OPTIMUM MARKET ORGANIZATIONS OF THE FLUID MILK INDUSTRY IN THE UNITED STATES UNDER ALTERNATIVE MARKETING STRATEGIES

By

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PREFACE

This study is concerned with the analysis of optimum market organizations of the United States fluid milk industry under each of several alternative assumptions. The primary objective is to determine the number, size, and location of fluid processing plants that would minimize the total assembly, processing, and distribution costs under alternative assumptions. A spatial equilibrium model is used in the analysis which includes economies of size in processing as well as assembly and distribution costs.

The author wishes to express his appreciation to his major adviser, Dr. Leo V. Blakely, for his guidance and assistance throughout this study. Appreciation is also expressed to the other committee members, Dr. Vernon R. Eidman, Dr. Joseph Klos, Dr. Robert Morrison, and Dr. Odell L. Walker, for their invaluable assistance in the preparation of the final manuscript.

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TABLE OF CONTENTS

Chapter | Page

LIST OF TABLES

Table		Page

Table		Page
XXXI.	Plant Capacities in the Optimum Market Organization, United States and Regions, Models I Through VI	229
XXXII.	Processing Costs Per Pound in the Optimum Market Organizations, United States and Regions, Models I Through VI	230
XXXIII.	Total Processing Costs in the Optimum Market Organizations, United States and Regions, Models I Through VI	231
XXXIV.	Intermarket Movements of Packaged Milk, United States and Regions, Models I Through VI	232
XXXV.	Exports of Processed Milk, United States and Regions, Models I Through VI	233
XXXVI.	Total Distribution Cost of Optimum Market Organizations, United States and Regions, Models I Through VI	234
XXXVII.	Total Cost of All Market Activities of the Optimum Market Organizations, United States and Regions, Models I Through VI	235

LIST OF FIGURES

Figure | Page

Figure		Page

CHAPTER I

INTRODUCTION

The fluid milk industry in the United States is characterized by a constantly changing economic environment. Much of the economic change within the industry has been the result of the development and advancement of new techniques and innovations within several interrelated sectors making up the industry. In the years following World War II, changes in the quantity of milk produced on farms were irregular but generally the trend was upward. Milk production totaled 120 billion pounds in 1945 and had increased to 127 billion pounds by 1964.[1] After reaching a peak in 1964, production began to decrease and was only about 116 billion pounds in 1969.

The relative stability in total production concealed the drastic changes which were occurring in the production of milk. The number of dairy cows continually decreased throughout the period. In 1944 the total number of cows was 25 million, 15.5 million in 1965 and 14.1 million in 1969.[2] At the same time milk production per cow increased consistently throughout the period. From 4,787 pounds in 1945 production per cow increased to 9,189 pounds in 1969.

Factors contributing to increased production per cow include improved rations and better feeding practices, breeding and retention of higher producing cows in herds, and improved managerial practices.

Practices of dairy farms have also changed. Greater efficiencies in the production of milk have been introduced through technological advances such as bulk handling of milk, pipeline milkers, and automatic feed movement. The production sector has experienced the substitution of capital for labor as the more efficient stable producers have made use of this new technology to increase herd sizes of high-producing animals while marginal producers have been unable to make the transition and have been phased out of the industry.

Industry Changes

The market structure involving the assembly of raw milk and the distribution of the final product has undergone significant changes. Historically, milk production was concentrated near consumption centers because fresh fluid milk was bulky, perishable and relatively expensive to ship. The assembly and distribution functions were closely related and were limited in scope in terms of serving distant markets. However, as urban areas across the United States were expanding, the need for the separation of the production and distribution segments into specialized areas of the industry became apparent. New technologies within the transportation industry were developed to make this specialization possible. Improved highway systems, bulk handling of raw milk, large capacity transports capable of handling the final product, and new advances of in-route refrigeration greatly enhanced the flexibility of milk assembly and its distribution. Today, locally produced fluid milk can be used to serve distant markets with little or no deterioration in quality.

The processing sector has adapted to the changes occurring in the other segments of the industry. The fluid milk processing industry of the early 1900's typically consisted of single-plant firms. Each firm had a source of milk and processed the product for sale in a single town or urban center. The fundamental structure changed gradually until World War II, then changes intensified. The number of plants processing fluid milk products in the United States decreased by nearly two-thirds between 1948 and 1965 (Table I). Total plant numbers decreased 77 percent over the seventeen year period.

