continental United States.

Two models are considered in this section. In the first model, Model I, producers in all geographical areas are assumed to receive the same resource (raw milk) price. In Model II, the 1965 producer raw milk price structure is assumed.

Model I

Summary statistics for the production activities of Model I by regions are presented in Table I. The demand is for 4,679 million pounds of milk per month with 1,830 million pounds remaining unused.

Table 1. Summary Statistics of Production and Assembly Activities, United States and Regions, Model I.

Region	Production: Used (1,000 lbs.)	Production: Unused (1,000 lbs.)	Assembly Cost ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity* (1,000 lbs.)
West	761,815	251,914	338	0	852	MTN to PAC - 8,799
Pacific	575,593	210,894	361	8,799	0	MTN to WSC - 852
Mountain	186,221	41,021	27	0	852	
West South Central	393,730	24,185	158	7,827	6,301	WSC to ESC - 6,301
Southern	754,566	56,535	803	45,702	6,975	SA to ESC - 17,196
South Atlantic	534,001	56,535	621	20,719	17,196	ESC to WSC - 6,975
East South Central	220,565	0	182	62,898	27,694	ESC to SA - 20,719
North Central	1,516,271	889,425	124	0	39,401	ENC to WNC - 688
West North Central	412,388	406,162	73	688	0	ENC to ESC - 39,401
East North Central	1,103,883	483,263	51	0	40,089	
Northeast	1,252,329	608,363	1,743	0	0	
Mid-Atlantic	927,218	563,320	1,340	0	0	
New England	325,111	45,043	403	0	0	
Total	4,678,711	1,830,423	3,216	53,529	53,529	

*The abbreviations correspond to the following: MTN=Mountain, PAC=Pacific, WSC=West South Central, ESC=East South Central, SA=South Atlantic, WNC=West North Central, ENC=East North Central, MA=Mid-Atlantic, and NE=New England.

Of the 92 production areas defined for the United States, 76 have production utilized in the least cost solution. Transportation to distant markets is required for 1,138 million pounds of milk. Costs associated with supplying distant markets totals 3.3 million dollars and represents 6.1 percent of the total costs associated with the entire organization.

Processing costs total 46.1 million dollars or 86.8 percent of the total organizational costs. Costs associated with distribution functions account for 3.8 million or 7.1 percent of the total cost of the organization. In the optimum organization, 64 plants are operating at an average output of 73.1 million pounds per month. The processing cost averages 0.98 cents per pound or about 2.1 cents per quart.

Production and Assembly Activities

West—

Raw fluid milk is utilized from 15 of the 20 production areas in the region. The areas supply a total of 759 million pounds of raw milk to 14 processing facilities within the region, and 252 million pounds are unused. Assembly costs associated with the intermarket movements of raw fluid milk total $338,000 (Table 1). Most of the assembly costs involve milk moving from San Francisco, Las Vegas (Nevada) and Phoenix (Arizona) to serve the needs of the production deficit area of Los Angeles. Other movements include Billings (Montana), shipping to Helena; and Albuquerque and Phoenix supplying the El Paso facility. The Western region is a net exporter of the resource, shipping 852 thousand pounds to interregional markets. No imports are necessary.

West South Central—

Twelve processing facilities are established with a total capacity of 398 millions pounds per month in the West South Central region. Facilities are served by 14 of the 15 local supply areas. Imports from the Western and Southern regions total 8 million pounds, but the region has exports totaling 6 million pounds. Net imports, therefore, are small. Unused production in the region totals 24 million pounds.

Total costs associated with intraregional and interregional movements of raw fluid milk are $158,000. Although several shipments are involved, the major ones include San Angelo (Texas) serving the Texas-based facilities of Lubbock, Odessa and Corpus Christi; and Shreveport (Louisiana) serving facilities in Louisiana and Arkansas. Other transfers include Dallas shipping to Houston; Amarillo transporting to Lubbock (Texas); and Fort Stockton (Texas) supplying El Paso. The quantities of raw fluid milk transported between markets within the region and imports total 46 million pounds.

Southern—

Production from 19 of the 20 local areas is utilized in serving 17 processing facilities in the Southern Region. Assembly costs for intraregional movements and imports of the resource total $803,000. Production is utilized very effeceively with little unused production, approximately 57 million pounds. A total of approximately 46 million pounds of resource is imported from the West South Central and North Central regions.

Within the region, major movements include: Nashville (Tennessee) serving facilities in Tennessee, Alabama, and Atlanta; and Mobile (Alabama) shipping to facilities in Louisiana, Florida and Georgia. Other movements include Bristol (Virginia) and Charlotte (North Carolina) serving processors in the Carolinas and Tennessee with Jacksonville (Florida) transporting to southern and central Florida facilities and Jackson (Mississippi) supplying New Orleans.

North Central—

The North Central region has the smallest cost of intermarket milk assembly of any of the five major regions. Since the region requires no importation, the $124,000 assembly costs is for intraregional movements. Major intraregional movements of milk include Sioux City (Iowa) shipping to Omaha; Decatur (Illinois) supplying St. Louis; and Columbus (Ohio) transporting to Cincinati. Interregional movements are made from Indianapolis to Louisville (Kentucky) and from Evansville (Indiana) to Memphis.

Production from only 19 of the 27 production areas is utilized. The areas supply 16 processing facilities with 1,477 million pounds per month and export 39 million pounds per month to the Southern region. Even though more than 1,500 million pounds of milk are utilized from this area, 889 million pounds per month are unused for processing purposes.

Northeast—

Five processing facilities utilize raw fluid milk from 9 of the 10 production areas in the region. Assembly costs are the highest of any major region and total $1.7 million for intraregional shipments. The primary reason for the high assembly costs is the large quantity of milk shipped to New York City and Boston. Shipments total 634 million pounds per month. Shipments to New York originate at Williamsport (Pennsyvania), Philadelphia, and Hartford (Connecticut). Concord (New Hampshire) and Hartford serve the Boston facility. There are no import-export activities, and all demands are met with regional productio. Excess production totals 608 million pouds.

Processing and Distribution

Summary statistics of the spatial and processing activities of Model I are included in Tables 2 and 3. Table 2 includes processing and distribution costs and quantities transferred. Table 3 includes the number of firms by sizes which are indicated as optimal for this model. Data for individual markets are included in Appendix Table II.

West—

The least cost organization consists of 14 processing facilities (average size 54.2 million pounds) processing 759 million pounds at an average cost of 1.03 cents per pound in the Western region. In addition to processing for regional needs, Western facilities process 5 million pounds to serve a market in the North Central region. The interregional movement of the final product involves Denver transporting to Rapid City (South Dakota). Intraregional shipments of packaged milk include Denver shipping to Casper (Wyoming); Salt Lake City transporting to Idaho Falls (Idaho), Cedar City (Utah) and Rock Springs (Wyoming); Phoenix supplying Flagstaff; and San Francisco shipping to Reno (Nevada) and Alturas (California). Distribution costs associated with these movements total $192,000.

Influence of population density upon economies of size in processing is significant, as illustrated by the difference in processing costs between the Pacific and Mountain sub-regions. The population density of the Pacific area with its larger, more concentrated urban centers permits the location of larger processing. Processing cost per pound averages 0.98 cents in this area versus 1.18 cents for the Mountain area. Two facilities (Los Angeles and San Francisco) are established with more than 100 million pounds of processing per month. The Mountain subregion on the other hand is characteristized by smaller facilities, three of which are under 10 million pounds capacity. The largest facility is located at Denver with a capacity of 53 million pounds. The variation in the sizes of plants established accounts for the variation in per unit processing costs.

West South Central—

Processing of 398 million pounds per month requires the establishment of 12 facilities. Processing costs are 4.5 million dollars or 1.14 cents per pound, the highest per unit cost of any region. There are no interregional transshipments (imports or exports) but intraregional movements occur. The latter are comprised of Tulsa shipping to Little Rock and Oklahoma City; Dallas shipping to Wichita Falls (Texas); and San Antonio supplying Corpus Christi. The servicing of these markets requires distribution costs of $128,000.

Table 2. Summary Statistics of Processing and Distribution Activities, United States and Regions, Model I.

Region	Processing Costs ($1,000)	Distribution Costs ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs)
West	7,812	192	0	5,211	
Pacific	5,752	46	0	3,880	PAC → MTN - 3,880
Mountain	2,060	146	3,880	5,211	MTN → WNC - 5,211
West South Central	4,525	128	0	0	---
Southern	8,657	285	65,768	8,720	
South Atlantic	5,858	151	65,768	8,720	SA → MA - 5,211
East South Central	2,799	134	0	0	
North Central	14,018	1,825	5,211	0	
West North Central	4,416	369	5,211	16,592	WNC → ENC - 16,592
East North Central	9,602	1,456	16,592	32,272	ENC → WNC - 32,272
Northeast	11,073	1,363	8,720	65,768	
Mid-Atlantic	8,505	1,155	8,720	82,553	MA → NE - 16,785 MA → SA - 65,768
New England	2,568	208	16,785	0	
Total	46,084	3,793	79,699	79,699	

Table 3. Distribution of Firms by Size and Region Under the Assumptions of Model I.

Region	No. of Demand Areas	Potential Number of Processing Facilities	No. of Firms by Size Classification in Millions of Pounds								Avg. Size of Facility in Millions of lbs.
			Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	
West	21	21	0	3	4	4	1	1	1	14	54.2
Pacific	7	7	0	0	2	2	0	1	1	6	97.4
Mountain	14	14	0	3	2	2	1	0	0	8	21.8
West South Central	14	14	0	1	5	3	3	0	0	12	33.1
Southern	23	23	0	0	1	13	2	1	0	17	46.7
South Atlantic	15	15	0	0	1	8	1	1	0	11	48.9
East South Central	8	8	0	0	0	5	1	0	0	6	42.6
North Central	35	35	1	3	4	2	2	2	2	16	92.3
West North Central	19	19	1	2	3	1	2	1	0	10	41.3
East North Central	16	16	0	1	1	1	0	1	2	6	177.3
Northeast	12	12	0	1	0	0	0	4	1	5	250.5
Mid-Atlantic	7	7	0	0	0	0	0	2	1	3	325.2
New England	5	5	0	1	0	0	0	1	0	2	138.4
Total	105	105	1	8	14	22	8	8	4	64	73.1

Southern—

The least cost market organization indicates the utilization of 17 Southern processing facilities (average size 46.7 million pounds) to process 538 million pounds of fluid milk per month at a total cost of $8.7 million. The average processing cost of 1.09 cents per pound is relatively high, primarily because of the number of firms involved in the processing function. More firms are involved in processing, and the facilities are generally smaller and do not have the economies of size which appear to be present in some of the more populous regions.

With 17 facilities located in the region, only four serve more than their local markets. Approximately nine million pounds are processed for Northeastern markets, Baltimore shipping packaged milk to Philadelphia. These exports are more than offset by imports of 66 million pounds from Northeastern processing facilities. Movements within the region include Nashville (Tenessee) shipping to Paducah (Kentucky); Jackson (Mississippi) supplying Mobile (Alabama); and Raleigh (North Carolina) transporting to Danville (Virginia).

North Central—

North Central is the largest regional consumer of fluid milk, 1,482 million pounds per month. Of this total consumption, 1,477 million pounds per month are processed within the region by 16 facilities. The average size of a facility established is 92.3 million pounds. About five million pounds are imported from the Western region. Regional processing costs total $14.0 million or an average cost of 0.94 cents per pound.

As in the West, significant processing cost differentials exist within sub-regions. Processing costs in the East North Central area average 0.90 cents per pound compared with 1.07 cents in the West North Central area. The differentials in this region reflect the same factors as in the West. Facilities located in Chicago and Detroit are large enough to achieve economies of size in their local markets and can achieve still greater economies by serving nearby population centers. In the West North Central sub-region, Minneapolis is the only facility that approaches the magnitude of the Chicago and Detroit facilities. However, no additional large urban centers are located nearby.

Three facilities are very large. Intermarket transfers include Chicago serving markets in Illinois, Iowa, Wisconsin, Michigan, and Indiana; Detroit transporting processed milk to Ohio and Michigan markets; and Minneapolis shipping the final product to distribution points in Minnesota, North Dakota, South Dakota, Iowa and Wisconsin. Other intraregional movements include Kansas City transporting to Grand

Island (Nebraska) and Columbia (Missouri); and Cleveland shipping to Columbus (Ohio). Total costs for distribution are $1.8 million.

Northeast—

Five plants averaging 250.5 million pounds of capacity process 1,252 million pounds of milk. Processing costs total $1.1 million or an average of 0.88 cents per pound. This is the lowest per unit processing cost in any of the five major regions.

Distribution costs total $1.4 million for transporting 426 million pounds of processed fluid milk. About 66 million pounds of milk are transported from Pittsburgh to markets in Virginia in the Southern region. Other transfers consist of Rochester supplying Williamsport (Pennsylvania), Albny (New York), Utica (New York), and Burlington (Vermont); New York shipping to philadelphia; and Boston transporting to Portland (Maine) and Hartford (Connecticut).

Model II

Model II is similar to Model I. The assumptions regarding the structure of the model, supplies, demands, costs of transportation, processing costs, non-restriction of plant sizes, and grid refinement are the same. The only difference is the level of farm prices in individual markets. The purpose of Model II is to determine the optimum market organization under the price structures represented by 1965 f.o.b. plant prices paid to farmers. These prices are inserted into the model as a part of the assembly costs, and each processor has access to any milk produced anywhere in the United States as an alternative to his local supply.

Production and Assembly Activities

Summary statistics for the production activities of Model II are presented in Table 4. The least cost organization under the assumptions of Model II utilizes the production from 64 of the 92 production areas; a total of 59 processing facilities process 4,679 million pounds of raw fluid milk. Intermarket movements necessary to fulfill all needs across the nation total 1,138 million pounds or about one-fourth of total consumption. Assembly cost outlays amount to $9.1 million or 15 percent of total cost of the market functions under consideration.

West—

Production is utilized from 13 of 20 western production areas. Fourteen processing facilities are supplied with 713 million pounds of raw fluid milk. An additional 2 million pounds is exported to processing facilities in the West South Central region. Assembly costs for intra-regional movements of raw milk plus transfer costs for 47 million pounds

Table 4. Summary Statistics of Production and Assembly Activities, United States and Regions, Model II.

Region	Production		Assembly			Export Region and Quantity (1,000 lbs.)		
	Used (1,000 lbs.)	Unused (1,000 lbs.)	Cost ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)			
West	709,147	304,582	661	46,593	2,407			
Pacific	555,825	230,662	409	20,184	0			
Mountain	153,322	73,920	252	46,593	22,591	MTN → PAC		20,184
						MTN → WSC		2,407
West South Central	270,231	147,684	1,067	122,938	6,301	WSC → ESC		6,301
Southern	445,705	365,396	2,092	226,813	114,469			
South Atlantic	288,264	302,272	1,558	175,490	113,177	SA → MA		113,177
East South Central	157,441	63,124	534	76,005	25,974	ESC → WSC		1,292
North Central	2,404,059	1,637	1,917	0	608,541			
West North Central	816,913	1,637	389	0	238,304	WNC → MTN		46,593
						WNC → WSC		119,239
						WNC → ENC		51,717
						WNC → ESC		20,755
East North Central	1,587,146	0	1,528	51,717	421,954	ENC → SA		150,808
North East	849,568	1,011,124	3,387	335,374	0			
Mid-Atlantic	720,955	769,583	2,731	335,374	168,852	MA → NE		164,852
New England	128,613	241,541	656	164,852	0			
Total	4,678,710	1,830,423	9,124	731,718	731,718			

imported from production areas in the North Central region total $661,000. The major movements of raw milk within the region involve Los Angeles being supplied by San Francisco, Salt Lake City, Las Vegas, and Flagstaff (Arizona). The only interregional movement has Albuquerque shipping to El Paso. Approximately 305 million pounds are not utilized in processing activities.

West South Central—

Production is utilized from 9 of 15 production areas serving 9 processing facilities in the West South Central region. Imports total 121 million pounds while 148 million pounds of production throughout the region is unused because of the relatively higher 1965 resource prices. Total costs associated with assembly functions within the region and for imports total $1.1 million. Raw fluid milk imports come primarily from the North Central region. Grand Island (Nebraska) production serves facilities in San Antonio and the Panhandle area of Texas; Dodge City's supply is transported to El Paso and Lubbock (Texas); Wichita (Kansas) serves facilities in southern Texas; Sioux City (Iowa) ships to Houston; and Springfield (Missouri) serves facilities in Little Rock and New Orleans. Intraregional movement involves Fort Stockton (Texas) shipping to El Paso.

Southern—

Southern regional processing facilities consist of 14 plants utilizing production from 9 of 20 Southern production areas and imports of 227 million pounds. The quantity of imports moving into the Southern region creates an interesting dilemma for state control agencies since 366 million pounds of unused production remains in the South under these prices. With no barriers to interregional movement of milk, Model II results indicate the types and magnitudes of movements which would take place under the 1965 pricing structure. For example, in the Atlanta production area, the 1965 f.o.b. price paid to farmers is $6.86 per hundredweight while the price at Indianapolis, Indiana is $4.56 per hundredweight. Since the transportation rate per hundredweight is $0.46, the cheapest source of milk is the Indianapolis market. Processors therefore will import milk from this market rather than utilize local production if costs are to be minimized.

Total assembly costs associated with intraregional movements and imports total $2.2 million for the Southern region. Most of the milk imported (221 million pounds) originates in the North Central region. Significant quantities move from the Indianapolis, Evansville (Indiana), Decatur (Illinois), Davenport (Iowa), Des Moines and Wausau (Wisconsin) production areas. These movements are made primarily to

Florida, Alabama, Georgia, South Carolina and eastern Tennessee. Approximately six million pounds are imported from the West South Central region.

North Central—

The 1965 pricing structure reflects comparatively low prices which have evolved under Federal order pricing of milk in the North Central milk production area with large "surplus" supplies. As a result of the comparative price advantage in interregional movements of milk, North Central production totaling 2,404 million pounds is utilized from 26 of 27 production areas and total production is almost completely utilized in consumption. No imports are required but only 2 million pounds of raw milk are unused. Intraregional assembly costs total $1.9 million to ship the raw fluid milk to 16 regional processing facilities.

Exports are significant and total 238 million pounds of raw fluid milk. Generally, excess milk production in the Dakotas moves to Western facilities; Nebraska and Kansas production is shipped to Texas and Colorado facilities; southwestern Missouri's production is shipped to facilities located in Little Rock and New Orleans; and production from southern Illinois and southern Indiana moves to various markets throughout the Southwest. In addition, production located in northern Indiana and southern Michigan moves to Northeastern facilities.

Northeast—

Production is used from 7 of the 10 northeastern regional production areas and transported to 7 regional processing facilities. These facilities have a combined capacity totaling 1,073 million pounds per month. Of this total, 738 million pounds are obtained from local regional production areas. Over one billion pounds of regional production are unused as Class I milk. Imports are 335 million pounds and consist of 222 million pounds from the North Central production areas of South Bend (Indiana) and Detroit and 113 million pounds from the Washington (D.C.) supply area of the Southern region. Asembly costs total $3.4 million for the intraregional and interregional movements of 683 million pounds of milk.

Processing and Distribution Activities

The processing and distribution costs and intermarket transfers in the optimum organization for Model II are summarized in Table 5 and given in detail in Appendix Table II. Processing costs in 64 facilities total $46.0 million at an average of 0.98 cents per pound. Processing costs represent approximately 76 percent of the total cost of all activities. Distribution costs associated with intra-and interregional movements total $5.5 million and accout for 9 percent of the total cost.

Table 5. Summary Statistics of Processing and Distribution Activities, United States and Regions, Model II.

Region	Processing Costs ($1,000)	Distribution Costs ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs)
West	7,723	232	0	0	
Pacific	5,680	0	3,880	0	
Mountain	2,043	232	0	3,880	MTN → PAC 3,880
West South Central	4,287	273	10,795	0	
Southern	7,271	353	180,375	0	
South Atlantic	5,013	249	132,076	0	
East South Central	2,258	105	48,299	0	
North Central	16,764	4,313	0	313,427	
West North Central	5,946	1,061	0	144,631	WNC → WSC 10,795
					WNC → ENC 124,303
					WNC → ESC 9,533
East North Central	10,818	3,252	124,303	293,099	ENC → SA 132,076
					ENC → ESC 38,767
					ENC → MA 122,256
Northeast	9,938	311	122,256	0	
Mid Atlantic	6,988	269	122,256	0	
New England	2,951	41	0	0	
Total	45,983	5,483	313,426	313,426	

West—

The number of processing facilities established totals 13 in the west. These facilities operate at an average capacity of 57.9 million pounds and a combined capacity of 753 million pounds (Table 6). Costs associated with processing this quantity total $7.7 million at an average of 1.03 cents per pound. Average processing costs vary within the region from 0.98 to 1.15 cents per pound for the Pacific and Mountain sub-regions, respectively. The difference reflects economies of size of plants located in metropolitan areas of Pacific coast cities versus plants located in the less populus centers in the mountain sub-region. San Francisco and Los Angeles have the largest plants, and the lowest costs, with facilities in excess of 100 and 200 million pounds per month, respectively.

Processing facilities shipping processed milk to intraregional markets include Boise (Idaho) transporting to Alturas (California), Reno (Nevada) and Idaho Falls (Idaho); Billings (Montana) shipping to Helena (Montana), Idaho Falls (Idaho), Rock Springs (Wyoming), and Casper (Wyoming); Salt Lake City supplying Cedar City (Utah); and Phoenix serving Flagstaff (Arizona). Distribution costs for intra-regional movements of 44 million pounds total $232,000.