TABLE I

NUMBER OF FLUID MILK PROCESSING PLANTS OPERATED BY PROCESSOR-DISTRIBUTORS AND PRODUCERS-DEALERS, 1948 AND JANUARY 1965

Type of Operation	1948 Number	1948 Percent	January 1965 Number	January 1965 Percent	Change 1948 to 1965 (Percent)
Processor-distributor	8,392	43	3,920	70	-53
Producer-dealer	11,319	57	1,677	30	-85
Total Plants	19,711	100	5,597	100	-77

Source: Data prepared for National Commission on Food Marketing by the U. S. Department of Agriculture, Economic Research Service, Marketing Economics Division.[3]

Several factors have contributed to the large structural change in the post World War II period. Fluid milk processing functions had been developed to such a degree that considerable investment in equipment was required. Larger manufacturing firms with their superior financial strength and opportunities to gain better utilization of their existing plant facilities were encouraged to enter fluid milk operations. In many instances, these were multi-plant companies seeking the most efficient use of existing facilities.[4] Mergers and sale or dissolution of some businesses resulted in a new consolidation of the fluid milk processing industry. In addition, many existing firms operating high-capacity urban plants were motivated to penetrate new markets to increase their plant volume and operating efficiency.

The adoption of paper containers also created an incentive for management to increase plant size. The greater capacity of equipment adapted to paper containers gave large wholesale processors a competitive advantage over small processors. The equipment is associated with high costs in small-scale operations. As a result, many local processors were acquired by larger firms while others were phased out of the industry.

The changing structure of the industry and expansion of marketing areas also gave rise to certain institutional factors. Federal milk market orders were set up as a legal instrument to define the terms upon which handlers, who are engaged primarily in the handling of fluid milk distribution in a regulated market, purchase milk from farmers.[5] The purpose of a market order is to promote and maintain orderly marketings of milk by farmers while assuring that an adequate supply of wholesome milk is always available to processors.

The relative success of the market order concept can be appraised from its growth in number of markets in existence and amount of milk affected. There were 29 milk marketing orders in 1947, 39 in 1950, and a peak of 83 reached in 1962. As a result of mergers and consolidation the number was reduced to 73 in 1965 and to 67 in 1969 (Figure 1).[6] However, the volume of milk affected by Federal orders was at an all-time high in 1969.

State milk control orders have the same basic goals as the Federal orders. However, in addition to assuring an orderly flow of milk from the farm to the processor, state agencies have the authority to set minimum farm prices and/or resale prices at the wholesale and retail levels. In 1965, 20 state milk control orders were in existence. States involved in State milk control orders are illustrated in Figure 2. Although Federal and State orders do not directly influence the market structure of the industry, they do add stability in the production and processing sectors.

The advancements and changes occurring in the fluid milk industry enhanced the development of other institutional factors to assure that a high quality product reached the consumer. Since fluid milk is highly perishable and is an excellent medium for the transmission of disease-producing organisms, City, County, State and Federal health agencies have maintained a constant surveillance of sanitary conditions in the industry. The sanitary standards provide assurance of high quality fluid milk by their regulations and requirements for appropriate construction of facilities in all aspects of the industry.

The Problem and Justification

The ever changing economic environment has resulted in significant changes in the fluid milk industry with respect to size, type, number