West South Central—

Imports of 11 million pounds of processed milk are required to supplement the 387 million pounds processed within the West South Central region. Imports are from one facility in Wichita (Kansas) supplying distribution outlets in Wichita Falls (Texas). Processing costs associated with regional facilities total $4.3 million with an average unit cost of 1.11 cents per pound. Per unit costs in this region are higher than for any of the other four major regions, and are exceeded in only one sub-region, the Mountain with per unit costs of 1.15 cents. The high costs reflect relatively low population concentrations within the markets of these regions in which it is difficult to take advantage of economies associated with large facilities. This region has the lowest average capacity of all regions at 43.0 million pounds.

Movements of processed milk within the region total 89 million pounds, and costs associated with these distribution activities total 273,000. Shipments from four facilities within the regional account for the intermarket movements which consist of Tulsa serving Oklahoma City and Wichita Falls (Texas) markets; Dallas shipping to the Shreveport (Louisiana) and Corpus Christi (Texas) markets; Lubbock (Texas) transporting to Odessa (Texas); and San Antonio (Texas) transferring processed milk to Corpus Christi (Texas).

Table 6. Distribution of Firms by Size and Region, Model II.

Region	No. of Demand Areas	Potential Number of Processing Facilities	No. of Firms by Size Classification in Millions of Pounds								Avg. Size of Facility in Millions of lbs.
			Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	
West	21	21	0	1	5	5	0	1	1	13	57.9
Pacific	7	7	0	0	2	2	0	1	1	6	96.0
Mountain	14	14	0	1	3	3	0	0	0	7	25.3
West South Central	14	14	0	1	3	0	5	0	0	9	43.0
Southern	23	23	0	0	1	10	2	1	0	14	47.9
South Atlantic	15	15	0	0	1	6	1	1	0	9	51.4
East South Central	8	8	0	0	0	4	1	0	0	5	41.5
North Central	35	35	0	1	3	4	4	1	3	16	112.2
West North Central	19	19	0	1	2	3	3	0	1	10	57.9
East North Central	16	16	0	0	1	1	1	1	2	6	202.8
Northeast	12	12	0	1	1	0	1	3	1	7	153.3
Mid Atlantic	7	7	0	0	0	0	0	2	1	3	259.9
New England	5	5	0	1	1	0	1	1	0	4	73.4
Total	105	105	0	4	13	19	12	6	5	59	79.3

Southern—

This region processes 670 million pounds of milk at a total processing cost of $7.3 million, an average of 1.09 cents per pound. Processing activities are carried out in facilities averaging 47.9 million pounds of capacity. Processed milk does not flow as freely into the South as raw milk because of the relatively higher transportation costs for processed milk. Nevertheless, distribution outlets require approximately 181 million pounds of processed milk from interregional sources and is supplied by North Central regional processing facilities. The Columbus (Ohio) facility ships to markets in the Virginias and North Carolina; the Chicago facility serves Louisville (Kentucky); and the St. Louis facility supplies Paducah, Kentucky. Within the region, four facilities process an additional 96 million pounds of milk above local demands to meet demands of other markets in the region. Jackson (Mississippi) serves Mobile (Alabama); Charleston (West Virginia) supplies Danville (Virginia); Baltimore transports to Richmond (Virginia); and Charleston (South Carolina) ships to Jacksonville (Florida) and Columbia (South Carolina). Distribution costs associated with these movements total $354,000.

North Central—

The region represents the hub of activity in the fluid milk industry under the assumptions of Model II. The region has abundant fluid milk resources for export activities and at the same time provides adequate supplies to regional processors. The region is also characterized by several larger population centers of significant magnitude which allows the establishment of large processing facilities with economies of size and sufficiently low costs to penetrate distant markets. This region has 16 processing facilities operating at an average volume of 112 million pounds per plant per month. Total processing costs are $16.8 million or 0.93 cents per pound.

Distribution cost for intraregional and interregional market movements of processed milk totals $4.3 million and represents the highest cost among all regions. Much of the distribution cost is attributed to the role of this region in the exportation of processed milk to other regions. The North Central region ships 11 million, 180 million, and 122 million pounds respectively to the West South Central, Southern, and Northeastern regions.

Only the Western region did not import milk from the North Central region. Interregional movements of milk from the individual North Central region facilities have been discussed, except for exports to the Northeast region. Shipments to the Northeast originate at the Cleveland

(Ohio) facility and serves the Pittsburg and Williamsport (Pennsylvania) distribution outlets.

On a sub-regional basis, the West North Central exports 20 million pounds and the East North Central exports 385 million pounds. Reasons for higher exports from the eastern portion include (1) larger processing facilities serving a larger number of metropolitan areas, (2) a geographical advantage in serving the Southern and Northeastern regions, and (3) economies of size of the larger plants which are established (average size of 202.8 million pounds in the East North Central versus 57.9 million pounds in the West North Central).

Shipments within the North Central region are relatively large. The Chicago facility, the largest in the region, serves Indiana, Kentucky, Ohio and Michigan markets; the St. Louis facility ships to Southern Illinois and western Kentucky markets; the Kansas City facility transports to Missouri markets; the Minneapolis facility supplies markets in Iowa and Wisconsin; the Moorehead facility transports to distribution outlets in North Dakota, Iowa and Minnesota; the Pierre (South Dakota) and the Marquette (Michigan) facility serves the Bay City (Michigan) market.

Northeast—

As in Model I, 7 processing facilities are established in the Northeast. Total processing costs are $9.9 million. The average plant size is 153.3 million pounds per month, and the average processing cost is 0.93 cents per pound.

Intermarket movements of fluid processed milk within the region total 92 million pounds and the distribution cost is $311,000. Intraregional shipments consist of movements of processed milk from Rochester (New York) to distribution outlets in Albany and Utica (New York) and from Boston to Portland (Maine).

In summary, the least cost organization under the assumptions of Model II allocates the production from 65 areas to 59 processing facilities across the nation. In supplying the resource to these facilities, assembly costs of $9.1 million are incurred, aproximately 15 percent of the total cost of the organization. Costs incurred in the processing functions total $46.0 million and represent 76 percent of the total. Moving the final product to distribution outlets costs 5.5 million dollars and accounts for 9.1 percent of the total cost. The total of all costs included is $60.6 million. On a regional basis, the proportions of West, West South Central, Southern, North Central, and Northeastern regions are 14.2, 9.3, 16.0, 38.0 and 22.5 percent of total cost respectively.

Comparisons of Results under Models I and II

Models I and II are identical except for the prices which are assumed to be paid to farmers for raw milk. Model I assumes that the same f.o.b. plant price is paid to a farmer regardless of his location in the United States. Model II, on the other hand, assumes that 1965 f.o.b. plant prices are paid to farmers and reflects the past institutional influences upon the organization. The results indicate quite different organizations under the two assumptions.

Production is utilized from a larger number of areas in Model I than in Model II, 76 as compared with 64 out of a or the possible number of 92. Apparently, the result of using the 1965 price structure in the models would result in large displacements of local milk in the markets more distant from the upper Midwest by shipments from the North Central region. The North Central region production was utilized from 26 areas in Model II and 19 in Model I, an increase of seven. The effects of displacement were greater in the Southern and West South Central regions than in the Western and Northeast regions. For example, comparing Model II with Model I, the number of production areas involved in the optimum market organization declined by 5 in the West South Central region and by 10 in the Southern region.

The effect of displacement is only partially reflected in the changes in the number of supply areas. The amounts of unused production changed in some markets even though the same supply areas were involved. The amounts of unused production increased dramatically in all regions with the exception of the North Central region where unused production was significantly lower. In the Western region unused production increased approximately 21 percent from 252 million pounds in Model I to 305 million pounds in Model II. Unused production in the Southern region increased 540 percent from 57 to 365 million pounds, and the West South Central region's unused production increased 517 percent from 24 to 148 million pounds. The Northeast region's unused production increased from 608 million pounds in Model I to 1,011 million pounds in Model II, the largest absolute increase. The demand needs for these regions were met from production in the North Central region and unused production declined from 889 million pounds in Model I to only 2 million pounds in Model II.

The 1965 pricing structure of Model II was such that if the institutional restraints were removed to allow a free flow of raw milk, farmers in many Southern areas would either experience lower prices or they would lose their markets. Prices in the Southern region were effectively held above prices paid to farmers in the North Central region by state agencies. Model II illustrates the apparent pressure of production in

the North Central region to penetrate Southern markets and the apparent success of state agencies in regulating the flow.

A function closely associated with production activities involves the assembly of milk. Assembly involves the functions of moving raw fluid milk from production assembly points within the selected regions to processing facilities. In moving from an organization under Model I to one under Model II, total assembly costs for the nation would increase 184 percent from $3.2 to $9.1 million. Every region in the analysis, and the corresponding sub-regions making up the regions, would experience increases in assembly costs under the 1965 pricing structure. For the Western, West South Central, Southern, and Northeastern regions, the increases were due to the quantities of raw fluid milk imported from the North Central region. However, the North Central region's assembly costs also increased from $124,000 to $1.9 million. This increase was the result of exports of raw milk from some parts of the region and the necessary replacements from production regions which were not as strategically located relative to processing in regional facilities.

The processing and distribution functions of the market organizations were not as sensitive to the variation in models as the production and assembly activities. In comparing the total cost associated with the processing functions, total processing costs were 46.1 million for Model I and 46.0 million dollars for Model II, a difference of approximately $100,000. Total costs were lowest for Model II but average costs were unchanged.

Processing costs per unit were lower under Model II in three regions and higher in one region. Costs were lower by .03 cents per pound in the West South Central region and .02 cents per pound in the North Central region. Costs were higher by .05 cents per pound for the Northeastern region. Per unit costs for the nation as a whole were unchanged.

The per unit cost changes reflect shifts in regional capacities in Model II. The West, West South Central, and Southern regions experienced decreases in firm numbers and increases in the average size of processing facilities. In the Northeast, firm numbers increased and processing capacity decreased. The North Central region increased its processing capacity by 319 million pounds and was able to penetrate into the West South Central, Southern, and Northeast regional markets because of a price advantage in the raw resource market. Western facilities failed to achieve the capacity levels of Model I because processors lost their markets in North Central and West South Central regions.

Distribution costs increased $1.7 million to $5.5 million in Model II as compared with $3.8 million in Model I. All regions experienced increases in distribution costs with the exception of the Northeast region

which had a decrease of nearly $1.1 million. The decrease resulted from increased penetration into the Northeast region by North Central regional processing facilities. In turn, the North Central region experienced sharp increases in distribution costs from $1.8 to $4.3 million of which a substantial portion of this amount, $1.8 million, was in the East North Central sub-region which borders the Northeast region.

Total costs for the optimum market organizations were 53.2 million for Model I and $60.6 million for Model II. Although each region except the South experienced higher total costs in Model II, the major increase was in the North Central region where total costs increased $5.9 million. The increase resulted primarily from additional assembly and distribution costs involved in supplying other regions from supplies in the North Central region.

Multiple Firm Market Organizations

The input data and basic design of the transport-separable model used in the analyses of Models III, IV and V of this section are essentially the same as for Models I and II. However, there are two major differences, one in pricing structure and one in design.

The first difference in the models involves the alignment of prices among markets. Current price alignment in the fluid milk markets reflects the establishment of prices of milk according to a base price of milk in the major surplus area plus transfer costs to more distant markets. Intermarket price-misalignment and pressures for large movements of milk can result from the use of a rigid formula for transfer costs, as verified by Model II. Therefore, the transfer costs were varied to test the sensitivity of the various market organizations to changes in the base point pricing scheme. The price of the resource, milk, is determined in each market using a base price of $3.60 per hundredweight plus a different transfer cost allowance per hundredweight per 100 miles from Eau Claire, Wisconsin for each of three Models.

The second difference between the groups of models in this section and those in the previous section relates to the number of firms that must supply a distribution outlet for packaged milk. The models in the previous section involve an organizational structure characterized by the establishment of one processing facility to serve one or more distribution points. The result is that the economic environment of the optimum market organization is essentially a monopoly for a given market and the firms in such an organization would be vulnerable to anti-trust action. In this section, the models were designed to require the establishment of at least two processing facilities in all major markets. It is pos-

sible that in some of the smaller less populous markets only one processing facility will service that market but most markets will be serviced by two to six processing facilities.

Multiple firms are ensured through the establishment of market share restrictions on individual firms. Specifically, the restriction is:

$$X_{gij} \leqslant \alpha_{gj} D_j \qquad (9)$$

where

X_{gjj} = the quantity of milk processed by plant g in processing area i for demand area j, defined only for i=j,

α_{gj} = the maximum proportion of the market j served by plant g.

The grid refinement in the special variables section of the transport-separable model is structured in such a way that plants enter the solution in descending order of size. In a market with demand for 75 million pounds or less, 4 potential plants can be established. The order of entry and plant sizes are as follows: Plant size I may represent up to 55 percent of the market in which the plant is located, plant size II may represent up to 35 percent, and plant size III may represent up to 10 percent of the market.

In addition, one auxiliary plant can be established to compete in the domestic and intermarket activities up to a capacity equivalent to 50 percent of the market demand in its home market. This plant is, however, allowed to be established only after the first three plants are in operation at their maximum capacities.

In markets with demand needs of 75-150 million pounds, the grid refinement of the special variables section is organized to allow five potential processing plants to enter the market. The plant sizes are up to 55, 30, 10 and 5 percent, respectively, of the domestic market with the fifth plant available for establishment to compete in intermarket activity after the first four have been established. This plant has a potential capacity of 50 percent of the local market demand. Markets with consumer demands of fluid milk greater than 150 million pounds are allowed to establish six processing facilities. Plant sizes are allocated according to local market demand with five plants from largest to smallest representing 55, 25, 10, 7 and 3 percent of the home market. A sixth plant is allocated enough capacity to serve outside markets up to an equivalent of 50 percent of its own market.

Model III

The Class I price structure in Model III is the base price plus a transfer cost allowance of 15 cents per hundredweight per 100 miles from Eau Claire, Wisconsin, a level consistent with price relationships in the late 1960's. Total costs under the least cost optimum market organization of Model III are $71.5 million. Costs for the assembly function total $15.1 million or 21 percent of the total. Raw fluid milk is moved from 71 of the 92 production areas to 237 processing facilities located in 89 major market areas. The milk is processed at an average cost of 1.16 cents per pound and distributed to 105 market distribution points across the nation. Total cost for the processing functions are $54.2 million. Distribution costs are relatively small and total 2.6 million dollars or four percent of the total.

Production and Assembly Activities

West—

Production totaling 385 million pounds of milk is utilized from 15 of the 20 production areas (Table 7). It is processed at 55 plants located within the region. As the result of the pricing structure, a significant inflow of 373 million pounds of milk from the North Central and West South Central regions is observed.

The procurement areas for both the San Francisco and Los Angeles (California) markets are skewed toward the surplus production areas of the North Central region. The results are consistent with expectations.

Consider the following hypothetical example for the Los Angeles market. Assume that Los Angeles is a deficit production area, San Francisco is a surplus production area, and a 15 cent per cwt. per 100 miles is used as the differential for pricing from the base point. Assume further that San Francisco is on the same concentric circle as Los Angeles. The price paid to farmers in both areas would be equivalent. Under conditions of competitive nation-wide pricing, the San Francisco market could not become the source of supply for Los Angeles-based processors. The Los Angeles processors would seek supplies in the direction of the base point.

At 500 miles from Los Angeles, the transportation costs are 68 cents per hundredweight from a point in the direction of the base point as compared with 46 cents for moving milk 400 miles from San Francisco. However, milk could move from the supply point 500 miles away because the milk would be 75 cents per hundredweight cheaper which would more than offset the 22-cent lower transport cost from San Francisco. At the 15-cent differential, therefore, milk located in San Francisco could

Table 7. Summary Statistics of Production and Assembly Activities, United States and Regions, Model III.

Region	Production: Used (1,000 lbs.)	Production: Unused (1,000 lbs.)	Assembly Cost ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs.)
West	379,975	633,754	7,071	372,994	0	
Pacific	183,693	602,794	6,502	390,451	0	
Mountain	196,282	30,960	568	75,763	93,220	[MTN → PAC 93,220]
West South Central	360,217	57,698	428	26,784	18,501	[WSC → PAC 12,200]
						[WSC → ESC 6,201]
Southern	483,576	327,525	2,908	331,271	0	
South Atlantic	317,071	273,465	2,578	249,577	0	
East South Central	166,505	54,060	330	81,694	0	
North Central	2,398,970	6,726	1,066	0	825,899	
West North Central	818,550	0	502	29,000	360,167	[WNC → PAC 249,331]
						[WNC → MTN 75,763]
						[WNC → WSC 26,784]
						[WNC → ENC 4,220]
						[WNC → ESC 4,069]
East North Central	1,580,420	6,726	563	4,220	498,791	[ENC → PAC 35,700]
						[ENC → WNC 29,000]
						[ENC → SA 249,577]
						[ENC → ESC 71,324]
						[ENC → MA 56,053]
						[ENC → NE 57,138]
Northeast	1,055,972	804,720	3,595	113,191	0	
Mid Atlantic	1,055,972	434,566	2,133	56,053	164,862	[MA → NE 164,862]
New England	0	370,154	1,463	222,000	0	
Total	4,678,710	1,830,423	15,068	844,240	844,240	

not be transported into Los Angeles until the source of supply is depleted in the direction of the base point.

In the solution of Model III, both San Francisco and Los Angeles are the recipients of substantial quantities of milk from the North Central region, primarily from Minnesota, Nebraska, Kansas, Missouri, Wisconsin and Iowa. Quantities are also imported from the Mountain states where significant flows (93 million pounds) originate in Arizona, New Mexico, Colorado, Utah, Wyoming, Nevada and Montana. Processing facilities located at Spokane, Helena (Montana), Billings (Montana), Idaho Falls (Idaho), and Boise (Idaho) import milk from production areas located at Moorehead (Minnesota) and Dickinson (North Dakota). Other imports from the North Central region include Grand Island (Nebraska) serving Eureka (California), Rock Springs (Wyoming) and Denver; Minneapolis supplying Casper; and Dodge City (Kansas) transporting to Albuquerque.

Total costs associated with assembly functions in the West are the highest of all regions. Costs total $7.1 million and most of this, $6.5 million, is associated with movements into the Pacific sub-region. Unused production within the region totals 634 million pounds or approximately 63 percent of the region's total production.

West South Central—

Intermarket movement of milk in the West South Central region is common as 54.0 million pounds is transferred between supply points and processing facilities. The North Central region supplies 27 million pounds, Dodge City (Kansas) transports milk to El Paso; Springfield (Missouri) ships to Dallas, Corpus Christi and Houston; and Evansville (Indiana) ships to New Orleans. Intraregional movements include Tulsa, shipping to facilities in Lubbock and Odessa (Texas) and both Little Rock and San Antonio shipping to Corpus Christi. Assembly costs associated with these movements total $428,000. Milk produced in 11 of the 15 production areas is utilized but unused production totals 58 million pounds.

South—

The situation in the Southern region is simiar to that for the West. The pricing structure of a base price plus a 15-cent transfer cost allowance is such that much of the production in the South is not utilized. The distant markets are influenced most. For example, production areas located within the state of Florida have aggregate production of 106 million pounds. None of this production is involved in the optimum organization of the industry.

Aproximately 331 million pounds of milk are imported from outside sources, primarily from the North Central region. Evansville (Ind-

iana) ships to Alabama, Georgia and northern Florida; Chicago ships to markets in Tennessee, Georgia and Florida; Decatur (Illinois) ships to Louisville processing facilities; Indianapolis transfers raw milk to South Carolina and northern Florida; Chicago ships to markets in Tennessee, Georgia, and Florida; Decatur (Illinois) ships to Louisville processing facilities; Indianapolis transfers raw milk to South Carolina and northern Florida; Columbus (Ohio) moves milk into the Virginias; and Davenport (Iowa) transports to Memphis.

Within the region, milk produced in the Bristol (Virginia) area is transported to Danville (Virginia), Raleigh (North Carolina) and Charleston (South Carolina), Clarksburg (West Virginia) serves facilities in Charlottesville (Virginia).

Production from 13 of 20 production areas is utilized in the least cost market organization. However, 40 percent of local production is not used in the processing of fluid packaged milk. Costs associated with intermarket transfers including 331 million pounds from interregional production areas are $2.9 million.

North Central—

The pricing policy assumed in Model III will assure that nearly all milk produced in the North Central region will be used. Production from all 27 regions is utilized in 76 processing facilities within the region. Only 7 million pounds of unused production remains in the region. Based on the method of allocating assembly costs, the North Central region has an assembly cost of $1.1 million, the second lowest among the five major regions.

Exports from the region total 827 million, nearly depleting all reserves. The region's exports to the West, Southern and West South Central regions has been discussed. Flows into the Northeastern region involves movements from Columbus (Ohio) to facilities in New York City; South Bend (Indiana) to facilities in New York City; and Detroit to facilities in Bangor (Maine). These transfers total 113 million pounds.

Northeastern—

The region experiences some intraregional milk transfer activities as Williamsport (Pennsylvania) and Pittsburgh production areas supplement facility resource requirements in New York City and production in the Rochester (New York) area serves facilities in Utica (New York), Boston, and Hartford. Total assembly costs for intraregional and interregional movements of raw milk for the Northeast region totals $3.6 million.

Production is utilized from 5 of 10 production areas and 1,056 million pounds are shipped to 21 processing facilities located in 9 major con-

suming markets. Excess production remaining in the Northeastern region is 805 million pounds or 43 percent of the total production available, the largest quantity of unused production of any region.

Processing and Distribution Activities

West—

Processing capacity in the West is 753 million pounds per month, and the total processing cost is $8.7 million or 1.16 cents per pound (Table 8). Distribution costs total $131,000. Processing functions are carried out in 55 facilities with a regional average volume of 13.7 million pounds (Table 9). Data for the individual markets are included in Appendix Table III.