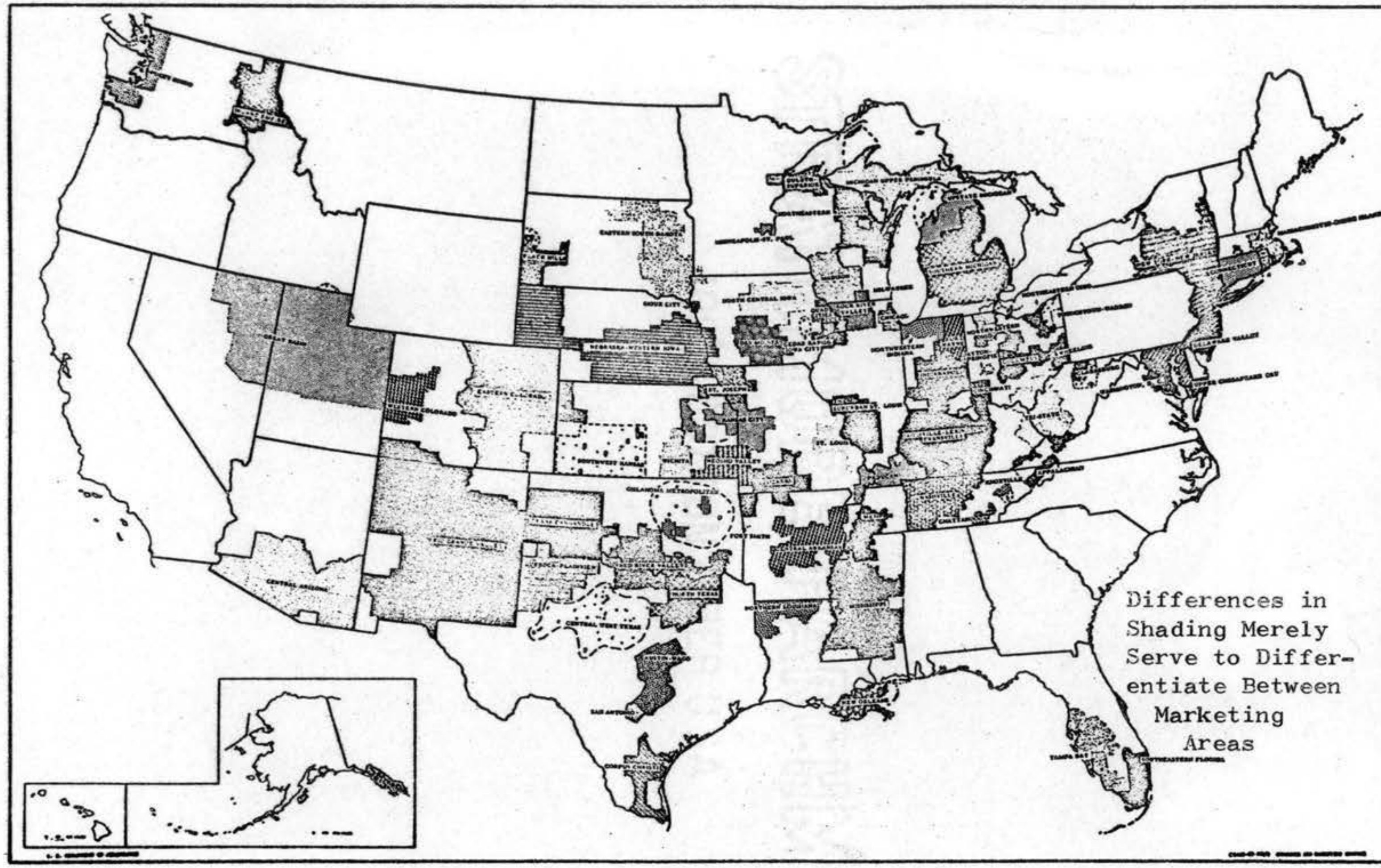

Figure 1. Milk Marketing Areas Under Federal Orders as of January 1, 1966

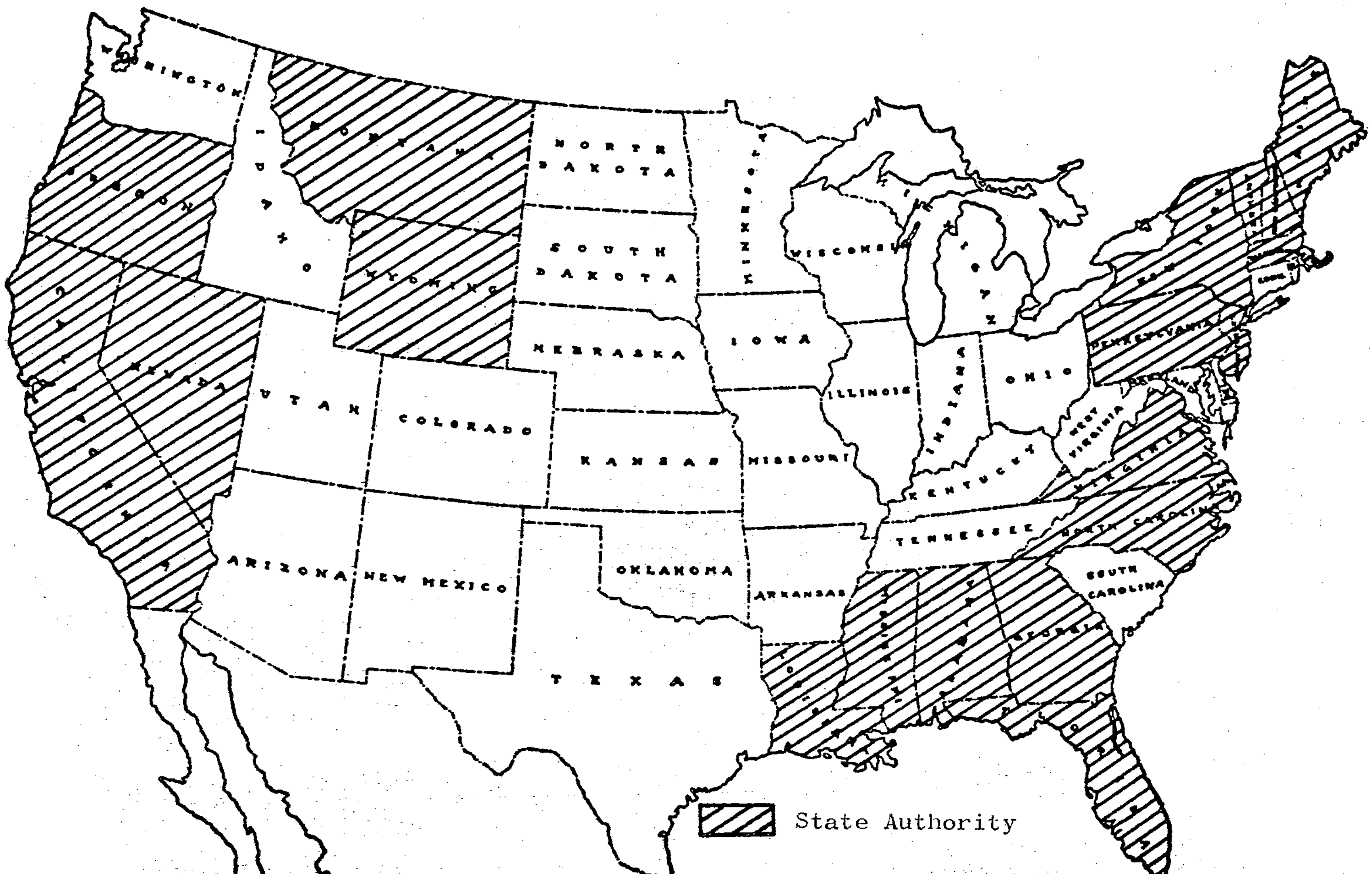

Figure 2. States With Authority to Regulate Milk Prices at the Farm Wholesale or Retail Levels, 1965

and location of fluid milk processing facilities in the United States. The competitive behavior of the industry has been influenced significantly by these changes, resulting in an alteration of the market structure of the industry. These developments provide an environment of change which affects the efficiency of all functions associated with the marketing of fluid milk. There is little doubt that changes within the various segments of the industry can affect the behavior of those involved in the many functions of the fluid milk industry.

Any effort to determine the optimum number, size, and location of fluid milk processing facilities or direction of adjustment requires both data and analysis. Although an optimum organization may never be attained in a dynamic economic environment, a partial equilibrium analysis may provide the direction and magnitude for desirable changes. The analysis of an optimum market organization should provide: (1) guidelines to individual firms to eliminate any unnecessary inefficiencies in their existing organization and future growth, and (2) guidelines to those involved in policy formulation to better facilitate the needs of producers, processors, and consumers.

Objectives and Procedures

The purpose of this study is to test the applicability of a model which may serve as a useful tool to those individuals interested in a more efficient fluid milk market organization in the United States. The specific objectives are to determine: (1) the least cost market organization under conditions of pure monopoly in a given market (a non-restricted model in which a firm in a given market has no capacity restrictions), (2) the optimum market organization using the 1965 resource pricing structure (a non-restricted model), (3) the sensitivity of optimum market organization using a restricted model (both capacities and firm numbers restricted) and alternative assumptions pertaining to base point pricing schemes in the resource market, and (4) the least cost market organization for the existing market structure.