The West has one of the lower levels of capacity with aproximately 25 percent of the firms established operating at a volume of less than 3 million pounds per month. Most of the smaller facilities are established in the Mountain states where the average size of facility is 5.4 million pounds. The average was 26.2 million pounds for facilities established in the Pacific states (Table 9).

In addition to the region's own processing, a small quantity (.3 million pounds) is imported from the North Central region. The movements originate at Dickinson (North Dakota) and serve Helena and Billings (Montana). Intraregional movements include Salt Lake City serving Cedar City (Utah), Reno (Nevada) and Alturas (California); Albuquerque transporting to outlets in Flagstaff (Arizona); Denver supplying Grand Junction (Colorado); and Boise supplementing Alturas (California).

West South Central—

The optimum distribution and processing organization of the West South Central region requires 20 million pounds of packaged milk from the North Central region to supplement local processing. Kansas City supplies the Oklahoma City market; Springfield (Missouri) serves markets in Oklahoma City, and Little Rock; and St. Louis also ships to Little Rock. Within the region, two facilities are involved in intraregional market activity. Tulsa ships to Oklahoma City and Dallas serves eight of nine Texas markets. The Dallas-based facilities are interesting because they illustrate the influence and importance of the inclusion of economics of size. The Dallas export facility in the optimum solution has a capacity of 29 million pounds which generates enough economies to offset transfer costs into these other markets.

Thirty processing facilities within the region are established with combined capacities totaling 377 million pounds. The average size of a

Table 8. Summary Statistics of Processing and Distribution Activities, United States and Regions, Model III.

Region	Processing Costs ($1,000)	Distribution Costs ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs)
West	8,736	131	321	0	
Pacific	6,521	0	4,503	0	
Mountain	2,215	131	321	4,503	MTN → PAC 4,503
West South Central	4,783	170	20,422	0	
Southern	9,672	67	79,979	0	
South Atlantic	6,603	67	38,503	0	
East South Central	3,069	0	47,152	5,676	ESC → SA 5,676
North Central	18,642	1,523	0	126,839	
West North Central	6,161	443	3,272	56,688	WNC → MTN 321
					WNC → WSC 20,422
					WNC → ENC 23,346
					WNC → ESC 12,589
East North Central	12,481	1,080	23,346	96,779	ENC → WNC 3,272
					ENC → SA 32,827
					ENC → ESC 3,766
					ENC → MA 56,914
Northeast	12,319	703	56,914	30,797	
Mid Atlantic	9,839	703	56,914	102,263	MA → NE 71,466
					MA → SA 30,797
New England	2,480	0	71,466	0	
Total	54,152	2,594	157,636	157,636	

Table 9. Distribution of Firms by Size and Region, Model III.

Region	No. of Demand Areas	Potential Number of Processing Facilities	No. of Firms by Size Classification in Millions of Pounds								Avg. Size of Facility in Millions of lbs.
			Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	
West	21	88	14	21	13	4	2	1	0	55	13.7
Pacific	7	32	2	5	9	3	2	1	0	22	26.2
Mountain	14	56	12	16	4	1	0	0	0	33	5.4
West South Central	14	56	3	14	9	4	0	0	0	30	12.6
Southern	23	93	5	11	33	5	1	0	0	55	14.0
South Atlantic	15	61	4	7	20	4	1	0	0	36	14.7
East South Central	8	32	1	4	13	1	0	0	0	19	12.6
North Central	35	145	7	27	20	15	5	2	0	76	21.2
West North Central	19	76	5	20	11	6	0	0	0	42	11.6
East North Central	16	69	2	7	9	9	5	2	0	34	33.0
Northeast	12	56	0	4	6	7	3	2	1	23	50.8
Mid Atlantic	7	34	0	2	4	5	2	2	1	16	59.2
New England	5	22	0	2	2	2	1	0	0	7	31.7
Total	105	438	29	77	81	35	11	5	1	239	19.6

facility is 12.6 million pounds, the lowest level of capacity among the major regions. As a result, per unit costs of processing is the highest of all regions at 1.27 cents per pound. Aggregate processing costs for the region are $4.8 million. Distribution costs are associated only with shipments within the region since no exporting is involved from the region. These costs total $170,000 and represent the cost for intermarket movements of 42 million pounds.

Southern—

Processing functions consist of 770 million pounds of milk being processed in 55 facilities at a total cost of $9.7 million. Even though most processing is done within the region, imports of 80.0 million pounds are required. The North Central region supplies 49 million pounds and Northeastern region supplies 31 million pounds.

Intermarket activities involving facilities and distribution centers within the Southern region total 16 million pounds. These facilities and distribution centers involve Charleston (South Carolina) shipping to Columbia (South Carolina); Louisville transferring packaged milk to Danville (Virginia); and Clarksburg (West Virginia) serving outlets in Charlottesville (Virginia).

North Central—

There are 76 firms with processing capacity of 1,608 million pounds. Processing costs total $18.6 million or an average cost of 1.16 cents per pound. The distribution costs associated with the intraregional and interregional movements of milk total $1.5 million.

The North Central region is involved extensively in processing activities where the final product is transported to various intraregional and interregional markets. Facilities located in eight markets are involved in transshipments of the final product. About 127 million pounds are shipped to interregional destinations. Shipments include the following: Dickinson (North Dakota) serving markets in Montana, and South Dakota; Kansas City transporting to markets in Kansas and Oklahoma; Springfield (Missouri) shipping to Arkansas and Oklahoma markets; St. Louis serving markets in Missouri, Arkansas, Tennessee, Kentucky and Illinois; Detroit shipping milk to markets in Michigan, Ohio, North Carolina, West Virginia, Virginia and New York; Chicago transferring processed milk to Illinois, Indiana, Ohio, Wisconsin, and Iowa markets; and Minneapolis shipping to markets in the Dakotas, Nebraska, Iowa, Wisconsin and Minesota.

Northeast—

Within the region, 21 processing facilities have a total capacity of 1,169 million pounds. Processing costs average 1.05 cents per pound and

total $12.3 million. Facilities established are the largest of any region and average 50.8 million pounds.

Total distribution costs associated with intermarket activity are $703,000. In addition to the amount of processed milk provided by regional plants, an additional 57 million pounds is required from North Central facilities to meet total demand within the region. Within this region three facilities are established that involve penetration of other markets. Pittsburgh transports processed milk to Virginia markets while New York City serves markets in New York, Pennsylvania, Virginia, Connecticut, Massachusetts, and Maine. In addition, the Rochester (New York) facility transports to intraregional markets in New York and Vermont.

Total organizational costs for all market activities represented in the analysis were $71.7 million. On a regional basis, the Western, West South Central, Southern, North Central, and Northeastern contributed $15.9, $5.4, $12.6 ,$21.2 and $16.6 million, respectively to total costs.

Model IV

The Class I price structure in Model IV reflects the $3.60 base price paid to farmers f.o.b. plant plus a transfer cost allowance of 9 cents per hundredweight per 100 miles from Eau Clair. The other assumptions, model organization, basic data, and techniques are the same as in Model III.

The least cost market organization of the fluid milk industry indicates a total organizational cost of $62.1 million for Model IV. Costs of assembly activities total $5.5 million with 1.3 billion pounds of milk involved in intermarket transport activities (Table 10). Total processing cost outlays are $53.9 million or 1.15 cents per pound. The distribution costs associated with the least cost organization is $2.7 million which represents the cost of transferring 711 million pounds of processed milk from various processing facilities to distribution outlets across the United States.

Production and Assembly Activities

West—

Fifty-five processing facilities are established to utilize milk from 19 of 20 production areas. Local regional production of 432 million pounds is used and supplemented with 36 million pounds of milk produced in the North Central region. Costs associated with the assembly activities are $934,000. Surplus production remaining in the region totals 296 million pounds.

Table 10. Summary Statistics of Production and Assembly Activities, United States and Regions, Model IV.

Region	Production		Assembly Cost ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs.)	
	Used (1,000 lbs.)	Unused (1,000 lbs.)					
West	717,247	296,482	934	35,629	0		
Pacific	510,591	275,898	796	65,445	0		
Mountain	206,656	20,586	138	16,781	46,597	MTN → PAC	46,597
West South Central	365,244	52,671	212	14,621	6,301	WSC → ESC	6,301
Southern	689,009	122,092	1,112	90,086	39,021		
South Atlantic	506,957	83,579	831	56,146	30,237	SA → MA	30,237
East South Central	182,052	38,513	281	33,940	8,784	ESC → WSC	8,784
North Central	1,826,939	578,757	899	0	189,350		
West North Central	527,936	290,614	208	0	42,164	WNC → PAC	18,848
						WNC → MTN	16,781
						WNC → WSC	5,837
						WNC → ENC	698
East North Central	1,299,003	288,143	691	698	147,884	ENC → SA	56,146
						ENC → ESC	27,639
						ENC → MA	64,099
Northeast	1,080,271	780,421	2,352	94,336	0		
Mid Atlantic	893,271	597,267	2,194	94,336	0		
New England	187,000	183,154	158	0	0		
Total	4,678,710	1,830,423	5,509	234,672	234,672		

Los Angeles is the major recipient of raw fluid milk transfers with shipments originating in Arizona, Kansas, Colorado, Utah, Montana, and South Dakota. Other intermarket movements include Dickinson (North Dakota) shipping to Helena (Montana) and Idaho Falls (Idaho); Billings (Montana) supplying Idaho Falls; Pierre (South Dakota) transporting to Casper (Wyoming); and Dodge City (Kansas) supplementing Lubock (Texas) supplies.

West South Central—

Production is utilized from 12 of the 15 production areas, and 30 processing facilities make use of 365 million pounds of local milk. In addition, 15 million pounds are imported from the North Central and Southern regions. Exports total six million pounds and are transported into the Southern region. Including imports, 308 million pounds require transportation between points of production and processing. Costs incurred in these movements total $212,000. Unused production in the region totals 53 million pounds.

Interregional shipments into the West South Central region include the following flows: Grand Island (Nebraska) to Odessa (Texas); Dodge City to Lubbock and Odessa (Texas); Wichita (Kansas) to El Paso; and Jackson (Mississippi) to New Orleans. Intraregional movements include: Amarillo shipping to Lubbock (Texas); San Antonio shipping to Corpus Christi; and Houston receiving milk produced in Tulsa (Oklahoma) and Shreveport (Louisiana).

Southern—

Raw fluid milk totaling 689 million pounds, and produced in 19 of 35 production areas are utilized. An additional 90 million pounds are imported from the North Central and Northeastern regions. Costs associated with assembly activities for 308 million pounds total $1.1 million. Unused production totals 122 million pounds or 15 percent of the region's total production.

Major imports into the Southern region from interregional production areas are: Chicago moving milk to processing facilities in Memphis, Birmingham, Albany (Georgia), Atlanta, Louisville and Knoxville; Indianapolis milk moving to Tampa, Knoxville and Charleston (West Virginia); and Decatur (Illinois) transporting milk to Louisville. Intraregional movements include: Bristol (Virginia) shipping to facilities in Columbia (South Carolina), and Jacksonville serving the other Florida-based facilities of Tampa and Miami.

Two production areas export milk. Jackson (Mississippi) ships to New Orleans and Washington (D.C.) supplies facilities in New York City.

North Central—

The North Central region is the major exporting region in the U.S. under Model IV. About 190 millions pounds per month is exported. Production is utilized from 26 of 27 production areas and serves 77 local processing facilities with 1,602 million pounds of milk per month. Production remaining unused totals 579 million pounds, the largest amount of unused production in any region. Assembly costs total $899,000 for intermarket shipments of 302 million pounds. The spatial dimension of North Central flow patterns has been discussed in the analysis of the other regions with the exception of movements into the Northeastern region. The latter includes Columbus (Ohio) and South Bend (Indiana) shipping to facilities located in New York City. Intraregional movements in the North Central region include: Moorehead (Minnesota) supplying facilities in Grand Forks and Jamestown (North Dakota); Sioux City (Iowa) transporting to facilities in Omaha; Minneapolis serving facilities located in Omaha and Des Moines (Iowa); Davenport (Iowa) shipping to Cedar Rapids (Iowa), Peoria (Illinois) and St. Louis; Wausau (Wisconsin) transporting to Green Bay and Madison (Wisconsin); Chicago supplying facilities located in Peoria (Illinois), Cincinnati and Grand Rapids (Michigan); and South Bend (Indiana) shiping to Cleveland and Toledo.

Northeast—

The Northeastern region utilizes 1,080 million pounds per month of local production. An additional 94.3 million pounds is imported from the Southern and North Central regions. However, unused production within the region totals 780 million pounds.

Assembly costs for movement of 569 million pounds to various interregional and intraregional markets total $2.4 million. Imports into the Northeastern region involve New York City receiving milk from Columbus (Ohio), South Bend (Indiana) and Washington (D.C.) Intraregional movements include Williamsport, Pittsburgh and Phiadelphia shipping to New York City.

Processing and Distribution Activities

West—

The least cost organization associated with processing and distribution activities involves the establishment of 55 processing facilities with an aggregate capacity of 753 million pounds per month. With the plants operating at various capacities, the total costs are $8.9 million (Table 11). The average plant capacity is 13.7 million pounds and the average per unit cost is 1.19 cents (Table 12). Data for the individual markets are included in Appendix Table III.

Table 11. Summary Statistics of Processing and Distribution Activities, United States and Regions, Model IV.

Region	Processing Costs ($1,000)	Distribution Costs ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs)	
West	8,949	110	458	0		
Pacific	6,522	0	4,475	0		
Mountain	2,427	110	458	4,475	MTN → PAC	4,475
West South Central	4,739	163	20,422	0		
Southern	9,701	151	78,060	0		
South Atlantic	6,632	151	61,705	0		
East South Central	3,069	0	16,355	0		
North Central	18,302	1,309	0	119,614		
West North Central	6,154	348	0	51,390	WNC → MTN	458
					WNC → WSC	20,422
					WNC → ENC	17,921
					WNC → ESC	12,589
East North Central	12,148	961	17,921	89,417	ENC → WNC	3,272
					ENC → SA	30,908
					ENC → ESC	3,766
					ENC → MA	51,471
Northeast	12,196	950	51,471	30,797		
Mid Atlantic	10,181	950	51,471	137,263	MA → NE	106,466
					MA → SA	30,797
New England	2,015	0	106,466	0		
Total	53,887	2,683	150,411	150,411		

Table 12. Distribution of Firms by Size and Regions, Model IV.

Region	No. of Demand Areas	Potential Number of Processing Facilities	No. of Firms by Size Classification in Millions of Pounds								Avg. Size of Facility in Millions of lbs.
			Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	
West	21	88	14	21	14	3	2	1	0	55	13.7
Pacific	7	32	2	6	8	3	2	1	0	22	26.2
Mountain	14	56	12	15	6	0	0	0	0	33	5.4
West South Central	14	56	4	11	11	4	0	0	0	30	12.6
Southern	23	93	6	11	34	4	1	0	0	56	13.8
South Atlantic	15	61	5	7	20	4	1	0	0	37	14.4
East South Central	8	32	1	4	14	0	0	0	0	19	12.6
North Central	35	145	6	29	21	14	5	2	0	77	20.8
West North Central	19	76	4	23	12	5	0	0	0	44	11.0
East North Central	16	69	2	6	9	9	5	2	0	33	33.9
Northeast	12	56	0	4	4	7	3	2	1	21	55.9
Mid Atlantic	7	34	0	2	4	5	2	2	1	16	61.7
New England	5	22	0	2	0	2	1	0	0	5	37.4
Total	105	438	30	76	84	32	11	5	1	239	19.6

Costs or $110,000 in transport charges are involved in distributing the final product from points of processing to intermarket destinations. Intermarket movements total 16 million pounds per month but involve no interregional exports. Intermarket movements within the Western region include: Salt Lake City serving Alturas (California), Idaho Falls (Idaho), Rock Springs (Wyoming) and Cedar City (Utah); Denver shipping to Grand Junction (Colorado); Albuquerque transporting to Flagstaff (Arizona); and Portland (Oregon) supplementing Alturas (California) supplies. Interregional movements include Helena and Billings (Montana) importing from Dickinson (North Dakota); and Casper (Wyoming) importing from Minneapolis.

West South Central—

Processors establish 30 facilities with a combined capacity of 377 million pounds. These facilities are the smallest of any region and average only 12.6 million pounds per month per plant. The average processing cost is 1.26 cents per pound.

Intermarket distribution of the final product to central distribution outlets totals 40 million pounds and originates from two points. Dallas ships to eight of nine Texas distribution outlets and also serves the Shreveport (Louisiana) market. Tulsa transports the final product to Oklahoma City because Tulsa was permitted to have the only Oklahoma-based processing facilities. Distribution charges for intermarket movements are $163,000. The Oklahoma City market imports processed milk from interregional origins of Wichita (Kansas), Kansas City and Springfield (Missouri). Little Rock also imports milk from Springfield (Missouri).

Southern—

Imports of 78 million pounds of processed milk come from the Northeast and North Central regions. St. Louis ships to Paducah (Kentucky) and Memphis; Chicago supplies Louisville; Detroit serves Clarksburg (West Virginia), Charlottesville (Virginia) and Raleigh (North Carolina); and Cleveland transports to Pittsburgh, Baltimore, and Williamsport (Pennsylvania). A combined capacity of 772 million pounds for 54 processing facilities is involved in this region. The aggregate processing cost is $9.7 million or an average of 1.26 cents per pound.

There is very little intraregional distribution of the final product. Only two markets are involved. These markets include Charleston (West Virginia) transporting to Danville and Charlottesville (Virginia); and Charleston (South Carolina) shipping to Columbia (South Carolina). Transport costs associated with the distribution of the final product from these facilities totals $151,000.

North Central—

The North Central region establishes the largest number, 77, of facilities of any region. The average monthly volume is 20.8 million pounds per plant and total operating capacity is 1,602 million pounds per month. Total operating expenses are $18.3 million or an average of 1.14 cents per pound.

Intermarket activity, both within and between regions, consists of monthly shipments totaling 358 million pounds of processed milk. Of this total, 120 million pounds are exported to interregional destinations.

Facilities established in nine locations make use of an exporting plant. Three primary facilities, located at Minneapolis, Chicago, and Detroit, have economies of size which allow their participation at various magnitudes in 30 of the 105 market areas. The markets being served by these facilities are located in all the states of the North Central region with the exception of Kansas and Missouri. They serve markets in the Virginias, Kentucky and North Carolina in the Southern region, and Casper (Wyoming) in the Western region. In addition to the three primary locations, other facilities include Dickinson (North Dakota) serving markets in Montana; Wichita (Kansas) serving markets in Kansas and Oklahoma; Kansas City transporting to markets in Kansas, Oklahoma and Missouri; Springfield (Missouri) shipping to markets in Missouri, Arkansas and Oklahoma; St. Louis supplementing markets in Missouri, Kentucky and Tennessee; and Cleveland transferring the final product to markets in Ohio, Pennsylvania and Maryland. Distribution costs associated with these movements total $1.3 million.

Northeast—

Processing costs per unit are lower in the Northeast than in any other region. The cost averages 1.05 cents per pound and reflects the influence of the economies generated by large facilities within the Mid-Atlantic sub-region. The average size is 61.7 million pounds processed per month in this sub-region and per unit costs are 1.04 cents compared with 1.12 cents for the New England sector. The largest facilities are located in New York City and Rochester (New York).

Operating at 1,175 million pounds of capacity, regional facilities generate a total monthly cost of $12.2 million. Of the 1,175 million pounds of processed milk in the region, 30.8 million pounds are exported to Southern markets and 51 million pounds are imported from the North Central region. Points of origin and destination for the interregional movements have been discussed.

Distribution costs associated with 280 million pounds of intermarket shipments originating in the Northeastern region are $950,000. Intraregional market activities include: Rochester (New York) supplying

local markets in New York state; Utica (New York) serving the Burlington (Vermont) market; and New York City supplementing markets in Maine, Massachusetts, Connecticut, and Pennsylvania.

Model V

Model V is structured on the assumption that the price paid to farmers, f.o.b. plant, is the same in all areas of the United States. That is, base-point pricing of raw milk is not practiced. The other basic assumptions, data and operative conditions of the model are the same as in Models III and IV in this section.

The least cost market organization for the fluid milk industry utilizes production from 89 of the 92 production regions. Of the 4,679 million pounds, 1,179 million pounds are involved in intermarket transfers. Costs associated with movements from production areas to processing facilities total $3.6 million per month. Operating at an average monthly capacity of 18.8 million pounds, 250 facilities are established. Total costs associated with the processing functions are 54.8 million dollars or the equivalent of 1.17 cents per pound. Intermarket activity in the distribution of packaged milk involves the transshipment of 578 million pounds at a monthly distribution cost of $1.9 million.

Production and Assembly Activities

West—

Production from 18 of 20 of the production areas is utilized and 54 processing facilities are established in the region. Reserves of unused production total 257 million pounds (Table 13).

Intermarket transportation of 370 million pounds requires cost outlays of $414,000. The region is a net exporting region with 2 million pounds of production exported from Albuquerque to El Paso.

Some intraregional shipments also occur. Los Angeles facilities are partially supplied from production areas in San Francisco, Phoenix and Las Vegas. Facilities in Casper (Wyoming) receive milk from production areas in Rock Springs (Wyoming), Denver and Laramie (Wyoming). Salt Lake City serves facilities located at Idaho Falls (Idaho). Also, Billings (Montana) supplies facilities located in Helena (Montana) and Reno (Nevada) transports milk to Alturas (California).

West South Central—

Production is utilized from all 15 of the West South Central production areas. Production serves 30 processing facilities operating with a combined capacity of 380 million pounds. In addition, a net inflow of imports over exports of 23 million pounds of milk is indicated.

Table 13. Summary Statistics of Production and Assembly Activities, United States and Regions, Model V.

Region	Production: Used (1,000 lbs.)	Production: Unused (1,000 lbs.)	Assembly Cost ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs.)
West	756,593	257,136	414	0	2,407	
Pacific	570,750	215,737	371	11,799	0	
Mountain	185,842	41,400	43	0	14,206	MTN → PAC 11,799
						MTN → WSC 2,407
West South Central	376,770	41,145	109	11,191	7,751	WSC → ESC 7,751
Southern	797,017	14,084	863	42,751	8,784	
South Atlantic	577,530	13,006	679	15,072	17,196	SA → ESC 17,196
East South Central	219,487	1,078	184	59,947	23,856	ESC → WSC 8,784
						ESC → SA 15,072
North Central	1,546,604	859,092	456	0	35,000	
West North Central	477,185	341,365	156	688	13,974	WNC → ENC 13,974
East North Central	1,069,419	517,727	300	0	35,688	ENC → WNC 688
						ENC → ESC 35,000
Northeast	1,201,727	658,965	1,787	0	0	
Mid Atlantic	930,401	560,137	1,493	0	0	
New England	271,326	98,828	294	0	0	
Total	4,678,711	1,830,422	3,629	53,942	53,942	

Within the region, Texas production requires some relocation to supply processing facilities as production in San Angelo is shipped to Lubbock, Odessa and Houston; San Antonio serves Corpus Christi and Houston; Fort Stockton supplies El Paso; Amarillo ships to Lubbock; and Dallas ships to Houston. Other movements include Little Rock, and West Memphis (Arkansas) exporting to Memphis. Imports involve shipments originating at Albuquerque and Jackson (Mississippi) transporting to El Paso and New Orleans, respectively. With all facilities adequately supplied and export markets served, the region has 41 million pounds of fluid milk remaining unused.

Southern—

All 20 of the Southern region's production areas supply some milk to the 60 facilities which are established. Even though 14 million pounds of production are unused, additional supplies totaling 43 million pounds are imported from the North Central and West South Central regions. Export activities include the transporting of nine million pounds from Jackson (Mississippi) to New Orleans. Assembly costs associated with interregional and intraregional transporting of 263 million pounds of milk are $863,000.

Intraregional movements involve six production areas: Jacksonville (Florida) serving other Florida-based facilities; Jackson (Mississippi) supplementing facilities located in Mississippi, Louisiana, Alabama, Georgia and Tennessee; Nashville (Tennessee) transporting to facilities in Tennessee, Alabama and Georgia; Charlotte (North Carolina) shipping to facilities located in North Carolina, South Carolina, Florida and Virginia; Bristol (Virginia) transporting to Tennessee and Virginia-based facilities; Washington (D.C.) serving facilities in Virginia and Maryland; and Clarksburg (West Virginia) serving facilities located in Charlottesville (Virginia).

North Central—

The North Central region had large exports in previous models. However, under the assumptions of this model, only one facility exports milk. The flow consists of 35 million pounds shipped to Louisville from Indianapolis. Production within the region is utilized from 26 of 27 production areas supplying 75 regional processing facilities. Unused production totals 859 million pounds or 36 percent of total production.

Intraregional movements of 190 million pounds of milk require transportation outlays of $456,000. The movements include: Moorehead (Minnesota) shipping to Jamestown and Grand Forks (North Dakota); Pierre transporting to Rapid City (South Dakota); Sioux City (Iowa) supplying Omaha; Wausau (Wisconsin) serving Green Bay (Wisconsin);

Davenport (Iowa) supplying Cedar Rapids (Iowa) and Peoria (Illinois); Decatur (Illinois) shipping to Peoria and Centralia (Illinois) plus St. Louis; South Bend (Indiana) supplying Grand Rapids (Michigan); and Columbus (Ohio) serving Cincinnati.

Northeast—

All 10 of the Northeast's production areas are involved in supplying 31 processing facilities with milk. The region has no importing or exporting activities. At current levels of processing and interregional market involvement, the region has 659 million pounds of unused production or 35 percent of the region's total production.

Intermarket shipments of 548 million pounds are required and result in $1.8 million in transport charges. The shipments include: New York City importing from Utica (New York) and Williamsport (Pennsylvania); and Concord (New Hampshire) exporting to Burlington (Vermont), Portland (Maine), Boston, and Hartford.

Processing and Distribution Activities

West—

The least cost market organization for the Western region consists of the establishment of 54 processing facilities with an aggregate capacity for the region of 754 million pounds (Table 14). This entire capacity is utilized in meeting local regional demands with the exception of .9 million pounds moving from Phoenix (Arizona) to El Paso (Texas). Total cost per month for processing functions totals $8.9 million or an average cost of 1.19 cents per pound. The average volume per plant is 14.0 million pounds (Table 15). Data for the individual markets are included in Appendix Table III.

Intermarket transportation of 23 million pounds of processed milk is needed. The associated costs of distribution total $111,000.

The intermarket movements include: Salt Lake City moving processed milk to Cedar City (Utah), Rock Springs (Wyoming) and Idaho Falls (Idaho); San Francisco supplying markets in Reno (Nevada) and Alturas (California); Phoenix transporting fluid milk to El Paso and Flagstaff (Arizona); Denver supplementing distribution outlets in Casper (Wyoming); Spokane (Washington) serving Helena (Montana).

West South Central—

Within the West South Central region, 30 processing facilities are established which are the smallest of any region. The average facility processes 12.7 million pounds of milk per month. Processing costs total $4.8 million per month or an average cost of 1.27 cents per pound.

Table 14. Distribution of Firms by Size and Region, Model V.

Region	No. of Demand Areas	Potential Number of Processing Facilities	No. of Firms by Size Classification in Millions of Pounds								Avg. Size of Facility in Millions of lbs.
			Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	
West	21	88	14	20	14	3	2	1	0	54	14.0
Pacific	7	32	3	7	8	3	2	1	0	24	24.3
Mountain	14	56	11	13	6	0	0	0	0	30	5.9
West South Central	14	56	3	12	11	4	0	0	0	30	12.7
Southern	23	93	4	14	37	4	1	0	0	60	13.8
South Atlantic	15	61	3	10	22	4	1	0	0	40	14.4
East South Central	8	32	1	4	15	0	0	0	0	20	12.8
North Central	35	145	6	29	21	13	4	2	1	75	20.2
West North Central	19	76	5	23	11	5	0	0	0	44	10.5
East North Central	16	69	1	6	10	8	4	2	1	31	33.8
Northeast	12	56	2	6	8	8	3	2	1	30	40.1
Mid Atlantic	7	34	1	2	6	5	2	2	0	19	49.0
New England	5	22	1	4	2	3	1	0	1	11	24.7
Total	105	438	29	81	91	32	10	5	2	249	18.8

Table 15. Summary Statistics of Processing and Distribution Activities, United States and Regions, Model V.

Region	Processing Costs ($1,000)	Distribution Costs ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs)	
West	8,949	111	0	852		
Pacific	6,612	27	0	2,038	PAC → MTN	2,038
Mountain	2,337	84	2,038	852	MTN → WSC	852
West South Central	4,827	161	17,453	0		
Southern	10,470	116	20,752	1,395		
South Atlantic	7,194	54	19,166	0		
East South Central	3,276	62	3,766	3,575	ESC → SA	2,180
					ESC → ENC	1,395
North Central	17,621	986	1,395	30,907		
West North Central	5,932	261	3,272	33,193	WNC → WSC	16,601
					WNC → ENC	16,592
East North Central	11,689	724	17,987	17,578	ENC → WNC	3,272
					ENC → SA	2,743
					ENC → ESC	3,766
					ENC → MA	7,797
Northeast	12,908	502	7,797	14,243		
Mid Atlantic	9,792	502	7,797	36,383	MA → NE	22,140
					MA → SA	14,243
New England	3,115	0	22,140	0		
Total	54,775	1,876	47,397	47,397		

The region has processing facilities at two locations which are involved in intraregional transfers of 41 million pounds of processed milk. The distribution cost is $161,000. Tulsa supplies the Oklahoma City market; and Dallas ships to the Texas markets of Wichita Falls, Lubbock, Odessa, San Antonio, Corpus Christi and Houston, to the Oklahoma City market and to the Shreveport (Louisiana) market.

In addition to the 380 million pounds of processed milk utilized within the region, 18 million pounds are required from the North Central and Western regions to supplement local regional processing. Imports include: Wichita (Kansas) supplying Oklahoma City; and Springfield (Missouri) transporting to Little Rock. The region has no exports.

Southern—

Sixty processing facilities with a combined capacity of 831 million pounds are established in the Southern region. Operating at an average level of 13.8 million pounds per plant, these firms generate a total monthly cost of $10.5 million or an average cost of 1.26 cents per pound.

Southern markets have a net flow into the region of 19 million pounds from facilities located in the North Central and Northeastern regions. Imports include: Chicago shipping to Louisville; Cleveland supplying Clarksburg (West Virginia); Pittsburgh transporting to Charlottesville (Virginia); and New York City serving Baltimore and Richmond (Virginia).

Movements originating at Southern facilities for shipment to intraregional market destinations include: Nashville (Tennessee) shipping to markets at Evansville (Indiana), Paducah (Kentucky), Memphis, and Albany (Georgia); Birmingham transporting to Albany (Georgia); Atlanta serving the Albany (Georgia) market; and Charleston (West Virginia) transporting to Charlottesville (Virginia). Distribution costs associated with the 29 million pounds being transported between markets total $116,000.

North Central—

The North Central region is characterized by an optimum organization in which 75 processing facilities are established. These facilities operate at an average capacity of 20.2 million pounds per month and an average cost of 1.17 cents per pound. The quantity of processed milk moving between processing facilities to intermarket distribution points totals 317 million pounds of which 31 million pounds are shipped into interregional markets. Distribution costs for this milk total $986,000.

Within the region, processing facilities located in Minneapolis, Chicago, Detroit and Cleveland constitute the center of the region's

processing facilities. These plants serve 30 markets in all states within the region except for markets in Kansas and Missouri. The Chicago and Cleveland plants serve markets in Kansas and Missouri. The Chicago and Cleveland plants serve markets in Kentucky, West Virginia and Pennsylvania. Other intermarket movements from plants located within the region include: Dickinson (North Dakota) transporting to Rapid City (South Dakota); Kansas City facilities serving outlets in Omaha and Columbia (Missouri); Wichita (Kansas) shipping to Dodge City (Kansas) and Oklahoma City; and Springfield (Missouri) supplementing the Little Rock market supplies.

Northeast—

Facilities established in this region total 31 and operate at the largest average volume of any region, 40.1 million pounds per plant. Processing costs total $12.9 million and average 1.07 cents per pound.

Of 1,202 million pounds processed within the region, 1,188 million pounds are utilized within the region and 14 million pounds move into interregional markets. However, imports totaling eight million pounds partially offset the exports. Intraregional and interregional transshipments from local processing facilities total 169 million pounds. The associated distribution costs are $502,000.

Intermarket movements originating from facilities located within the Northeastern region include: Pittsburgh shipping to Charlottesville (Virginia); Rochester (New York) transporting to Utica (New York), Albany (New York) and Williamsport (Pennsylvania); Utica (New York) supplying Burlington (Vermont); and the largest complex of facilities in the nation, New York City serves the Portland (Maine), Boston, Hartford, Albany (New York), Philadelphia, Richmond (Virginia) and Baltimore markets. Imports into the region involves Cleveland shipping to Pittsburgh.

The Current Plant Size Environment

Model VI

Model VI was formulated to determine the minimum cost flow through the marketing channels of the approximate organization of the market as it existed in the mid 1960's. The model is structured somewhat differently from the other models. The major difference is that the separable programming technique is not used for processing costs; the processing costs are handled as linear functions.

Estimates of processing costs are made using the same function used in the other models for the estimated 1965 plant capacities. The capacities reflect an adaptation of the distribution and average size

of firms as obtained from data in the 1963 Census of Manufacturers.[19] Firm numbers and employment figures from the Census were used to compute the capacities. Processing was restricted to the processing for local demands, and an additional 20 percent over domestic needs was allowed for serving export markets. In general the model is not designed to determine the location, number and size of processing facilities as in previous models but to minimize the cost flow pattern of the organization as it existed in the mid 1960's. All other assumptions, basic data on production and consumption, and cost functions are consistent with the previous models.

Production from 69 of the 92 production areas supply milk to processing facilities in Model VI. The total cost of the organization is $83.8 million. To supply all processors 1,907 million pounds are transported from local production areas to distant processors. Cost of assembly related to these movements is $11.6 million or aproximately 14 percent of the total organizational costs. The processing functions are performed in over 4,000 facilities (an average size of about 1.0 million pounds) at cost outlays of $71.4 million. Processing costs are 85 percent of total organizational costs. Packaged milk involved in intermarket activity totals 225 million pounds. Distribution costs are $755,000 and represent approximately one percent of the total costs of the organization.

Production and Assembly Activities

West—

Producers in 16 of the 20 areas provide 693 million pounds (68 percent of the region's total production) for movement into processing facilities (Table 16). The region is a net importer of raw fluid milk with exports of 2 million pounds and imports of 63 million pounds. The export market consists of Albuquerque supplying El Paso. Imports originate in the North Central region and include: Dickinson (North Dakota) supplying Helena (Montana), Billings (Montana), and Idaho Falls; Moorehead (Minnesota) serving Idaho Falls; Pierre (South Dakota) transporting to Casper (Wyoming); and Grand Island (Nebraska) shipping to Denver. Intraregional movements include: San Francisco, Salt Lake City, Las Vegas, Flagstaff, and Phoenix transporting to Los Angeles; Burns (Oregon) supplying Alturas (California); and Rock Springs (Wyoming) shipping to Salt Lake City. Intraregional movements and imports total 134 million pounds. Assembly costs associated with these movements total $842,000.

West South Central—

The West South Central region allocates 63 percent (262 million pounds) of its production from 10 of 15 production areas to serve pro-

Table 16. Summary Statistics of Production and Assembly Activities, United States and Regions, Model VI.

Region	Production: Used (1,000 lbs.)	Production: Unused (1,000 lbs.)	Assembly Cost ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs.)
West	693,114	320,615	842	62,626	2,407	
Pacific	564,214	222,273	427	20,177	0	
Mountain	128,900	98,342	415	62,626	22,584	MTN → PAC 20,177 MTN → WSC 2,407
West South Central	261,870	156,045	1,246	139,131	6,301	WSC → ESC 6,301
Southern	445,705	365,396	4,232	415,413	21,717	
South Atlantic	288,264	302,272	3,123	304,899	0	
East South Central	157,441	63,124	1,109	135,196	46,399	ESC → WSC 21,717 ESC → SA 24,682
North Central	2,404,059	1,637	1,285	0	880,945	
West North Central	816,913	1,637	406	0	355,621	WNC → MTN 62,626 WNC → WSC 115,008 WNC → ENC 49,106 WNC → SA 42,128 WNC → ESC 72,244 WNC → MA 14,036 WNC → NE 473
East North Central	1,587,146	0	879	49,106	574,430	ENC → SA 238,089 ENC → ESC 56,651 ENC → MA 265,964 ENC → NE 13,726
Northeast	873,962	986,730	4,042	294,200	0	
Mid-Atlantic	742,329	748,209	3,293	280,000	139,373	MA → NE 139,373
New England	131,633	238,521	749	153,099	0	
Total	4,678,710	1,830,423	11,647	911,370	911,370	

cessing facilities located within the region and one export market. The export market consists of West Memphis (Arkansas) shipping to Memphis. Imports into the region total 139 million pounds and are made up of the following movements: Albuquerque shipping to El Paso; Dodge City (Kansas) transporting to El Paso and Amarillo; Grand Island (Nebraska) supplying Texas-based facilities at Amarillo, Lubbock and Odessa; Wichita (Kansas) transferring to Oklahoma City; Sioux City (Iowa) supplementing Houston; Kansas City shipping to Corpus Christi; Mason City (Iowa) transporting to Houston and Corpus Christi; and both Springfield (Missouri) and Jackson (Mississippi) serving New Orleans. Intraregional movements include: Fort Stockton (Texas) serving El Paso; Tulsa supplying Oklahoma City, Houston, and Shreveport; and Dallas transporting to Houston. Intraregional movements plus imports total 182 million pounds and account for $1.2 million in assembly costs.

Southern—

Producers in the Southern region are affected significantly by the relatively higher prices in the region during 1965. About 45 percent of the region's total production (365 million pounds) is unused. Production from only 9 of 20 production regions provide raw fluid milk to local processors. The region is a net importer with 415 million pounds shipped into the region and only 22 million pounds exported. Most of the imports originate in the North Central region with the main flows from Illinois, Wisconsin, Indiana, Ohio, Southeastern Michigan, Northeastern Iowa, and Southeastern Minnesota.

Intraregional movements include: Jackson (Mississippi) shipping to Mobile; Nashville (Tennessee) transporting to Albany (Georgia) and Tampa; Charleston (West Virginia) supplying Charlottesville (Virginia) and Danville (Virginia); and Washington (D.C.) serving Norfolk (Virginia). Intraregional movements plus imports total 618 million pounds. Assembly costs associated with these movements total $4.2 million.

North Central—

Production in the North Central region is nearly all utilized in Model VI. Milk from 26 of 27 production areas and totalling 2,404 million pounds are used. Of this total 881 million pounds or 27 percent is exported to interregional markets in the form of raw fluid milk. Exports into the Northeastern region (the other exports have been discussed) total 294 million pounds and include the following movements: Cleveland, Detroit, Minneapolis and Wausau (Wisconsin) shipping to New York City; South Bend (Indiana) supplying Philadelphia; Chicago serving Rochester (New York); and Duluth (Minnesota) and Marquette

(Michigan) transporting to Portland (Maine). Intraregional movements involve the transportation of 346 million pounds at an assembly cost of $1.3 million.

Northeast—

In the Northeastern region, 874 million pounds of local production is used for processing. Unused production totals 987 million pounds and represents approximately 53 percent of the region's total production, the largest percentage of unused production of any region. The large percentage results in part from the relatively high milk prices in this region in 1965 and from the inability of processing facilities to generate the significant economies of size with the large number of firms in the current market structure.

The region is involved in no export activities and imports 294 million pounds of milk. Intraregional movements involve: Pittsburgh supplying New York City; Utica (New York) transporting to New York City, Boston, Hartford, Albany (New York) and Burlington (Vermont); and Concord (New Hampshire) serving Portland (Maine). Assembly costs associated with intraregional movements plus imports total $4.0 million.

Processing and Distribution Activities

There is very little movement of packaged fluid milk in Model VI for two reasons. First, in determining the upper limits on processing capacity, each market was allowed 20 percent excess capacity. This level limits the participation by a given market in intermarket competition. Second, when all processing facilities existing in the mid-1960 organization are included, the distribution of firm sizes is quite similar in most regions of the United States. The result is that the variation between processing costs of different markets is not very large. For increased participation of packaged milk in intermarket activities, a spread in the per unit cost of processing would have to be wider between markets to offset the added transport costs.

West—

Processing facilities numbering 645 operate at a total capacity of 753 million pounds per month. Total processing costs are $10.7 million and average 1.43 cents per pound, the lowest of any region (Table 17). Data for the individual markets are included in Appendix Table III.

Intraregional movements of the final product total 13 million pounds per month and involve the following markets: San Francisco ships to Reno (Nevada); Salt Lake City transports to Rock Springs (Wyoming) and Cedar City (Utah); and Phoenix (Arizona) supplies

Table 17. Summary Statistics of Processing and Distribution Activities, United States and Regions, Model VI.

Region	Processing Costs ($1,000)	Distribution Costs ($1,000)	Imports (1,000 lbs.)	Exports (1,000 lbs.)	Export Region and Quantity (1,000 lbs)
West	10,747	51	0	0	
Pacific	8,068	16	0	3,880	[PAC → MTN 3,880]
Mountain	2,679	35	3,880	0	
West South Central	6,055	59	2,962	0	
Southern	12,922	57	10,941	0	
South Atlantic	9,063	57	1,408	0	
East South Central	3,859	0	9,533	0	
North Central	23,368	555	0	41,022	
West North Central	7,289	122	0	27,314	[WNC → ENC 14,819] [WNC → ESC 9,533] [WNC → WSC 2,962]
East North Central	16,079	433	14,819	28,527	[ENC → SA 1,408] [ENC → MA 27,119]
Northeast	18,290	33	27,119	0	
Mid-Atlantic	13,740	29	27,119	8,259	[MA → NE 8,259]
New England	4,550	4	8,259	0	
Total	71,382	755	41,022	41,022	

Flagstaff (Arizona). Distribution costs associated with these movements total $51,000.

West South Central—

The West South Central region has 395 million pounds of processing within the region and 231 processing facilities. Processing costs are 1.53 cents per pound and total $6.1 million. Imports into the region of 3 million pounds originate in Springfield (Missouri) facilities and are shipped to Little Rock. Within the region, 15 million pounds are transported. Tulsa supplies Oklahoma City and Dallas ships to Shreveport (Louisiana). Distribution costs total $59,000.

Southern—

The Southern region imports 11 million pounds of processed milk from the North Central region. St. Louis ships to Paducah (Kentucky) and Columbus (Ohio) transports to Clarksburg (West Virginia). The processing of 839 million pounds of regional production involves 587 firms. Total processing costs are $6.1 million and the average per pound cost is 1.54 cents. Intraregional shipments of 4 million pounds include Baltimore serving Richmond (Virginia) and Charleston (South Carolina) supplying Jacksonville (Florida). Distribution costs associated with intraregional movements and imports total $57,000.