Chapter II is devoted to the theoretical considerations in the location of processing plants. Examined in detail are the locations and market areas of processing plants under alternative assumptions. Chapter III contains the model selected for use in the study. The model involves the use of linear programming as the foundation and includes the transportation problem and a nonlinear programming technique. The generation of basic data and cost estimation procedures are included in Chapter IV. Market areas are also defined. Chapter V contains the results of the optimum non-restricted market organizations under alternative assumptions concerning the level of farm prices. The optimum restricted market organizations under alternative farm price assumptions are discussed in Chapter VI. Also included in this chapter are the results for a model based on the 1963 structure of processing firm numbers and farm prices. Finally, Chapter VII contains the summary and conclusion and some comments on the limitations of the study.

FOOTNOTES

[1]National Commission on Food Marketing, Organization and Competition in the Dairy Industry, Technical Study No. 3 (Washington: National Commission on Food Marketing, 1966), p. 23.

[2]National Commission on Food Marketing, p. 24.

[3]National Commission on Food Marketing, p. 64.

[4]Daniel I. Padberg and D. A. Clarke, "Structural Changes in the California Fluid Milk Industry ... Their Effects on Competition and Market Performance," California Agricultural Experiment Station Bulletin 802, June 1964, pp. 1-14.

[5]U. S. Department of Agriculture, Federal Milk Marketing Orders, (Washington: U. S. Government Printing Office), p. 3.

[6]R. E. Freeman and E. M. Babb, Marketing Area and Related Issues in Federal Milk Orders, Purdue University Agricultural Experiment Station Bulletin 782, 1964, pp. 1-8.