North Central—

Processing in the North Central region operates at a volume of 1,523 million pounds and total costs of $23.4 million. The facilities average processing 1.0 million pounds of milk per month at an average cost of 1.53 cents per pound.

The region is responsible for exports to the West South Central region (3 million pounds), Southern region (12 million pounds) and Northeastern region (27 million pounds). Intraregional movements involve: Moorehead (Minnesta) transporting to Grand Fork (North Dakota); Minneapolis supplying Eau Claire (Wisconsin); Des Moines serving Cedar Rapids (Iowa) and Columbia (Missouri); Kansas City shipping to Columbia (Missouri); Madison (Wisconsin) transporting to Peoria (Illinois); Chicago serving Grand Rapids (Michigan); and Detroit supplying Bay City (Michigan) and Toledo (Ohio). Intraregional transportation and exports of the final product total 168 million pounds and require distribution costs of $555,000.

Northeast—

The Northeastern region processes 1,168 million pounds at total cost outlays of $18.3 million or 1.57 cents per pound. Regional processing is supplemented by imports of 27 million pounds from the North Central

region. Intraregional movements total 10 million pounds and consist of movements from Utica (New York) to Burlington (Vermont) and Bangor (Maine) to Portland (Maine). Distribution costs associated with intraregional movements are $33,000.

Effects of Alternative Transfer Cost Allowance Levels

Three of the models permit an evaluation of the effects of alternative raw milk pricing structures. These are Models III, IV, and V and differ only in the transfer cost allowances which are combined with the base price in a basing-point pricing system. The models implicitly assume that retail prices of milk are unchanged from one model to the next. Actually consumption would change as price levels were affected by the specific model. The equilibrium results, however, are not greatly different with or without an adjustment of consumption to price.[20] Some of those results in this section are being reported in another article.[21]

Interregional Shipments

Intermarket transfers of milk varied betwen the models but not as much as net regional imports and exports. The export-import position of each region by model is shown in Figure 5. Interregional flows under

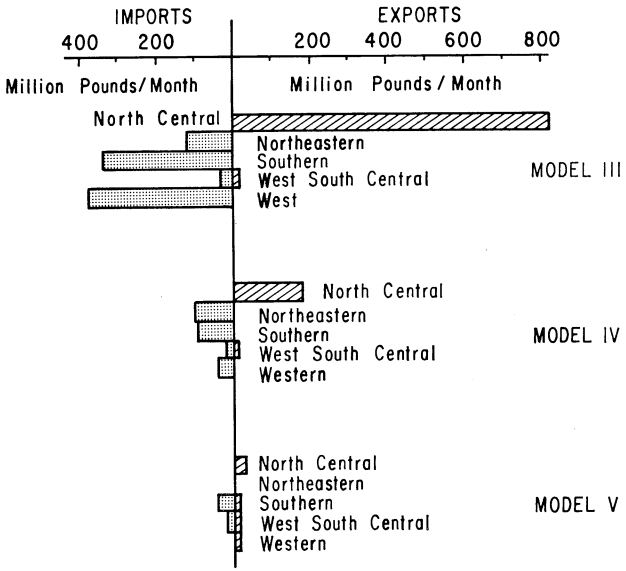


Figure 5 Quantities of Raw Fluid Milk Imported and Exported by Region, Models III, IV and V.

Models III and V are shown in Figure 6. Under the assumptions of Model III (15-cent transfer cost allowance) only two regions are involved in exporting raw fluid milk. The North Central region dominates interregional movements, transporting 826 million pounds to distant markets. The West South Central region exports 19 million pounds. The Northeastern, Southern, West South Central and West regions import 113, 331, 27, and 373 million pounds, respectively.

Interregional flows decrease to 234 million pounds under the assumptions of Model IV (nine-cent transfer cost allowance). Exports from the North Central region decline to 189 million pounds. The Southern and West South Central account for exports totaling 39 and 6 million pounds, respectively. Imports of 94, 90, 15, and 35 million pounds are required by the Northeast, South, West South Central, and West regions, respectively.

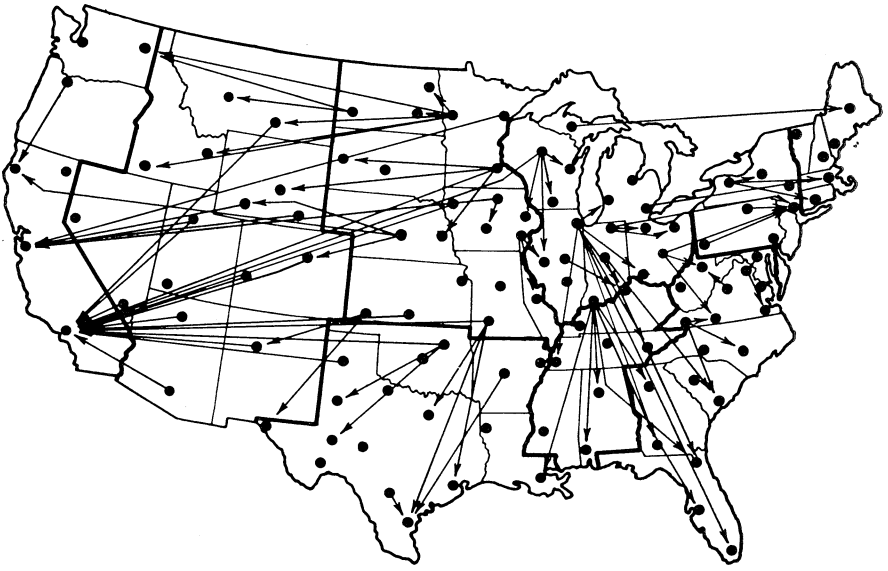
The organization of Model V (no basing-point pricing scheme—raw milk prices are the same in all production areas) reflects the smallest quantities of interregional transfers of milk among regions. Exports decline to 54 million pounds and consist of movements from the North Central (35 million pounds), Southern (9 million pounds), West South Central (8 million pounds), and West (2 million pounds) regions. These exports flow into the Southern (43 million pounds) and the West South Central (11 million pounds) regions.

Unused Production

Quantities of unused production by regions also vary as alternative resource pricing schemes are assumed. Generally the trend outside the North Central region is toward decreased quantities of excess production as the transfer cost allowance is reduced (Figure 7). The West's unused production decreases from 634 million pounds to 296 million pounds in Model IV and to 257 million pounds in Model V. Similar decreases are evident in the Southern, West South Central and Northeastern regions. In contrast, the North Central region experienced increases in unused production from 7 to 579 to 859 million pounds under the assumptions of successively lower transfer cost allowances of Models III, IV and V.

The number of production areas involved in the optimum market organization also increase as the transfer cost allowance decreased. In Model III, production is utilized from 71 of the 92 production regions. As pricing differentials are decreased to nine cents, the number of production areas in the organization increase to 86. At the zero differential level, milk from 89 of the 92 production regions is utilized.

Model III



Model V

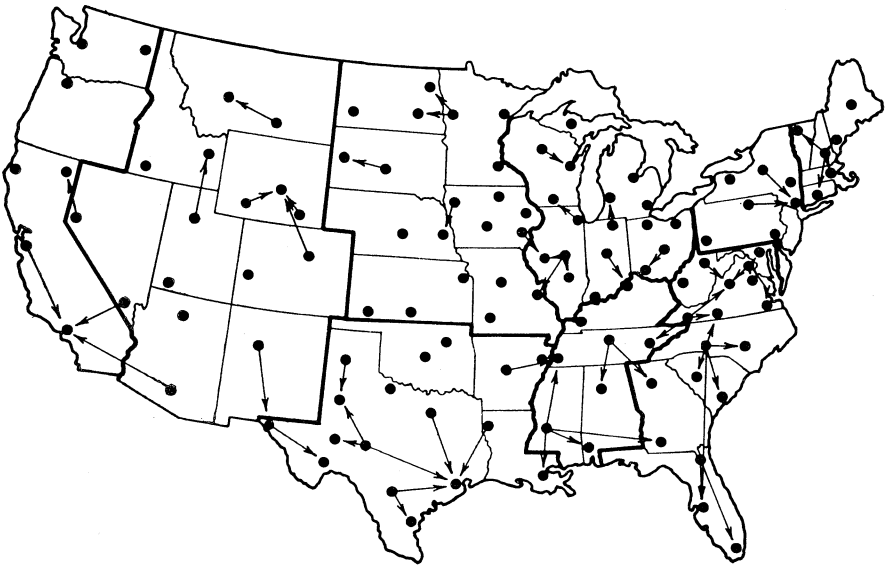


Figure 6 Optimum Flow Patterns of Milk From Production Areas to Processing Facilities, Model III (15-cent transfer cost differential) and Model V (zero transfer cost differential).

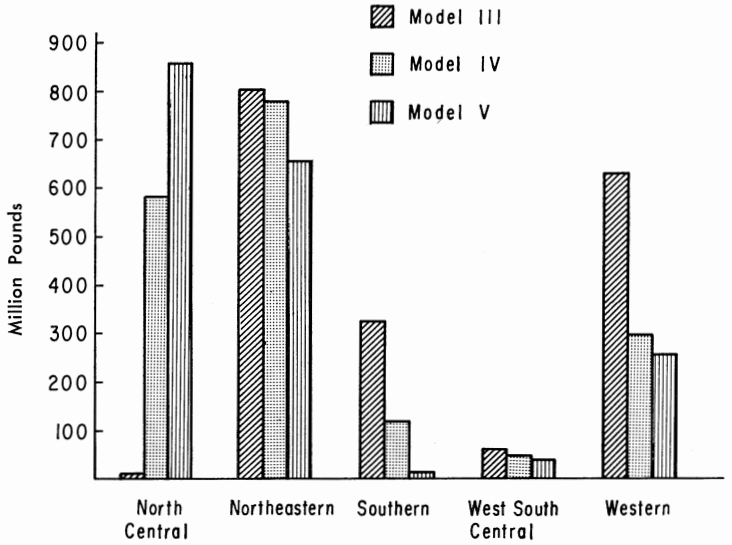


Figure 7 Quantities of Unused Production by Region, Models III, IV and V.

Costs

The cost components (assembly, processing, distribution and total costs) associated with Models III, IV and V are illustrated in Figure 8. The most volatile cost component in the organizations is assembly cost. As a result of altered transfer cost allowance between models and the associated shifts in quantities of intermarket movements, assembly costs are \$15.1, \$5.5 and \$3.6 million for Models III, IV and V, respectively.

The processing and distribution sectors of the market organizations are not nearly as sensitive to changes in resource pricing as the production and assembly activities. Processing costs total \$54.2, \$53.9 and \$54.8 million for Models III, IV, and V. Since distribution costs total \$2.6, \$2.7, and \$1.9 million for the same models, total costs were \$71.8, \$62.1 and \$60.3 million.

If assembly costs were subtracted from total costs, the remainders, representing other marketing functions, would total \$56.7, \$56.6, and \$56.7 million for Models III, IV and V, respectively. These costs reflect the stability in the processing and distribution sectors under alternative basing-point pricing schedules. Most variations in total organizational costs are the result of the sensitivity of assembly functions to resource price changes.

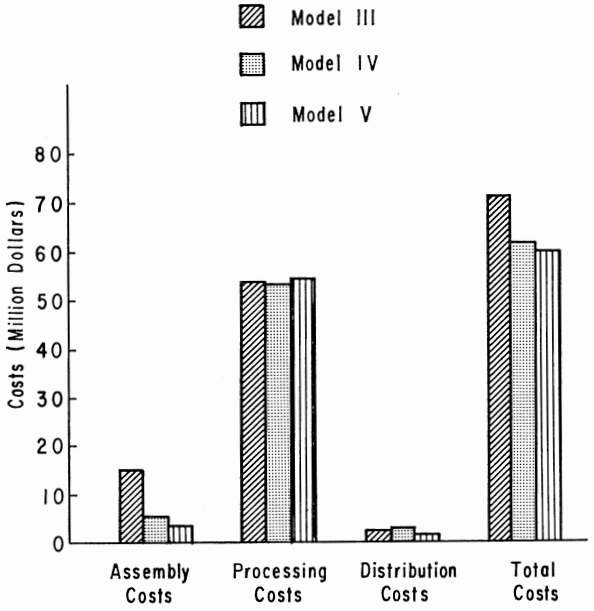


Figure 8 Assembly, Processing, Distribution and Total Costs, Models III, IV and V.

In general, the production and assembly activities are significantly influenced by changes in the resource pricing structure. As the transfer costs were increased from zero to 15 cents per hundredweight per hundred miles, several significant developments occurred: (1) as the differential increases, the production in many distant markets from the base point is displaced by production from the surplus producing North Central region (this type of displacement becomes evident when the pricing differential exceeded the transportation costs which generally occurs around 10 to 12 cents per hundredweight per hundred miles); (2) as the differential is increased, resource procurement areas became increasingly skewed toward the base point; (3) as the differential increases, producers in the North Central region benefit because of the location of the base point in the region which allowed large quantity movements from the region especially at higher differentials; and (4) as the differential increases, the transportation industry benefits because of the increased intermarket movements of raw fluid milk.

One additional comment should be made about the production and assembly sectors and the location of future production. The optimum market organization of Model III indicates the displacement of produc-

tion in distant areas by production in the Mid-Western states. A policy reflecting a pricing structure similar to the one in Model III would lead to the eventual relocation of production from these distant supply areas to a more central location (the incentive would be to locate in the North Central region).

Effects of Market Share Restrictions for Individual Firms Flat Class I Price Environment

The location of processing facilities could shift if market share restrictions were imposed on the individual firms. Presumably, more firms would be forced into the organization of an industry when the restrictions were effective. Models I and V were constructed such that this type of comparison could be made. They involved the same resource pricing structure; therefore, the involvement of the production and assembly activities were similar in both models. The only basic changes in these activities were the result of shifts in the processing sectors. Since these changes influence the processing sectors, most comments will be directed toward the processing and distribution functions of these organizations. Some of these results have been reported previously.[22]

Model I is characterized by an organization in which 64 processing facilities are established. In Model V the number of firms increases by 186 to 250 facilities. The distribution of firms by size classification is illustrated in Figure 9. In Model I, the most commonly established facility is in the 25-50 million pound per month range (22 facilities are established within this range). The most common sized facility established in Model V is in the 10-25 million pound per month range (91 facilities are established). Of the total firms established in Model V (250), 201 of these facilities operate at less than 25 million pounds per month.

Firm capacities average 73.1 million pounds per month in Model I compared with 18.8 million pounds in Model V. Processing functions are carried out at costs of 0.98 cents per pound versus 1.17 cents per pound for the two models.

Distribution activities are also influenced by the organization. Quantities involved in intermarket transfers total 1,152 and 578 million pounds per month for Models I and V, respectively. Transportation costs associated with these movements decline from $3.8 million in Model I to $1.9 million in Model V. Decreases experienced in distribution activities and costs of Model V are the result of increased processing in local areas. Firms are restricted in size and the necessary economies needed to offset transport costs to distant markets are not attained. However,

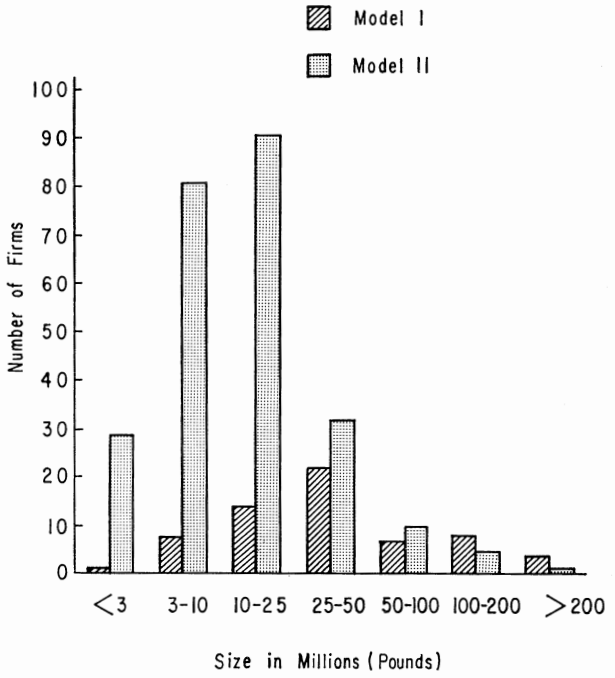


Figure 9 Distribution of Firm Size, Model I and V.

an interesting phenomenon occurs in the flow patterns of packaged milk. In Model I, 49 markets import packaged milk. In Model V, 69 markets are involved in the importation of packaged milk, but total intramarket movements are only approximately 50 percent of those in Model I. This is apparently the influence of the structure of the processing industry in Model V.

Under the assumptions of Model V, most markets establish at least two processing facilities. However, the ratio of costs per unit of larger export facilities compared with the per unit costs of a smaller less efficient plant of another market are enough to offset transport costs. For example, the Dallas facility serves one additional distant market in Model I. In Model V, Dallas serves 10 additional markets from its export facility. The ratio of processing costs between the large export facility in Dallas versus the alternative potential establishment is enough to justify the transport costs.

Total organization costs are $53.2 million in Model I compared with $60.3 million in Model V (Figure 10). Processing costs are $46.1 million (87 percent of the total cost) in Model I and $54.8 million (91

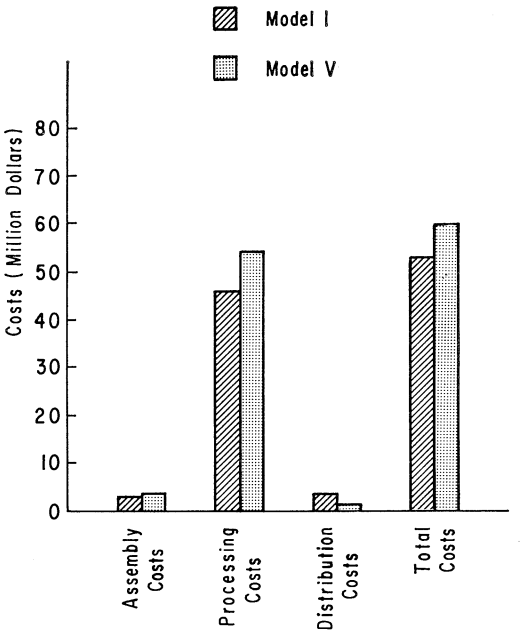


Figure 10 Assembly, Processing, Distribution, and Total Costs, Models I and V.

percent of the total cost) in Model V. Assembly costs were relatively stable at $3.2 and $3.6 million, respectively. Distribution costs total $3.8 million in Model I compared with $1.9 million in Model V.

In general, the type of structure assumed in the processing sector did influence the organization of the industry especially in the location of processing and the distribution of the final product. As a result of more firms being in the solution, several phenomena occur: (1) the location of processing does shift and become more localized; (2) the organization is characterized by smaller less efficient firms and, therefore higher processing costs; and (3) more markets are served by nonlocal firms (due to the ratio of per unit processing costs between markets) but participation in these markets by nonlocal firs is not as concentrated.

Current Class I Price Environment

Three of the models (II, III and VI) were formulated to permit three different levels of concentration to exist in the processing sector. Model II has the smallest number of firms and Model VI has the largest number. The resource pricing structure is similar to the current basing-

point pricing structure except that prices in distant markets tended to deviate from the actual pricing pattern in Model III.

Firms in the optimum organizations total 59 in Model II, 237 in Model III, and over 4,000 in Model VI. Average processing capacities are 73.1, 19.6, and 1.1 million pounds per month, respectively, as illustrated in Figure 11.

The largest facilities established in Model II are located in the Northeastern region (average capacity 153 million pounds) followed by the North Central, West, Southern and West South Central regions. The restrictions imposed in Model III lowered the average size of facility to 19.6 million pounds, but the Northeastern region still had the largest facilities (averaging 50.8 million pounds per month). In Model VI, the average firm size decreases to 1.1 million pounds and the location of the largest firms shifts to the West South Central, Southern and Western regions. This shift appears to result from the lack of potential market expansion in the sparse population of these regions where it is difficult to establish small local facilities and the fact that many marginal processors had already been phased out of the industry by the mid 1960's.

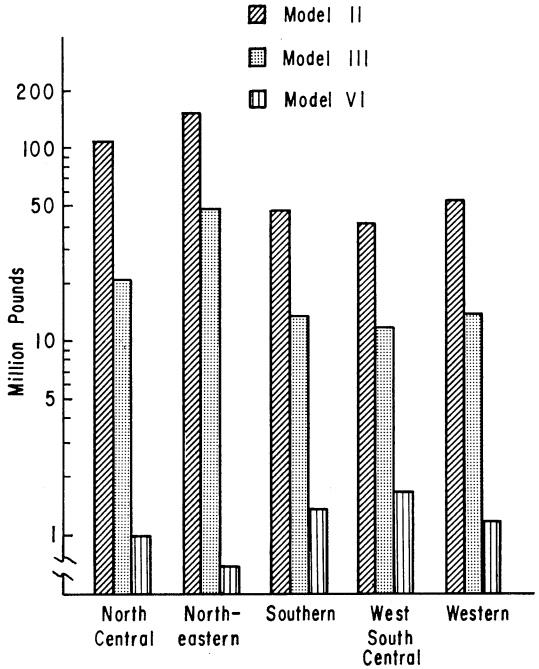


Figure 11 Average Size of Processing Facility Established by Region, Models II, III and VI.

Costs of processing increase as models become more restrictive. Total processing costs are $46.0, $54.2 and $71.4 million in Models II, III and VI, respectively (Figure 12).