CHAPTER II

THEORETICAL CONSIDERATIONS IN THE LOCATION OF PROCESSING PLANTS

Economic activities seldom occur in predetermined locations but are generally subject to locational choice. The basic determinants of location involve the following components of the economic environment: area resource endowments, transportation costs for moving to potential processing sites, transfer costs for moving products from processing locations to markets, and the demand for the final product in an area. Given these components, locations will exist where economic activity can be performed most efficiently.

In a sense, it is possible to call all locations where economic activity is possible a feasible location. However, among the numerous feasible locations for economic activity, there is one (in rare instances more than one may exist) optimal location for a particular facility or industry. Optimality as used in the context of this analysis refers to the location of economic activity which will minimize cost under the assumptions and restrictions set forth in the analysis. The purpose of this chapter is to examine some of the more relevant historical works in location theory and to modify some of these theories to provide a basis for the analysis of the spatial dispersion considered in this study.

Review of Selected Contributions to the Theory of Location

Location theory and economic theory are basic to an understanding of the space-economy. The theory of location was first conceived by the German Agricultural Economist von Thunen.[1] Von Thunen's analysis was restricted to the effect of transportation on the composition of crop farming, given a population cluster, within a uniformly fertile valley. The location decision rests upon the differences in the cost of a given crop at alternative sites. In turn, the cost differences are due to the land rent and the transportation costs. The basic solution of von Thunen's investigations consisted of a set of concentric circles around a central city with location of production being determined by the relative weight and bulkiness of the commodity being produced. The inner zones, located near the central city, were characterized by enterprises devoted to perishable and bulky products such as dairy products and fresh vegetables. Grains, being less perishable, were produced in the intermediate zones and cattle in the outer zones.

Alfred Weber, an early location theorist, is credited with being the first to attempt the analysis of choice of industry in terms of transport costs, wages and raw material prices. His analytical approach was procedurally the opposite of von Thunen's. In von Thunen's applications, the location is given while the type of production is to be determined. Weber's theory assumes that the production is given and that the location of the physical plant is to be determined. In applying his theory, Weber attempted to formulate an evolutionary historical theory of spatial development from the primitive agricultural settlement to an advanced degree of industrialization.[2]

Much of the theory dealing with spatial economies and location, up to and including the workers of Weber, did not firmly tie the theories of location to the general economic theory of the firm and equilibrium conditions. It was E. M. Hoover who successfully combined the relevant Weberian analysis with the contemporary economic notations embodied in the theory of the firm and partial equilibrium analysis.[3] Hoover's two volumes, Location Theory and The Shoe Leather Industries,[4] and The Location of Economic Activity[5] provide an excellent comprehensive and critical discussion of location.

Losch is generally regarded as the first location theorist to attempt to combine location theory with general equilibrium analysis and to create a general system. He recognized the general interrelationship of spatially separated economic units, and analyzed the choice of location in terms of spatial interdependence. Losch found the optimum shaped economic regions to be formed as hexagons.

The theory of location like many other areas of study advanced quite rapidly with the further development of spatial equilibrium analysis. The contributions of Samuelson, Koopsman, Dantzig and others in the development of linear programming, especially the transportation aspects, provided a tool for considering the spatial dimension in location theory and general equilibrium analysis. As a result, a theoretical basis for a spatial general equilibrium analysis of production and choice of industrial location can be presented in a programming framework. This allows the involvement of more relevant variables in determining an optimum location of a facility or an industry.

Locations and Market Areas of Processing Plants Under Alternative Assumptions

The least cost locational organization of the fluid milk industry will vary in form as well as complexity with the types of assumptions made regarding the activities involved in production, transportation and processing. Assumptions involved in delineating market areas were: (1) there are areas with given supplies of raw product (also referred to as the resource and/or raw resource throughout the text) and areas with given demands for the final product, (2) transfer costs per unit associated with the movement of the raw product to processing facilities are the same for given distances in all areas and do not vary with the quantity shipped, (3) transfer costs per unit are the same for given distances in all areas for the distribution of the final product and do not vary with the quantity shipped (transfer costs for the final product are not the same as for the raw product), (4) the input is localized; that is, it is available only at special points (assembly points) where the raw product has been accumulated from a homogeneous production density, (5) transfer costs incurred in the movement from producers to the localized assembly points are paid by producers, (6) the demand for the final product is also localized at special points referred to as distribution points, (7) the final product and the raw product are homogeneous for all areas, (8) processing costs per unit are variable with the size of plant but are determined by the same function at all potential sites.

In delineating a market area, consider first the case for a single isolated market with one processing facility located within the area. Given this facility, the procurement configuration would be circular as in Figure 3 and as described by von Thunen. Prices paid to producers would be the f.o.b. raw product (raw fluid milk) plant price, but the effective price would be the f.o.b. price minus transportation costs.