Processing also tends to become more localized as the models become more restrictive. For example, the North Central region has a potential comparative advantage in generating economies of size in the processing sector because of its location relative to production and population. In Model II, firms located in this region are large (average size 112 million pounds) and transshipments of the final product to distant markets are economically justified. In Model VI, the average size of facility in the North Central region is approximately one million pounds per month, and the same economics of size do not exist. As a result, more milk is processed in the Southern region, increasing from 670 million pounds per month in Model II to 839 million pounds in Model VI. The gains experienced in the Southern region generally are at the expense of processors in the North Central region.

Distribution costs decrease in all regions as the models become more restrictive. Costs of distribution decrease from $5.5 million in Model II, to $2.6 million in Model III to $0.8 million in Model VI. Quantities

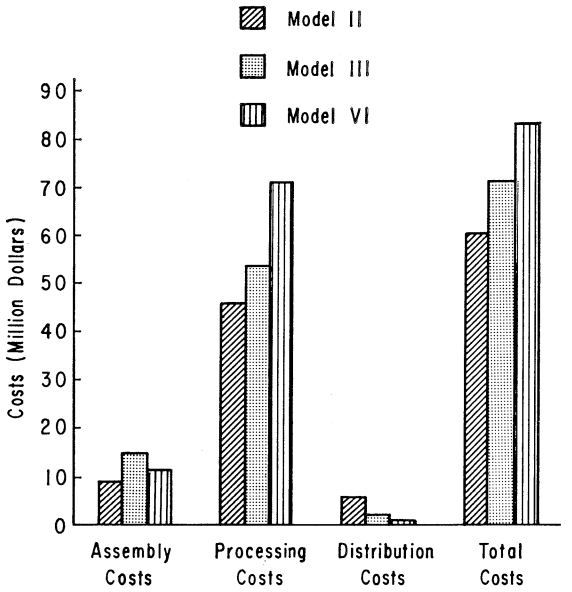


Figure 12 Assembly, Processing, Distribution and Total Costs, Models II, III and VI.

of milk associated with these costs were 1,248, 698 and 225 million pounds per month, respectively.

Assembly costs vary among the models, and in Model III were highest at $15.1 million. The high costs of Model III are the result of the basing-point pricing structure which used prices which were higher in the more distant markets than actually existed in 1965. Assembly costs totaled $9.1 and $11.6 million in Models II and VI.

Total organizational costs increase as the models become more restrictive. Total costs are $60.6 million per month in Model II, $71.8 million in Model III, and $83.8 million in Model VI. It is obvious that full advantage of economies of size is not being fully achieved in some models. Those models in which processing was unrestricted gives the greatest cost savings. Yet, the possibility of anti-trust action would make this alternative unattractive to processors. The cost of maintaining more than one firm in the marketing system is less than 20 percent based on Models II and III.

The producer can also be affected by structural changes in the processing sector. For example, if the industry moved from an organization as illustrated by Model VI to one represented by Model III, a total savings of $17.2 million per month could be realized. The question is "who will benefit from these savings?" As a result of fewer firms being established, farmers must transport raw milk greater distances. These costs have been absorbed by the farmer in the past, and the transportation industry has benefited by the larger volume of business. The possibility exists, however, for the farmer to receive some of the savings in the form of higher prices and for the consumer to benefit through lower retail prices of milk.

Summary and Conclusions

The major objective of the study was to determine optimum market organizations under alternative economic conditions reflecting (1) varying concentrations of firms in the processing sector and (2) alternative raw milk prices in a basing-point pricing structure. In the analysis, the United States was divided into 105 demand areas with resource supplies made available from 92 production areas. Since no data were available for consumption and production for the market areas as defined in the analysis, per capita consumption and production by area were estimated from equations. Assembly, processing and distribution costs were determined on the basis of functions developed in previous studies and adapted to meet the conditions of the models of this study.

A transport-separable model was developed and used to determine the optimum market organizations of the fluid milk industry under

alternative assumptions. The model was designed to determine the least cost flow of milk from supply sources to processing facilities and the movement of the final product from these facilities to distribution outlets. Determination of costs associated with the processing functions utilized a nonlinear programming technique to account for the nonlinear cost function which reflected economies of size.

In addition to the determination of least cost flow patterns, the model determined the optimum size, number and locations of processing. Three basic formulations were utilized in the analysis: (1) models in which the organization permitted only a single firm to serve each market; (2) models in which the organization required more than one firm to serve each market; (3) a model in which the least cost flow pattern was determined using the approximate 1965 number and size of firms and 1965 prices of raw milk.

Empirical Results

Model I was formulated to determine the least cost market organization when raw milk prices paid to farmers were equal in all production areas and the processing sector was unrestricted relative to firm size (e.g., a single firm served each market). In the optimum organization for this model, 76 production areas served 64 processing facilities with 4,679 million pounds of milk per month. To adequately supply these facilities 1,138 million pounds were involved in intermarket transfers at costs of $3.2 million. Processing functions were carried out in facilities averaging 73.1 million pounds in capacity. Average processing costs were 0.98 cents per pound or a total of $46.1 million. Distribution costs associated with movements of 1,152 million pounds of packaged milk to distribution outlets totaled $3.8 million. Total organizational costs were $53.2 million.

Model II was similar to Model I except that actual 1965 raw milk prices were used. In the optimum organization from this model, production was utilized from 64 production areas serving 59 processing facilities. Intermarket movements of raw fluid milk totaled 1,819 million pounds per month and required an assembly cost outlay of $9.1 million. Processing functions were performed in facilities averaging 79.3 million pounds at costs of $46 million or 0.98 cents per pound. Intermarket movements of final product totaled 1,248 million pounds at costs of $5.5 million.

The primary difference in the optimum organizations under Models I and II was that the incorporation of 1965 prices created milkshed configurations which were skewed toward the surplus production areas of Minnesota and Wisconsin. The result was the displacement of raw milk in

the distant markets by production in the surplus producing North Central region. Distribution configurations were skewed away from the surplus production areas because processors were more competitive in directions away from the base point.

Models III, IV and V were formulated to require that more than one firm serve each major market. They also incorporated basing-point pricing schemes which involved alternative levels of transfer cost allowances for distances from Eau Claire, Wisconsin.

The organization of Model III involved a multiple firm economic environment with a transfer cost allowance for raw milk which approximated the level currently in use except for the markets furthest from the base point. The transfer cost allowance was 15 cents per hundredweight per 100 miles. The least cost solution utilized production from 71 production areas to serve 239 processing facilities. A total of 1,939 million pounds of raw milk were transported to distant markets at costs of $15.1 million. Processing functions were carried out in facilities averaging 19.6 million pounds at a total cost of $54.2 million or 1.16 cents per pound. Intermarket movements of packaged milk totaled 698 million pounds at costs of $2.6 million. Total organizational costs were $71.8 million.

The intermarket flows of milk for Model III were very similar to those for Model II. Procurement areas were skewed toward the base point and distribution configurations became skewed away from the base point under the 15-cent transfer cost allowance. The major difference in the models occurred in the processing sector where the requirement to have more than one firm serve each market caused higher processing costs ($8.2 million over Model II). Smaller, less efficient firms were forced into the organization under Model III.

Model IV was formulated to determine the optimum organization conditions similar to Model III except a nine-cent transfer cost allowance was assumed. The results of Model IV were analogous to Model III. The skewness, however, was not as intense since producers in many of the more distant markets were able to compete in the market for raw milk. In the optimum organization, production was utilized from 15 more areas with $9.6 million lower assembly costs and about the same processing costs as compared with Model III.

Model V was formulated to have the transfer cost allowance reduced all the way to zero. That is, the raw milk price was assumed to be identical in every area of production. In the optimum organization, production was utilized from 89 production areas and served 249 processing facilities. This was the largest number of areas of any for Models I through V. Assembly costs totaled $3.6 million for intermarket movements of raw milk totaling 1,189 million pounds in Model V. Processing

functions were performed at total costs of $54.8 million. Supplying all markets required intermarket movements of processed milk totaling only 578 million pounds. Costs associated with these movements were $1.9 million. Total organizational costs were $60.3 million.

Production and distribution sectors in Model V were no longer characterized by the type of skewness which was evident under the pricing structures of Models III and IV. Total organizational costs were only 10 percent more than the maximum efficiency single firm organization of Model I.

Model VI was formulated to determine the minimum cost flow under the existing firm number and raw milk pricing structure. In the optimum solution, production was utilized from 69 production areas serving 4,151 processing facilities. Intermarket movements of raw fluid milk consisted of 1,907 million pounds being transported at costs totaling $11.6 million. Processing costs totaled $71.4 million. Only 225 million pounds of the final product were transported to distant markets at costs of $755,000. Total organizational costs were $83.8 million.

The least cost organization of the industry as it existed in 1965 (Model VI) represented the organization with the largest total cost. Milkshed configurations were similar to those of Models II and III in which the configurations of the West, West South Central and Southern regions were skewed toward the surplus North Central region. In the processing sector, variations in per unit processing costs were very small between markets which resulted in the localization of processing.

Implications

The hypothetical market organizations in the analysis of this study were sensitive to change. Results of the analysis indicated that considerable saving could be made by altering the existing market organization. The extent and magnitude of these savings would depend upon the model and underlying assumptions. Assuming a flat class I pricing system for raw milk, $30.6 million could be saved if maximum efficiency as exemplified by a single firm organization were the goal. If institutional and legal restrictions were placed on the organization to guarantee some level of competition, increased costs were experienced as compared with the maximum efficiency models. However, about one-half of the potential savings could still be realized.

Various assumptions were made regarding the raw milk pricing structure. At a 15-cent transfer cost allowance in a basing-point pricing system, large transfers of milk occurred. Milk was transferred as processed milk in a single firm organization but as raw milk in the multiple firm organization. The results indicated potential shifts or relocation of prod-

uction if these prices would persist with no institutional or legal controls on the flows.

As the transfer cost allowance level decreased first to nine cents then to zero, utilization of production became more localized. The justification for the base point pricing differentials is the persistence of differential costs of production between areas. The variations in the pricing structure should, therefore, be reflections of actual cost variations. If costs decrease, then pressures on the price system exist which could result in the movement of milk between markets which are not needed for consumption.

The hypothetical market organization illustrated potential cost savings as firm numbers decreased. Throughout the analysis, the traditional assumption was made that producers paid the transfer costs from the farm to the central processing facility. If firm numbers should decrease, some of the costs saved in performing the market functions could be passed on to the farmers because the distances milk is shipped have expanded.

The consumer is in a similar position as firm numbers decrease. The processing industry could change from a situation of monopolistic competition to one of oligopoloy or monopoly. The lack of competition could result in higher prices paid by consumers. Consideration could be given to the consumers' position and the ability of the organization to pass economic efficiencies on to the consumer in the form of reduced retail prices.

Footnotes

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APPENDIX

APPENDIX TABLE I. Codes Used in Identifying Demand (Distribution Points) and Supply (Assembly Points) Areas.

Demand		Supply	
Code	Distribution Points and Location of Processing	Code	Points of Assembly
1	Seattle, Washington	1	Seattle, Washington
2	Spokane, Washington	2	Spokane, Washington
3	Portland, Oregon	3	Portland, Oregon
4	Eureka, California	4	Eureka, California
5	San Francisco, California	5	San Francisco, California
6	Los Angeles, California	6	Los Angeles, California
7	Alturas, California	7	Burns, Oregon
8	Boise, Idaho	8	Boise, Idaho
9	Idaho Falls, Idaho	9	Laramie, Wyoming
10	Helena, Montana	10	Helena, Montana
11	Billings, Montana	11	Billings, Montana
12	Rock Springs, Wyoming	12	Rock Springs, Wyoming
13	Casper, Wyoming	13	Las Vegas, Nevada
14	Reno, Nevada	14	Reno, Nevada
15	Salt Lake City, Utah	15	Salt Lake City, Utah
16	Cedar City, Utah	16	Albuquerque, New Mexico
17	Flagstaff, Arizona	17	Flagstaff, Arizona
18	Phoenix, Arizona	18	Phoenix, Arizona
19	Grand Junction, Colorado	19	Grand Junction, Colorado
20	Denver, Colorado	20	Denver, Colorado
21	Albuquerque, New Mexico	21	Fort Stockton, Texas
22	Amarillo, Texas	22	Amarillo, Texas
23	Lubbock, Texas	23	Lubbock, Texas
24	Odessa, Texas	24	San Angelo, Texas
25	El Paso, Texas	25	El Paso, Texas
26	Wichita Falls, Texas	26	Wichita Falls, Texas
27	Dallas, Texas	27	Dallas, Texas
28	Houston, Texas	28	Houston, Texas
29	San Antonio, Texas	29	San Antonio, Texas
30	Corpus Christi, Texas	30	Corpus Christi, Texas
31	Tulsa, Oklahoma	31	Tulsa, Oklahoma
32	Oklahoma City, Oklahoma	32	West Memphis, Arkansas
33	Little Rock, Arkansas	33	Little Rock, Arkansas
34	Shreveport, Louisiana	34	Shreveport, Louisiana
35	New Orleans, Louisiana	35	New Orleans, Louisiana
36	Paducah, Kentucky	36	Memphis, Tennessee
37	Louisville, Kentucky	37	Nashville, Tennessee
38	Memphis, Tennessee	38	Knoxville, Tennessee
39	Nashville, Tennessee	39	Jackson, Mississippi
40	Knoxville, Tennessee	40	Birmingham, Alabama
41	Jackson, Mississippi	41	Mobile, Alabama
42	Birmingham, Alabama	42	Clarksburg, W. Virginia
43	Mobile, Alabama	43	Charleston, W. Virginia
44	Clarksburg, W. Virginia	44	Washington, D. C.
45	Charleston, W. Virginia	45	Bristol, Virginia
46	Baltimore, Maryland	46	Norfolk, Virginia
47	Danville, Virginia	47	Raleigh, North Carolina
48	Richmond, Virginia	48	Charlotte, North Carolina
49	Charlottesville, Virginia	49	Atlanta, Georgia
50	Norfolk, Virginia	50	Albany, Georgia
51	Raleigh, North Carolina	51	Columbia, South Carolina
52	Atlanta, Georgia	52	Charleston, South Carolina

APPENDIX TABLE I. (Continued)

Demand		Supply	
Code	Distribution Points and Location of Processing	Code	Points of Assembly
53	Albany, Georgia	53	Jacksonville, Florida
54	Columbia, South Carolina	54	Tampa, Florida
55	Charleston, South Carolina	55	Miami, Florida
56	Jacksonville, Florida	56	Dickinson, North Dakota
57	Tampa, Florida	57	Pierre, South Dakota
58	Miami, Florida	58	Rapid City, South Dakota
59	Dickinson, North Dakota	59	Duluth, Minnesota
60	Grand Forks, North Dakota	60	Moorehead, Minnesota
61	Jamestown, North Dakota	61	Minneapolis, Minnesota
62	Pierre, South Dakota	62	Mason City, Iowa
63	Rapid City, South Dakota	63	Sioux City, Iowa
64	Duluth, Minnesota	64	Des Moines, Iowa
65	Moorehead, Minnesota	65	Davenport, Iowa
66	Minneapolis, Minnesota	66	Grand Island, Nebraska
67	Sioux City, Iowa	67	Dodge City, Kansas
68	Des Moines, Iowa	68	Wichita, Kansas
69	Cedar Rapids, Iowa	69	Kansas City, Kansas
70	Grand Island, Nebraska	70	Springfield, Missouri
71	Omaha, Nebraska	71	St. Louis, Missouri
72	Dodge City, Kansas	72	Decatur, Illinois
73	Wichita, Kansas	73	Chicago, Illinois
74	Kansas City, Kansas	74	Wausau, Wisconsin
75	Springfield, Missouri	75	Marquette, Michigan
76	Columbia, Missouri	76	Detroit, Michigan
77	St. Louis, Missouri	77	Cleveland, Ohio
78	Centralia, Illinois	78	Columbus, Ohio
79	Peoria, Illinois	79	Cincinnati, Ohio
80	Chicago, Illinois	80	South Bend, Indiana
81	Madison, Wisconsin	81	Indianapolis, Indiana
82	Green Bay, Wisconsin	82	Evansville, Indiana
83	Eau Claire, Wisconsin	83	Pittsburg, Pennsylvania
84	Marquette, Michigan	84	Williamsport, Pennsylvania
85	Bay City, Michigan	85	Philadelphia, Pennsylvania
86	Grand Rapids, Michigan	86	Rochester, New York
87	Detroit, Michigan	87	Utica, New York
88	Toledo, Ohio	88	New York, New York
89	Cleveland, Ohio	89	Hartford, Connecticut
90	Cincinnati, Ohio	90	Boston, Massachusetts
91	Columbus, Ohio	91	Concord, New Hampshire
92	Indianapolis, Indiana	92	Bangor, Maine
93	Evansville, Indiana		
94	Pittsburg, Pennsylvania		
95	Williamsport, Pennsylvania		
96	Philadelphia, Pennsylvania		
97	New York, New York		
98	Albany, New York		
99	Rochester, New York		
100	Utica, New York		
101	Hartford, Connecticut		
102	Boston, Massachusetts		
103	Burlington, Vermont		
104	Portland, Maine		
105	Bangor, Maine		

APPENDIX TABLE II. Processing and Distribution Activities for Individual Markets in the Optimum Market Organization of the United States Fluid Milk Industry, Models I and II.[1]

	MODEL I				MODEL II			
Demand Area	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost
1	1	49,761,200	49,761,200	552,450	1	49,761,200	49,761,200	552,450
2	2	23,157,220	23,157,220	287,850	2	23,157,220	23,157,220	287,850
3	3	41,073,450	41,073,450	465,490	3	41,073,450	41,073,450	465,490
4	4	22,795,720	22,795,720	279,580	4	22,795,720	22,795,720	279,580
5	5	166,805,000	175,187,200	1,683,230	5	166,805,000	166,805,000	1,610,880
6	6	272,397,780	272,297,780	2,486,230	6	272,397,780	272,397,780	2,486,230
7	5	4,502,500	---	---	8	4,502,500	---	---
8	8	6,494,370	6,494,370	91,240	8	6,494,370	21,699,600	240,720
9	15	7,297,900	---	---	8	6,822,310	---	---
9	---	---	---	---	11	475,490	---	---
10	10	10,157,250	10,157,250	135,450	11	10,157,250	---	---
11	11	6,164,000	6,164,000	87,090	11	6,164,000	24,379,590	
12	15	2,446,480	---	---	15	2,446,480	---	---
13	20	5,136,260	---	---	11	5,136,260	---	---
14	5	3,880,420	---	---	15	3,880,420	---	---
15	15	22,846,660	38,961,040	445,240	15	22,846,660	29,217	345,230
16	15	6,370,000	---	---	15	6,370,000	---	---
17	18	4,530,000	---	---	18	4,530,000	---	---
18	18	33,392,920	37,922,930	435,210	18	33,392,920	37,923	435,210
19	19	5,461,170	5,461,170	72,290	18	5,461,170	5,461	78,290
20	20	42,707,600	53,065,040	585,480	20	42,707,600	42,708	482,540
21	21	15,937,620	15,937,620	201,790	21	15,937,620	15,937,620	201,790
22	22	9,616,200	9,616,200	128,960	22	9,616,200	9,616,200	128,960
23	23	14,139,220	14,139,220	181,490	23	14,139,220	24,433,670	294,650
24	24	10,294,450	10,294,450	137,060	23	10,294,450	---	---
25	25	14,073,900	14,073,900	180,740	25	14,073,900	14,073,900	180,740
26	27	13,378,930	---	---	31	2,584,080	---	---
26	---	---	---	---	73	10,794,860	---	---
27	27	65,056,870	78,436	827,430	27	65,056,870	93,917,500	970,500
28	28	56,406,800	56,406,800	617,170	28	56,406,800	56,406,800	617,170
29	29	32,152,120	34,905,720	403,950	29	32,152,120	51,645,270	571,630
30	30	18,984,370	18,984,370	235,370	27	2,244,830	---	---

[1] Quantity and size of plant are shown in pounds and cost is shown in dollars.

APPENDIX TABLE II (Continued)

Demand Area	MODEL I				MODEL II			
	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost
30	29	2,753,600	---	---	29	19,493,150	---	---
31	31	24,901,890	55,594,270	610,910	31	24,901,890	55,594,270	610,910
32	31	28,108,300	---	---	31	28,108,300	---	---
33	31	2,584,080	---	---	33	22,411,990	22,411,990	272,700
33	33	19,827,920	19,827,920	244,650	---	---	---	---
34	34	26,615,800	26,615,800	317,160	27	26,615,800	---	---
35	35	58,768,310	58,768,310	639,960	35	58,768,310	58,768,310	639,960
36	39	9,532,750	---	---	77	9,532,750	---	---
37	37	38,765,920	38,765,920	442,870	80	38,765,920	---	---
38	38	36,055,890	36,055,890	415,370	38	36,055,890	36,055,890	415,370
39	39	29,174,320	38,707,070	442,780	39	29,174,320	29,174,320	344,370
40	40	42,705,970	42,705,970	482,530	40	42,705,970	42,705,970	482,530
41	41	27,786,640	55,871,570	523,170	41	27,786,640	55,871,570	
42	42	43,662,670	43,662,670	492,050	42	43,662,670	43,662,670	492,050
43	41	28,084,920	---	---	41	28,084,920	---	---
44	94	20,743,130	---	---	91	20,743,130	---	---
45	45	33,072,000	33,072,000	384,850	45	33,072,000	44,788,290	503,770
46	46	119,934,360	128,654,660	1,287,170	46	119,934,360	132,512,380	1,322,300
47	51	58,676,350	---	---	91	58,676,350	---	---
43	94	12,578,020	---	---	46	12,578,020	---	---
49	94	32,446,920	---	---	91	32,446,920	---	---
50	50	44,582,090	44,582,090	501,350	50	44,582,090	44,582,090	501,350
51	51	31,926,010	90,602,370	906,450	91	20,209,730	---	---
51	---	---	---	---	45	11,716,290	---	---
52	52	49,300,480	49,300,480	547,880	52	49,300,480	49,300,480	547,880
53	53	31,879,100	31,879,100	372,420	53	31,879,100	31,879,100	372,420
54	54	28,747,950	28,747,950	339,950	55	28,747,950	---	---
55	55	19,728,000	19,728,000	243,620	55	19,728,000	63,219,320	643,830
56	56	39,146,440	39,146,440	446,650	56	24,403,060	24,403,060	294,130
56	---	---	---	---	55	14,743,370	---	---
57	57	31,645,190	31,645,190	370,140	57	31,645,190	31,645,190	370,140
58	58	40,166,140	40,166,140	457,070	58	40,166,140	40,166,140	457,070
59	59	6,048,000	6,048,000	85,640	65	6,048,000	---	---

APPENDIX TABLE II (Continued)

Demand Area	MODEL I Processing Center	Quantity	Size of Plant	Cost	MODEL II Processing Center	Quantity	Size of Plant	Cost
60	66	8,731,750	---	---	65	8,731,750	---	---
61	66	8,443,540	---	---	65	8,443,540	---	---
62	66	8,619,470	---	---	62	8,619,470	15,477,900	196,810
63	63	1,637,250	1,637,250	26,850	62	6,858,430	---	---
63	20	5,221,110	---	---	---	---	---	---
64	66	12,211,520	---	---	65	12,211,320	---	---
65	66	10,088,850	---	---	65	10,088,850	50,568,620	498,840
66	66	74,092,500	163,386,830	1,573,900	66	74,092,500	217,291,580	1,999,280
67	66	20,491,110	---	---	65	5,045,160	---	---
67	---	---	---	---	66	15,445,650	---	---
68	68	16,389,840	16,389,840	207,050	66	20,506,470	---	---
68	66	4,116,630	---	---	---	---	---	---
69	80	32,272,030	---	---	69	32,272,030	32,272,030	376,510
70	74	12,498,850	---	---	70	12,498,400	12,498,400	162,720
71	71	31,899,400	31,899,400	372,630	71	31,899,400	31,899,400	372,630
72	72	6,812,050	6,812,050	95,030	72	6,812,050	6,812,050	95,030
73	73	23,998,820	23,998,820	289,640	73	23,998,820	34,793,670	403,040
74	74	55,172,550	79,865,170	840,980	74	55,172,550	85,402,910	892,430
75	75	18,036,600	18,036,600	225,060	74	18,036,600	---	---
76	74	12,193,760	---	---	74	12,193,760	---	---
77	77	65,002,120	65,002,120	699,690	77	65,002,120	91,591,530	949,000
78	80	17,056,650	---	---	77	17,056,650	---	---
79	80	44,654,770	---	---	79	44,654,770	44,654,770	502,080
80	80	237,478,800	498,075,200	4,141,120	80	237,478,800	637,279,300	5,255,010
81	80	71,892,790	---	---	66	71,892,790	---	---
82	80	18,762,220	---	---	66	18,762,220	---	---
83	66	16,591,650	---	---	66	16,591,650	---	---
84	84	8,176,990	8,176,990	111,790	84	8,176,990	22,631,022	257,530
85	87	14,454,030	---	---	84	14,454,030	---	---
86	87	40,251,540	---	---	80	50,129,320	---	---
86	80	9,877,780	---	---	---	---	---	---
87	87	164,922,800	287,209,420	2,608,540	80	164,922,800	---	---
88	87	58,311,370	---	---	80	58,311,370		

APPENDIX TABLE II (Continued)

Demand Area	MODEL I				MODEL II			
	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost
89	89	135,594,310	173,643	1,671,210	89	135,594,310	278,850,610	2,372,160
90	90	75,098,430	75,098,430	805,120	90	75,098,430	75,098,430	805,120
91	87	9,269,680	---	---	91	47,317,980	179,394,100	1,656,110
91	89	38,048,300	---	---	---	---	---	---
92	80	66,080,160	---	---	80	66,080,016	---	---
93	93	21,590,930	21,590,930	263,830	80	21,590,930	---	---
94	94	101,066,700	187,319, 000	1,787,080	89	101,066,700	---	---
95	99	21,189,600	---	---	89	21,189,600	---	---
96	46	8,720,300	---	---	96	166,313,590	166,314,590	1,606,640
96	97	137,109,050	---	---	---	---	---	---
96	94	20,484,230	---	---	---	---	---	---
97	97	458,890,950	596,000,000	4,908,920	97	458,890,950	458,890,950	3,874,630
98	99	33,431,620	---	---	99	33,431,620	---	---
99	99	79,626,300	192,329,960	1,809,480	99	79,626,300	154,354,920	1,506,350
100	99	41,297,000	---	---	99	41,297,000	---	---
101	102	72,677,070	---	---	102	72,677,070	72,677,070	771,870
102	102	179,457,820	269,354,400	2,466,330	102	179,457,820	196,677,330	1,866,250
103	99	16,785,440	---	---	103	16,785,440	16,785,440	210,990
104	102	17,219,510	---	---	102	17,219,510	---	---
105	105	7,325,760	7,325,760	101,530	105	7,325,760	7,325,760	101,530

Appendix Table III. Processing and Distribution Activities for Individual Markets in the Optimum Market Organization of the United States Fluid Milk Industry, Models III, IV, V and VI

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
1	1	49,761,200	1= 27,000,000 2= 17,000,000 3= 5,761,200	629,370	1	49,761,200	1= 27,000,000 2= 17,000,000 3= 5,761,200	629,370
2	2	23,157,220	1= 13,000,000 2= 8,000,000 3= 2,157,220	312,570	2	23,157,220	1= 13,000,000 2= 8,000,000 3= 2,157,220	312,570
3	3	41,073,450	1= 23,000,000 2= 14,000,000 3= 4,073,450	519,930	3	41,073,450	1= 23,000,000 2= 14,000,000 3= 4,073,450	520,300
4	4	22,795,720	1= 13,000,000 2= 8,000,000 3= 1,795,720	307,760	4	22,795,720	1= 13,000,000 2= 8,000,000 3= 1,795,720	307,760
5	5	166,805,000	1= 92,000,000 2= 42,000,000 3= 17,000,000 4= 12,000,000 5= 3,805,000	1,879,870	5	166,805,000	1= 92,000,000 2= 42,000,000 3= 17,000,000 4= 12,000,000 5= 3,805,000	1,879,870
6	6	272,397,780	1=150,000,000 2= 68,000,000 3= 27,000,000 4= 19,000,000 5= 8,397,780	2,871,640	6	272,397,780	1=150,000,000 2= 68,000,000 3= 27,000,000 4= 19,000,000 5= 8,397,780	2,871,640
7	9	2,599,590	---	---	3	27,620	---	---
7	15	1,902,910	---	---	15	4,474,880	---	---
8	8	6,494,370	1= 4,000,000 2= 2,000,000 3= 1,000,000	142,180	8	6,494,370	1= 4,000,000 2= 2,000,000 3= 494,370	100,280
9	9	7,297,900	1= 4,000,000 2= 3,000,000 3= 297,900	110,730	9	7,000,000	1= 4,000,000 2= 3,000,000	105,54
9					15	297,900	---	---

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
1	1	49,761,200	1= 27,000,000 2= 17,000,000 3= 5,761,200	629,370	1	49,761,200	49,761,200	762,342
2	2	23,314,480	1= 13,000,000 2= 8,000,000 3= 2,314,480	314,830	2	23,157,220	23,157,220	354,305
3	3	41,073,450	1= 23,000,000 2= 14,000,000 3= 4,073,450	519,930	3	41,073,450	41,073,450	632,120
4	4	22,795,720	1= 13,000,000 2= 8,000,000 3= 1,795,720	307,760	4	22,795,720	22,795,720	426,052
5	5	166,805,000	1= 92,000,000 2= 42,000,000 3= 17,000,000 4= 12,000,000 5= 5,000,000 6= 2,187,920	1,921,910	5	170,685,430	170,685,430	2,538,092
6	6	272,397,780	1=150,000,000 2= 68,000,000 3= 27,000,000 4= 19,000,000 5= 8,397,780	2,371,640	6	272,397,780	272,397,780	3,282,393
7	7	3,000,000	1= 3,000,000	46,100	7	4,502,500	4,502,500	72,2
7	5	1,502,500	---	---				
8	8	6,494,370	1= 4,000,000 2= 2,000,000 3= 494,370	100,280	8	6,494,370	6,494,370	106,3
9	9	1,961,040	1= 1,961,040	31,650	9	7,297,900	7,297,900	115,891
9	15	5,336,860	---	---				

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
10	10	10,000,000	1= 6,000,000 2= 4,000,000	144,590	10	10,000,000	1= 6,000,000 2= 4,000,000	144,590
10	59	157,250	---	---	59	157,250	---	---
11	11	6,000,000	1= 3,000,000 2= 3,000,000	92,220	11	6,000,000	1= 3,000,000 2= 3,000,000	92,220
11	59	164,000	---	---	59	164,000	---	---
12	12	2,446,480	1= 2,000,000 2= 446,480	40,000	12	2,439,970	1= 2,000,000 2= 439,970	39,890
12					15	6,510	---	---
13	13	5,136,260	1= 3,000,000 2= 2,000,000 3= 136,260	80,700	13	5,000,000	1= 3,000,000 2= 2,000,000	78,330
13					66	136,260	---	---
14	15	3,880,420	---	---	14	3,880,420	1= 2,000,000 2= 1,000,000 3= 880,420	64,960
14								
15	15	22,846,660	1= 13,000,000 2= 8,000,000 3= 2,000,000 4= 12,000,000	468,020	15	22,846,660	1= 13,000,000 2= 8,000,000 3= 2,000,000 4= 12,000,000	468,020
16	15	6,370,000	---	---	15	6,370,000	---	---
16								
17	21	4,530,000	---	---	21	4,530,000	---	---
18	18	33,392,920	1= 18,000,000 2= 12,000,000 3= 3,392,920	433,530	18	33,392,920	1= 18,000,000 2= 12,000,000 3= 3,392,920	433,530
19	19	5,000,000	1= 3,000,000 2= 2,000,000	78,330	19	5,000,000	1= 3,000,000 2= 2,000,000	78,330
19	20	461,170	---	---	20	461,170	---	---
20	20	42,707,600	1= 24,000,000 2= 15,000,000 3= 4,000,000	543,720	20	42,707,600	1= 24,000,000 2= 15,000,000 3= 4,000,000	543,720

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
10	10	10,000,000	1= 6,000,000 2= 4,000,000	144,590	10	10,157,250	10,157,250	175,517
10	2	157,250	---	---				
11	11	6,164,000	1= 3,000,000 2= 3,000,000 3= 164,000	95,060	11	6,164,000	6,164,000	111,815
11	12	2,000,000	1= 2,000,000	32,230	12	2,439,970	2,439,970	43,163
12	15	446,480	---	---	15	6,510	---	---
13	13	3,000,000	1= 3,000,000	46,100	13	5,136,260	5,136,260	90,039
13	20	2,136,260	---	---				
14	14	2,000,000	1= 2,000,000	32,230	5	3,880,420	---	---
14	5	1,880,420	---	---				
15	15	22,846,660	1= 13,000,000 2= 8,000,000 3= 2,000,000 4= 12,000,000	468,020	15	22,846,660	27,415,990	412,885
16	15	6,370,000	---	---	15	4,562,820	---	---
16					16	1,807,180	1,807,180	29,023
17	18	4,530,000	---		18	4,530,000	---	---
18	18	33,392,920	1= 18,000,000 2= 12,000,000 3= 4,000,000 4= 4,775,210	509,560	18	33,392,920	37,922,930	571,119
19	19	5,461,170	1= 3,000,000 2= 2,000,000 3= 461,170	86,360	19	5,461,170	5,461,170	97,973
19								
20	20	42,707,600	1= 24,000,000 2= 15,000,000 3= 4,000,000	567,080	20	42,707,600	42,707,600	672,218

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
			4= 168,770				4= 168,770	
21	21	15,937,620	1= 9,000,000	289,650	21	15,937,620	1= 9,000,000	289,6
			2= 6,000,000				2= 6,000,000	
			3= 1,000,000				3= 1,000,000	
			4= 4,467,620				4= 4,467,000	
22	22	9,616,200	1= 5,000,000	144,640	22	9,616,200	1= 5,000,000	146,640
			2= 3,000,000				2= 3,000,000	
			3= 1,616,200				3= 1,616,200	
23	23	13,000,000	1= 8,000,000	182,120	23	13,000,000	1= 13,000,000	182,120
			2= 5,000,000					
23	27	1,139,220	---	---	27	1,139,220	---	---
24	24	6,000,000	1= 6,000,000	85,150	24	6,000,000	1= 6,000,000	85,150
24	27	4,294,450	---	---	27	4,294,450	---	---
25	27	1,073,900	---	---	27	1,073,900	---	---
25	25	13,000,000	1= 8,000,000	182,120	25	13,000,000	1= 8,000,000	182,120
			2= 5,000,000				2= 5,000,000	
26	27	13,378,930	---	---	27	13,378,930	---	---
26								
27	27	65,056,870	1= 36,000,000	1,137,940	27	65,056,870	1= 36,000,000	1,124,000
			2= 23,000,000				2= 23,000,000	
			3= 7,000,000				3= 7,000,000	
			4= 29,240,260				4= 27,917,500	
28	27	5,406,800	---	---	27	3,406,800	---	---
28	28	51,000,000	1= 31,000,000	611,120	28	53,000,000	1= 31,000,000	590,630
			2= 20,000,000				2= 20,000,000	
							3= 2,000,000	
29	27	3,152,120	---	---	27	3,152,120	---	---
29	29	29,000,000	1= 18,000,000	370,690	29	29,000,000	1= 18,000,000	370,690
			2= 11,000,000				2= 11,000,000	
30	27	1,737,970	---	---	27	1,737,970	---	---
30	30	20,000,000	1= 12,000,000	267,030	30	20,000,000	1= 12,000,000	267,0
			2= 8,000,000				2= 8,000,000	
31	31	24,901,890	1= 14,000,000	491,590	31	24,901,890	1= 14,000,000	491,5
			2= 9,000,000				2= 9,000,000	
			3= 2,000,000				3= 2,000,000	

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
			4= 1,843,860					
21	21	15,937,630	1= 9,000,000	223,360	21	15,937,620	15,937,620	256,755
			2= 6,000,000					
			3= 937,620					
22	22	9,616,200	1= 5,000,000	144,640	22	9,616,200	9,616,200	152,513
			2= 3,000,000					
			3= 1,616,200					
23	23	13,000,000	1= 13,000,000	182,120	23	14,139,220	14,139,220	227,076
23	27	1,139,220	---	---				
24	24	6,000,000	1= 6,000,000	85,150	24	10,294,450	10,294,450	165,638
24	27	4,294,450	---	---				
25	18	852,290	---	---	25	14,073,900	14,073,900	223,775
25	25	13,221,610	1= 8,000,000	185,690				
			2= 5,000,000					
			3= 221,610					
26	27	6,378,930	---	---	26	13,378,930	13,378,930	214,330
26	26	7,000,000	1= 7,000,000	97,580				
27	27	65,056,870	1= 36,000,000	1,120,690	27	65,056,870	78,068,240	1,149,945
			2= 23,000,000					
			3= 7,000,000					
			4= 27,603,230					
28	27	5,406,800	---	---	28	56,406,800	56,406,800	850,615
28	28	51,000,000	1= 31,000,000	611,120				
			2= 20,000,000					
29	27	3,152,120	---	---	29	32,152,120	32,152,120	481,7
29	29	29,000,000	1= 18,000,000	370,690				
			2= 11,000,000					
30	27	1,737,970	---	---	30	21,737,970	21,737,970	318,0
30	30	20,000,000	1= 12,000,000	267,030				
			2= 8,000,000					
31	31	24,901,890	1= 14,000,000	491,590	31	24,901,890	29,882,270	434,789
			2= 9,000,000					
			3= 2,000,000					

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
			4= 12,000,000				4= 12,000,000	
32	31	12,098,110	---	---	31	12,098,110	---	---
32	75	8,012,750	---	---	75	4,206,510	---	---
32	74	7,997,440	---	---	74	10,802,500	---	---
32					73	1,001,180	---	---
33	33	18,000,000	1= 12,000,000	242,370	33	18,000,000	1= 12,000,000	242,370
			2= 6,000,000				2= 6,000,000	
33	77	2,461,340	---	---	75	4,411,990	---	---
33	75	1,950,650	---	---				
34	34	26,615,800	1= 15,000,000	354,060	34	25,938,570	1= 15,000,000	344,350
			2= 9,000,000				2= 9,000,000	
			3= 2,615,800				3= 1,938,570	
34					27	677,230	---	---
35	35	58,768,310	1= 32,000,000	714,420	35	58,768,310	1= 32,000,000	714,420
			2= 21,000,000				2= 21,000,000	
			3= 5,768,310				3= 5,768,310	
36	77	9,532,750	---	---	77	9,532,750	---	---
37	37	35,000,000	1= 21,000,000	438,200	37	35,000,000	1= 21,000,000	438,200
			2= 14,000,000				2= 14,000,000	
37	80	3,765,920	---	---	80	3,765,920	---	---
38	38	33,000,000	1= 20,000,000	415,810	38	33,000,000	1= 20,000,000	415,810
			2= 13,000,000				2= 13,000,000	
38	77	3,055,890	---	---	77	3,055,890	---	---
39	39	29,174,320	1= 16,000,000	384,660	39	29,174,320	1= 16,000,000	384,660
			2= 10,000,000				2= 10,000,000	
			3= 3,174,320				3= 3,174,320	
40	40	42,705,970	1= 23,000,000	539,690	40	42,705,970	1= 23,000,000	539,690
			2= 15,000,000				2= 15,000,000	
			3= 4,705,970				3= 4,705,970	
41	41	27,786,640	1= 15,000,000	368,390	41	27,786,640	1= 15,000,000	368,390
			2= 10,000,000				2= 10,000,000	
			3= 2,786,640				3= 2,786,640	
42	42	43,662,670	1= 24,000,000	549,840	42	43,662,670	1= 24,000,000	549,840
			2= 15,000,000				2= 15,000,000	
			3= 4,662,670				3= 4,662,670	

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
			4= 12,000,000					
32	27	3,821,060	---	---	32	23,127,920	23,127,920	343,450
32	31	12,098,110	---	---	31	4,980,370	---	---
32	73	12,189,130	---	---				
32								
33	33	18,000,000	1= 12,000,000	242,370	33	19,450,000	19,450,000	317,424
			2= 6,000,000					
33	75	4,411,990	---	---	75	2,961,990	---	---
33								
34	34	24,000,000	1= 15,000,000	313,480	34	13,604,430	13,604,430	218,351
			2= 9,000,000					
34	27	2,615,800	---	---	27	13,011,370	---	---
35	35	58,768,310	1= 32,000,000	714,420	35	58,768,310	58,768,310	956,748
			2= 21,000,000					
			3= 5,768,310					
36	39	9,532,750	---	---	77	9,532,750	---	---
37	37	35,000,000	1= 21,000,000	438,200	37	38,765,920	38,765,920	607,074
			2= 14,000,000					
37	80	3,765,920	---	---				
38	38	33,000,000	1= 20,000,000	415,810	38	36,055,890	36,055,890	537,593
			2= 13,000,000					
38	39	3,055,890	---	---				
39	39	29,174,320	1= 16,000,000	587,390	39	29,174,320	29,174,320	458,329
			2= 10,000,000					
			3= 4,000,000					
			4= 15,000,000					
40	40	42,705,970	1= 23,000,000	539,690	40	42,705,970	42,705,970	658,099
			2= 15,000,000					
			3= 4,705,970					
41	41	27,786,640	1= 15,000,000	368,390	41	27,786,640	27,786,640	462,925
			2= 10,000,000					
			3= 2,786,640					
42	42	43,662,670	1= 24,000,000	554,240	42	43,662,670	43,662,670	689,870
			2= 15,000,000					
			3= 5,000,000					

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
43	43	28,084,920	1= 15,000,000 2= 10,000,000 3= 3,084,920	372,340	43	28,084,920	1= 15,000,000 2= 10,000,000 3= 3,084,920	372
44	44	18,000,000	1= 11,000,000 2= 7,000,000	243,140	44	18,000,000	1= 11,000,000 2= 7,000,000	243,
44	87	2,743,130	---	---	87	2,743,130	---	---
45	45	33,072,000	1= 18,000,000 2= 12,000,000 3= 4,000,000 4= 12,000,000	599,010	45	33,072,000	1= 18,000,000 2= 12,000,000 3= 4,000,000 4= 12,000,000	599,010
46	46	102,000,000	1= 66,000,000 2= 36,000,000	1,126,210	46	102,000,000	1= 66,000,000 2= 36,000,000	1,126,210
46	89	17,934,360	---	---	89	17,934,360	---	---
47	47	53,000,000	1= 32,000,000 2= 21,000,000	632,430	47	53,000,000	1= 32,000,000 2= 21,000,000	632,430
47	37	5,676,350	---	---	46	5,676,350	---	---
48	94	12,578,020	---	---	94	12,578,020	---	---
48								
49	87	9,223,030	---	---	87	8,247,390	---	---
49	44	7,251,650	---	---	45	7,251,650	---	---
49	49	1,335,230	1= 1,335,230	18,950	49	2,310,870	1= 2,310,870	32,790
49	94	14,637,010	---	---	94	14,637,010	---	---
50	50	41,000,000	1= 25,000,000 2= 16,000,000	503,830	50	41,000,000	1= 25,000,000 2= 16,000,000	503,830
50	97	3,582,090	---	---	97	3,582,090	---	---
51	51	29,000,000	1= 18,000,000 2= 11,000,000	370,690	51	29,942,510	1= 18,000,000 2= 11,000,000 3= 942,510	385,880
51	87	2,926,010	---	---	87	1,983,500	---	---
52	52	49,300,480	1= 27,000,000 2= 17,000,000 3= 5,300,480	623,470	52	49,300,480	1= 27,000,000 2= 17,000,000 3= 5,300,480	623,470
53	53	31,879,100	1= 18,000,000	415,110	53	31,879,100	1= 18,000,000	415,