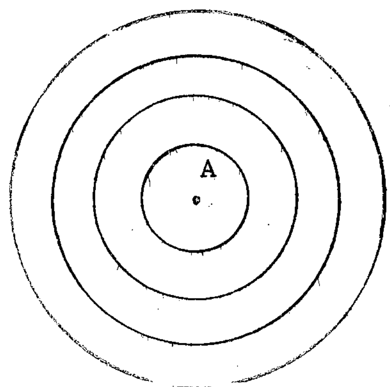

Figure 3. Milkshed and Market Area for an Isolated Market

The distribution configuration would consist of a similar set of concentric rings for retail prices but with the lowest prices at point A. Prices paid by consumers would be the f.o.b. plant retail price plus transportation costs. The transportation costs would not necessarily be the same on a per unit basis for the final product and the equivalent value of raw product.

The analysis is similar when consideration is given to a less isolated area and when two plants are established. Given a standardized product and the same procurement and processing cost functions as for the single market, the same f.o.b. plant prices for the resource and the product would exist in each market. Each processor would attempt to buy from whatever production area could supply it at the lowest cost (including transfer costs). If the production costs for the resource are equal at production areas equidistance from both markets, the procurement areas will be divided among markets on the basis of relative assembly costs alone.

The physical processing facilities in two sufficiently isolated markets will have milkshed configurations similar to those of Figure 4. The straight line CD is equidistant from the processing locations and would separate the milksheds of the two markets. If one or more of the cost factors become differentiated between the two markets, the straight line CD will take on curvature, being convex to the market with lower costs and shifting outward from that market.

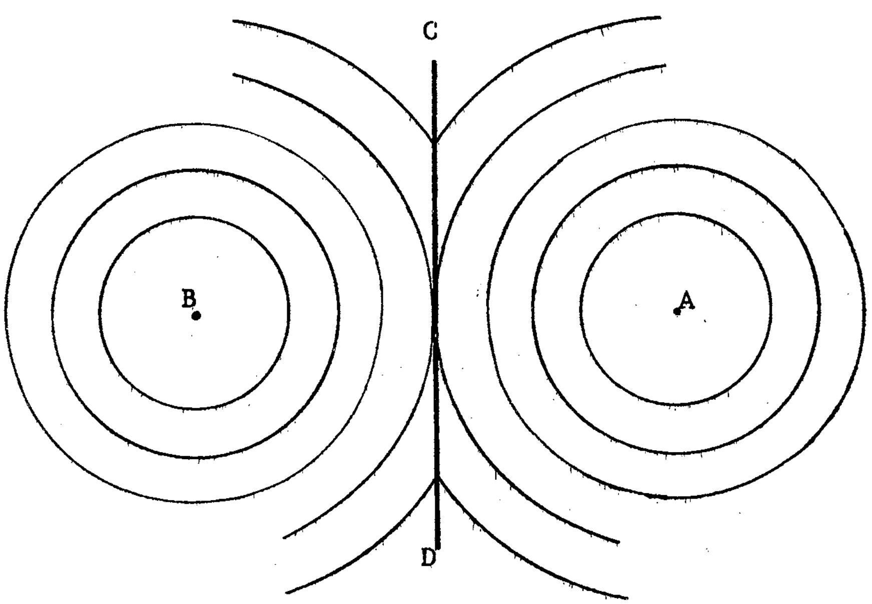

Figure 4. Milksheds and Market Areas for Two Markets With Equal Costs

Expanding the above analysis to three markets, a more general type of milkshed configuration as in Figure 5 would be observed. Points A, B, and C are equidistant from the boundry lines of the three markets. If the analysis were extended to include more markets under the same assumptions, the market configuration would become the familiar hexagons first developed by Losch.

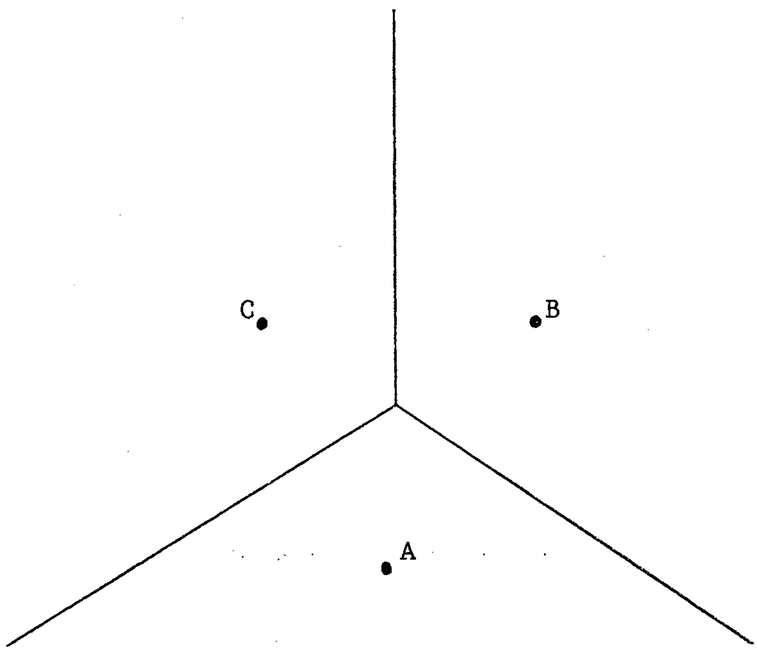

Figure 5. Market Areas of Three Processing Facilities With Equal Procurement or Processing Costs

If procurement or processing costs are less at one production area than at another, the outcome will be shown in Figure 6 rather than in Figure 5. The favored production area will be able to meet a less favored rival more than half-way. If the costs are unequal at the three potential processing locations, the market-area and production milkshed boundaries between any two locations is nearer the center of the higher cost area and is curved around it. In Figure 6, for example, costs of procurement (or processing) are assumed to be lowest at A and highest at C, and the curvature is around market C. The greater the cost differential, the more circumscribed will be the market areas of higher cost points.

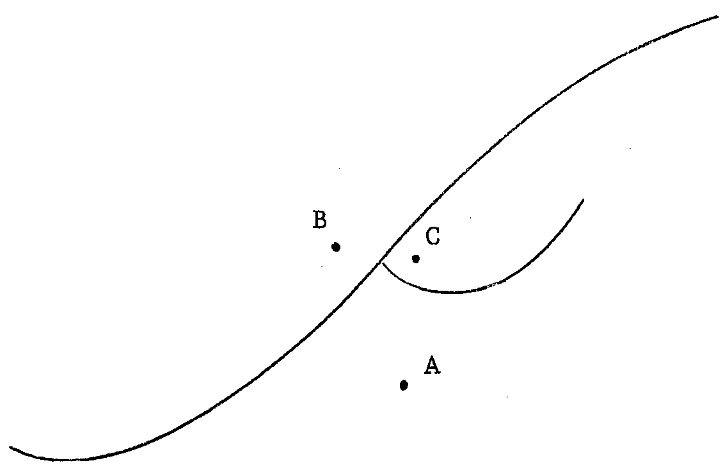

Figure 6. Market Areas of Three Processing Facilities With Unequal Procurement or Processing Costs

The cost differentials may be due to differences in production costs or production density on the production side. On the distribution side, the primary differences in costs may be due to population differences between market areas coordinated with a given market's ability to penetrate or absorb new market areas where further economies of size can be obtained by increasing the size of the market area.

Processing facilities located at A and B have economic superiority over the facility located at C. If market A should happen to gain further economies of size or increased efficiency, it will penetrate the markets of both B and C. The extent of penetration will depend on the relative costs in the market channels of B and C. Since C has the highest combined costs of procurement and processing, this market will be penetrated by A more effectively.

Within the existing organization of the fluid milk industry, there are certain components which will definitely influence the current location of the processing facilities. A fairly common pricing pattern is the basing-point system in which delivered prices of all sellers are aligned according to freight costs from some designated basing point or points, usually the important producing or distributing centers.[6] In many instances, the basing-point system is a reflection of originally lower production costs at the basing-point, even after new producing centers have attained comparable efficiency. The effect of geographic price discriminations upon the locations of the processors is an intricate question to which no complete or factual answer has yet been given. Regardless of the pricing tactics used, it is still advantageous for a seller of a commodity to be located at or near the center of a large market with as few near competitors as possible.

Actual market prices in the dairy industry are consistent with the use of a base-point pricing system as a method of determining a fair price to be paid to producers.[7] The base point is the surplus production area of Minnesota and Wisconsin. At this point, a base price is determined primarily on the basis of support prices for Grade A milk in alternative uses (e.g. manufacturing milk). At successively greater distances from this base point, the producer receives the base price plus a premium equivalent to the cost of transportation from the base point. The market areas in Figure 3, 4, and 5 under these conditions become distorted by the variation in resource prices.

For the single market case, with a processing facility already established at A and with a price premium from a base point, the milkshed configuration will be similar to the one illustrated in Figure 7. The processing facility located at point A will attract the resource from the cheapest source of supply which is back toward the base point. Plant A will be at a disadvantage in processing supplies from areas at greater distances from the base point.