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
43	43	28,084,920	1= 15,000,000 2= 10,000,000 3= 3,084,920	372,340	43	28,084,920	28,084,920	445,427
44	44	18,000,000	1= 11,000,000 2= 7,000,000	243,140	44	19,335,230	19,335,230	33,726
44	89	2,743,130	---	---	91	1,407,890	---	---
45	45	33,072,000	1= 18,000,000 2= 12,000,000 3= 4,000,000 4= 10,788,290	584,460	45	33,072,000	33,072,000	539,404
46	46	114,000,000	1= 66,000,000 2= 36,000,000 3= 12,000,000	1,283,430	46	119,934,360	132,512,380	1,894,927
46	97	5,934,360	---	---				
47	47	58,676,350	1= 32,000,000 2= 21,000,000 3= 5,676,350	713,230	47	58,676,350	58,676,350	882,492
47								
48	48	7,000,000	1= 7,000,000	97,580	46	12,578,020	---	---
48	97	5,578,020	---	---				
49	45	11,716,290	---	---	49	32,446,920	32,446,920	506,172
49	49	18,000,000	1= 18,000,000	225,130				
49	94	2,730,630	---	---				
49								
50	50	44,582,090	1= 25,000,000 2= 16,000,000 3= 3,582,090	557,300	50	44,582,090	44,582,090	696,818
50								
51	51	31,926,010	1= 18,000,000 2= 11,000,000 3= 2,926,010	415,760	51	31,926,010	31,926,010	482
51								
52	52	49,300,480	1= 27,000,000 2= 17,000,000 3= 6,000,000	632,430	52	49,300,480	49,300,480	737,535
53	53	29,000,000	1= 18,000,000	370,690	53	31,879,100	31,879,100	504,965

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
			2= 11,000,000				2= 11,000,000	
			3= 2,879,100				3= 2,879,100	
53								
53								
53								
54	54	26,000,000	1= 16,000,000	336,550	54	26,000,000	1= 16,000,000	336,550
			2= 10,000,000				2= 10,000,000	
54	55	2,747,950	---	---	55	2,747,950	---	---
55	55	19,728,000	1= 11,000,000	313,420	55	19,728,000	1= 11,000,000	313,420
			2= 7,000,000				2= 7,000,000	
			3= 2,000,000				3= 2,000,000	
			4= 2,475,950				4= 2,475,950	
56	56	39,146,440	1= 22,000,000	495,050	56	39,146,440	1= 22,000,000	495,050
			2= 14,000,000				2= 14,000,000	
			3= 3,146,440				3= 3,146,440	
56								
57	57	31,645,190	1= 17,000,000	414,220	57	31,645,190	1= 17,000,000	414,220
			2= 11,000,000				2= 11,000,000	
			3= 3,645,190				3= 3,645,190	
58	58	40,166,140	1= 22,000,000	510,660	58	40,166,140	1= 22,000,000	510,660
			2= 14,000,000				2= 14,000,000	
			3= 4,166,140				3= 4,166,140	
59	59	6,048,000	1= 3,000,000	106,050	59	6,048,000	1= 3,000,000	101,260
			2= 2,000,000				2= 2,000,000	
			3= 1,048,000				3= 1,369,250	
60	60	8,000,000	1= 5,000,000	118,590	60	8,000,000	1= 5,000,000	118,590
			2= 3,000,000				2= 3,000,000	
60	66	731,750	---	---	66	731,750	---	---
61	61	8,000,000	1= 5,000,000	118,590	61	8,000,000	1= 5,000,000	118,590
			2= 3,000,000				2= 3,000,000	
61	66	443,540	---	---	66	443,540	---	---
62	62	8,000,000	1= 5,000,000	118,590	62	8,000,000	1= 5,000,000	118,590
			2= 3,000,000				2= 3,000,000	
62	66	619,470	---	---	66	619,470	---	---
63	63	6,000,000	1= 4,000,000	91,670	63	6,000,000	1= 4,000,000	91,670

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
			2= 11,000,000					
53	52	669,520	---	---				
53	39	1,842,250	---	---				
53	42	337,330	---	---				
54	54	28,747,950	1= 16,000,000	379,160	54	28,747,950	28,747,950	458,817
			2= 10,000,000					
			3= 2,747,950					
54								
55	55	19,728,000	1= 11,000,000	271,340	55	19,728,000	23,673,600	375,937
			2= 7,000,000					
			3= 1,728,000					
56	56	39,146,440	1= 22,000,000	495,050	56	35,200,840	35,200,840	575,182
			2= 14,000,000					
			3= 3,146,440					
56					55	3,945,600	---	---
57	57	31,645,190	1= 17,000,000	414,220	57	31,645,190	31,645,190	484,804
			2= 11,000,000					
			3= 3,645,190					
58	58	40,166,140	1= 22,000,000	510,660	58	40,166,140	40,166,140	589,237
			2= 14,000,000					
			3= 4,166,140					
59	59	6,048,000	1= 3,000,000	109,230	59	6,048,000	6,048,000	109,166
			2= 2,000,000					
			3= 1,906,430					
0	60	8,000,000	1= 5,000,000	118,590	60	6,713,980	6,713,980	124,007
			2= 3,000,000					
0	66	731,750	---	---	65	2,017,770	---	---
1	61	8,000,000	1= 5,000,000	118,590	61	8,443,540	8,443,540	152,321
			2= 3,000,000					
61	66	443,540	---	---				
62	62	8,000,000	1= 5,000,000	118,590	62	8,619,470	8,619,470	163,511
			2= 3,000,000					
62	66	619,470	---	---				
63	63	6,000,000	1= 4,000,000	91,670	63	6,858,430	6,858,430	112,341

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
			2= 2,000,000				2= 2,000,000	
63	66	535,260	---	---	66	858,430	---	
63	59	323,180	---	---				
64	64	12,211,320	1= 7,000,000	176,540	64	7,000,000	1= 7,000,000	97,[illegible]
			2= 4,000,000					
			3= 1,211,320					
64					66	5,211,320	---	---
65	65	6,000,000	1= 6,000,000	85,150	65	6,000,000	1= 6,000,000	85,150
65	66	4,088,850	---	---	66	4,088,850	---	---
66	66	74,092,500	1= 41,000,000	1,313,450	66	74,092,500	1= 41,000,000	1,313,450
			2= 26,000,000				2= 26,000,000	
			3= 8,000,000				3= 8,000,000	
			4= 37,000,000				4= 37,000,000	
67	67	11,000,000	1= 11,000,000	145,560	67	18,000,000	1= 11,000,000	243,140
							2= 7,000,000	
67	66	9,491,110	---	---	66	2,491,110	---	---
68	68	18,000,000	1= 11,000,000	243,140	68	18,000,000	1= 11,000,000	243,140
			2= 7,000,000				2= 7,000,000	
68	66	2,506,470	---	---	66	2,506,470	---	---
69	69	29,000,000	1= 18,000,000	370,690	69	29,000,000	1= 18,000,000	370,690
			2= 11,000,000				2= 11,000,000	
69	80	3,272,030	---	---	80	3,272,030	---	---
70	70	12,498,850	1= 7,000,000	181,180	70	12,498,850	1= 7,000,000	181,180
			2= 4,000,000				2= 4,000,000	
			3= 1,498,850				3= 1,498,850	
71	71	29,000,000	1= 18,000,000	370,690	71	29,000,000	1= 18,000,000	370,690
			2= 11,000,000				2= 11,000,000	
71	66	2,899,400	---	---	66	2,899,400	---	---
71								
72	74	6,812,050	---	---	72	4,000,000	1= 4,000,000	59,440
72					74	2,812,050	---	
73	73	13,000,000	1= 13,000,000	168,750	73	23,998,820	1= 13,000,000	33[illegible]
							2= 8,000,000	
							3= 4,000,000	

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
			2= 2,000,000					
63	59	858,420	---	---				
64	64	7,000,000	1= 7,000,000	97,580	64	12,211,320	12,211,320	201,609
64	66	5,211,320	---	---				
65	65	6,000,000	1= 6,000,000	85,150	65	10,088,850	12,106,620	200,122
65	66	4,088,850	---	---				
66	66	74,092,500	1= 41,000,000	1,278,780	66	74,092,500	88,911,000	1,405,688
			2= 26,000,000					
			3= 8,000,000					
			4= 33,671,680					
67	67	18,000,000	1= 11,000,000	243,140	67	20,491,110	20,491,110	346,095
			2= 7,000,000					
67	66	2,491,110	---	---				
68	68	16,389,840	1= 11,000,000	222,670	68	20,506,470	24,607,760	369,855
			2= 5,389,840					
68	66	4,116,630	---	---				
69	69	29,000,000	1= 18,000,000	370,690	69	29,329,990	29,329,990	482,185
			2= 11,000,000					
69	80	3,272,030	---	---	68	2,942,040		
70	70	12,498,850	1= 7,000,000	181,180	70	12,498,850	12,498,850	206,856
			2= 4,000,000					
			3= 1,498,850					
71	71	18,000,000	1= 18,000,000	225,130	71	31,899,400	31,899,400	50?
71	66	284,850	---	---				
71	74	13,614,550	---	---				
72	72	6,000,000	1= 4,000,000	91,670	72	6,812,050	6,812,050	10[illegible]
			2= 2,000,000					
72	73	812,050	---	---				
73	73	23,998,820	1= 13,000,000	495,220	73	23,998,820	23,998,820	380,381
			2= 8,000,000					
			3= 4,000,000					
			4= 12,000,000					

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
3	74	10,998,820	---	---				
4	74	55,172,550	1= 30,000,000	987,700	74	55,172,550	1= 30,000,000	987,700
			2= 19,000,000				2= 19,000,000	
			3= 7,000,000				3= 7,000,000	
			4= 24,980,900				4= 24,980,900	
75	75	18,036,600	1= 10,000,000	386,910	75	18,036,600	1= 10,000,000	370,440
			2= 6,000,000				2= 6,000,000	
			3= 3,000,000				3= 3,000,000	
			4= 9,000,000				4= 7,655,100	
76	77	12,193,760	---	---	74	12,193,760	---	---
76								
77	77	65,002,120	1= 36,000,000	1,177,580	77	65,002,120	1= 36,000,000	994,980
			2= 23,000,000				2= 23,000,000	
			3= 7,000,000				3= 7,000,000	
			4= 33,000,000				4= 11,590,770	
78	77	6,754,130	---	---	80	17,056,650	---	---
78	80	10,302,520	---	---				
79	79	25,000,000	1= 25,000,000	301,050	79	25,000,000	1= 25,000,000	301,050
79	80	19,654,770	---	---	80	19,654,770	---	---
80	80	237,478,800	1=131,000,000	3,756,560	80	237,478,800	1=131,000,000	3,756,560
			2= 59,000,000				2= 59,000,000	
			3= 24,000,000				3= 24,000,000	
			4= 17,000,000				4= 17,000,000	
			5= 7,000,000				5= 7,000,000	
			6=119,000,000				6=119,000,000	
81	81	65,000,000	1= 40,000,000	757,250	81	65,000,000	1= 40,000,000	757,250
			2= 25,000,000				2= 25,000,000	
81	80	6,892,790	---	---	80	6,892,790	---	---
82	82	18,762,220	1= 10,000,000	259,750	82	17,432,980	1= 10,000,000	238,330
			2= 7,000,000				2= 7,000,000	
			3= 1,762,220				3= 432,980	
2					66	1,329,240	---	---
3	66	16,591,650	---	---	66	16,591,650	---	---
3								
4	84	8,176,990	1= 5,000,000	121,670	84	8,176,990	1= 5,000,000	121,670
			2= 3,000,000				2= 3,000,000	

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
73								
74	74	55,172,550	1= 30,000,000	987,700	74	55,172,550	66,207,060	1,003,699
			2= 19,000,000					
			3= 7,000,000					
			4= 24,980,000					
75	75	18,036,600	1= 10,000,000	316,960	75	18,036,600	20,998,590	322,538
			2= 6,000,000					
			3= 3,000,000					
			4= 3,448,590					
76	74	12,193,760	---	---	74	11,034,510	---	---
76					68	1,159,260	---	---
77	77	65,002,120	1= 36,000,000	780,110	77	65,002,120	74,534,880	1,097,153
			2= 23,000,000					
			3= 6,002,130					
78	78	9,000,000	1= 9,000,000	121,900	78	17,056,650	17,056,650	265,231
78	80	8,056,650	---	---				
79	79	25,000,000	1= 25,000,000	301,050	79	30,276,210	30,276,210	507,732
79	80	19,654,770	---	---	81	14,378,560	---	---
80	80	237,478,800	1=131,000,000	3,756,560	80	237,478,800	284,974,560	4,354,411
			2= 59,000,000					
			3= 24,000,000					
			4= 17,000,000					
			5= 7,000,000					
			6=119,000,000					
81	81	40,000,000	1= 40,000,000	456,200	81	71,892,790	86,271,350	1,237,131
1	80	31,892,790	---	---				
82	82	10,000,000	1= 10,000,000	133,770	82	18,762,220	18,762,220	311,640
82	80	8,762,220	---	---				
83	66	16,591,650	---	---	66	14,818,500	---	---
83					83	1,773,150	1,773,150	30,055
84	84	8,176,990	1= 5,000,000	121,670	84	8,176,990	8,176,990	140,880
			2= 3,000,000					

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
			3= 176,990				3= 176,990	
85	87	14,454,030	---	---	87	14,454,030	---	
86	86	28,000,000	1= 28,000,000	332,750	86	28,000,000	1= 28,000,000	33
86	80	22,129,320	---	---	80	22,129,320	---	---
86								
87	87	164,922,800	1= 91,000,000	2,693,560	87	164,922,800	1= 91,000,000	2,693,560
			2= 41,000,000				2= 41,000,000	
			3= 16,000,000				3= 16,000,000	
			4= 12,000,000				4= 12,000,000	
			5= 5,000,000				5= 5,000,000	
			6= 83,000,000				6= 83,000,000	
88	88	32,000,000	1= 32,000,000	374,460	88	32,000,000	1= 32,000,000	374,460
88	87	26,311,370	---	---	87	26,311,370	---	---
89	89	135,594,310	1= 75,000,000	2,269,380	89	135,594,310	1= 75,000,000	2,269,380
			2= 41,000,000				2= 41,000,000	
			3= 14,000,000				3= 14,000,000	
			4= 7,000,000				4= 7,000,000	
			5= 68,000,000				5= 68,000,000	
90	90	64,000.000	1= 41,000,000	745,890	90	64,000,000	1= 41,000,000	745,890
			2= 23,000,000				2= 23,000,000	
90	80	10,439,830	---	---	80	3,078,630	---	---
90	87	658,590	---	---	87	8,019,800	---	---
91	91	26,000,000	1= 26,000,000	311,630	91	26,000,000	1= 26,000,000	311,630
91	87	21,317,980	---	---	87	21,317,980	---	---
92	92	24,000,000	1= 24,000,000	290,350	92	24,000,000	1= 24,000,000	290,350
92	80	42,080,160	---	---	80	42,080,160	---	---
93	93	20,000,000	1= 12,000,000	267,030	93	20,000,000	1= 20,000,000	267,030
			2= 8,000,000				2= 8,000,000	
93	80	1,590,930	---	---	80	1,590,930	---	---
93								
94	94	58,784,970	1= 56,000,000	968,810	94	58,784,970	1= 56,000,000	968
			2= 30,000,000				2= 30,000,000	
94	89	42,281,730	---	---	89	42,281,730	---	
95	95	12,000,000	1= 12,000,000	157,220	95	12,000,000	1= 12,000,000	15

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
			3= 176,990					
85	87	14,454,030	---	---	87	14,454,030	---	---
86	86	28,000,000	1= 28,000,000	332,750	86	2,633,560	2,633,560	42,822
86	80	1,840,510	---	---	80	47,495,760	---	---
86	87	20,288,810	---	---				
87	87	164,922,800	1= 91,000,000	2,693,560	87	164,922,800	197,907,360	2,978,506
			2= 41,000,000					
			3= 16,000,000					
			4= 12,000,000					
			5= 5,000,000					
			6= 83,000,000					
88	89	9,977,010	---	---	88	39,780,840	39,780,840	647,632
88	87	48,334,370	---	---	87	18,530,530	---	---
89	89	135,594,310	1= 75,000,000	1,959,730	89	135,594,310	162,713,170	2,325,171
			2= 41,000,000					
			3= 14,000,000					
			4= 7,000,000					
			5= 36,642,610					
90	90	64,000,000	1= 41,000,000	745,890	90	75,098,430	75,098,430	1,122,722
			2= 23,000,000					
90	89	11,098,430	---	---				
90								
91	91	40,885,570	1= 26,000,000	508,040	91	47,317,980	48,725,870	782,050
			2= 14,885,570					
91	89	6,432,400	---	---				
92	92	24,000,000	1= 24,000,000	290,350	92	66,080,160	66,080,160	99
92	80	42,080,160	---	---				
93	93	20,000,000	1= 20,000,000	267,030	93	21,590,930	21,590,930	33
93	80	196,150	---	---				
93	39	1,394,780						
94	94	93,269,370	1= 56,000,000	1,101,930	94	101,066,700	101,066,700	1,632,227
			2= 30,000,000					
			2= 10,000,000					
94	89	7,797,330	---	---				
95	95	12,000,000	1= 12,000,000	157,220	89	21,189,600	---	---

Appendix Table III (Continued)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost
	89	9,189,600	---	---	89	9,189,600	---	---
	96	92,000,000	1= 92,000,000	975,660	96	92,000,000	1= 92,000,000	975,660
	97	74,313,590	---	---	97	74,313,590	---	---
	97	458,890,950	1=252,000,000 2=115,000,000 3= 46,000,000 4= 32,000,000 5= 14,000,000 6=196,174,080	6,080,000	97	458,890,950	1=252,000,000 2=115,000,000 3= 46,000,000 4= 32,000,000 5= 14,000,000 6=196,000,000	6,421,330
98	97	23,697,290	---	---	97	29,140,360	---	---
98	99	9,734,320	---	---	99	4,291,260	---	---
99	99	79,626,300	1= 44,000,000 2= 24,000,000 3= 8,000,000 4= 3,000,000 5= 40,000,000	1,378,770	99	79,626,300	1= 44,000,000 2= 24,000,000 3= 8,000,000 4= 3,000,000 5= 40,000,000	1,378,770
99					100	6,214,560	1= 23,000,000	279,630
100	100	6,214,560	1= 23,000,000	279,630	99	35,082,440	---	---
100	87	5,443,060	---	---				
100	99	29,639,380	---	---				
101	101	40,000,000	1= 40,000,000	456,200	101	36,000,000	1= 36,000,000	385,710
101	97	32,677,070	---	---	97	36,677,070	---	---
102	102	175,000,000	1= 99,000,000 2= 45,000,000 3= 18,000,000 4= 13,000,000	1,917,790	102	144,000,000	1= 99,000,000 2= 45,000,000	1,523,920
102	97	4,457,820	---	---	97	35,457,820	---	---
103	100	16,785,440	---	---	100	16,785,440	---	---
103								
104	97	17,219,510	---	---	97	17,219,510	---	---
105	105	7,000,000	1= 4,000,000 2= 3,000,000	105,540	105	7,000,000	1= 4,000,000 2= 3,000,000	105,540
5	97	325,760	---	---	97	325,760	---	---

Demand Area	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
95	99	9,189,600	---	---				
96	96	92,585,060	1= 92,000,000 2= 585,060	983,190	96	166,313,590	166,313,590	2,556,240
96	97	73,728,520	---	---				
97	97	458,890,950	1=252,000,000 2=115,000,000 3= 46,000,000 4= 32,000,000 5= 14,000,000 6=114,816,210	5,711,430	97	458,890,950	458,890,950	6,933,842
98	97	15,329,960	---	---	98	33,431,620	33,431,620	566,332
98	99	18,101,660	---	---				
99	99	79,626,300	1= 44,000,000 2= 24,000,000 3= 8,000,000 4= 3,000,000 5= 40,000,000	1,378,770	99	73,697,040	73,697,040	1,238,841
99					89	5,929,260	---	---
100	100	29,214,560	1= 23,000,000 2= 14,000,000	459,870	100	41,297,000	49,556,400	812,725
100								
100	99	12,082,440	---	---				
101	101	65,000,000	1= 40,000,000 2= 25,000,000	757,250	101	72,677,080	72,677,080	1,148,298
101	97	7,677,070	---	---				
102	102	175,000,000	1= 99,000,000 2= 45,000,000 3= 18,000,000 4= 13,000,000	1,917,790	102	179,457,820	179,457,820	2,833,632
2	97	4,457,820	---	---				
3	100	7,785,440	---	---	100	8,259,400	---	---
3	103	9,000,000	1= 9,000,000	121,900	103	8,526,040	8,526,040	154,066
04	97	2,219,510	---	---	105	1,465,150	---	---
104	104	15,000,000	1= 9,000,000 2= 6,000,000	206,960	104	15,754,360	15,754,360	270,502
105	105	7,325,760	1= 4,000,000 2= 3,000,000 3= 325,760	111,210	105	7,325,760	8,790,910	143,907
105	97							

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