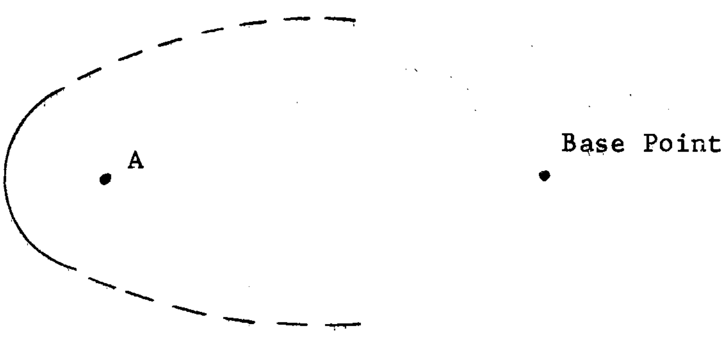

Figure 7. Milkshed Delineation of a Single Distant Market Under Base-Point Pricing

The same type of configuration will exist for each market in the two-market case. Processors will seek supplies in the direction of the base point. In addition, if the incremental increases in the pricing structure are greater than the transportation costs, the skewness of the milkshed will be more prominent in the direction of the base point and could result in displacement of local production. The configuration for two markets might be similar to the illustration in Figure 8.

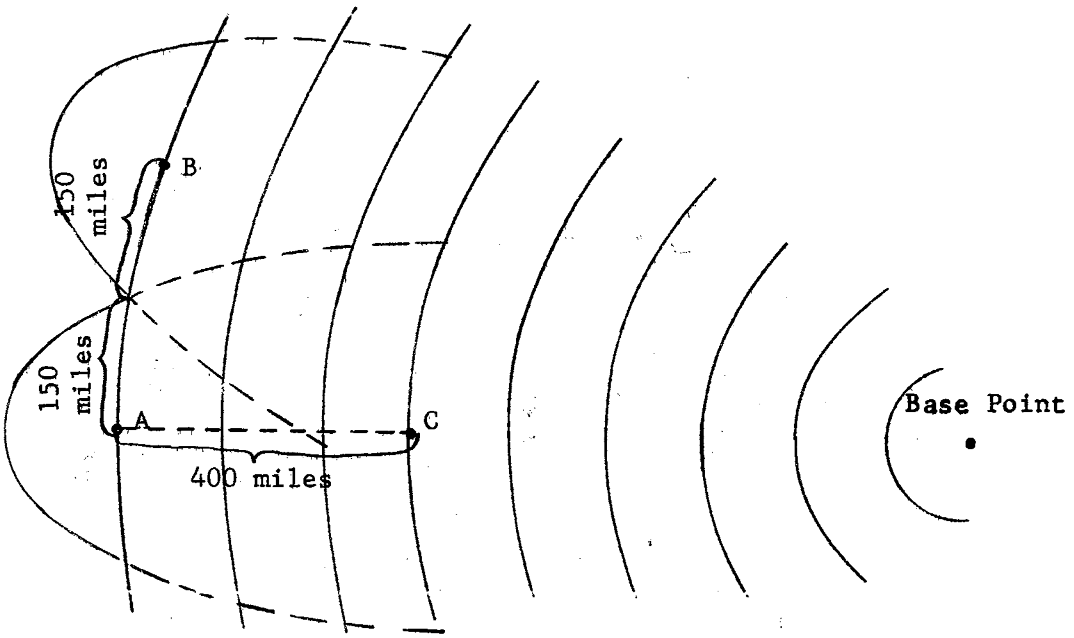

Figure 8. Milkshed Delineation of Two Distant Markets Under a Base-Point Pricing Scheme

Patterns of intermarket movements of milk between adjacent markets can also be affected. For example, assume that market B has production in excess of market needs, and market A has inadequate supplies of the resource to meet processing needs. The markets are 300 miles apart, and the same distance from the base point. Assume also that market C has excess production and that it is located 400 miles in the direction of the base point between A and the base point. Even though area B may have excess production and is located closer to market A, the excess will not flow into facilities located at point A because of the pricing structure. A processor at point A could obtain supplies at either B or C at outlays of market price plus transportation; however, the resource cost at C is significantly less than at B. If the differential and the transport cost were 20 cents per hundredweight per hundred miles, a processor would fill all his needs at the same f.o.b. price by obtaining milk in the direction of the base point. It would cost 60 cents per hundredweight more to obtain his resource supply from B rather than C. Market B would never be able to supply processors at A as long as supplies are available for A in the direction of the base point. Only at incremental increases in prices lower than transportation costs will lateral movements into a market be economically feasible. In general, the base point pricing scheme can lead to a heavily skewed milkshed configuration toward the base point.

The configuration of the distribution of the final product will also involve a skewed market area. The skewness will be represented by a configuration similar to that shown in Figure 9 for a two-market economy. Plants located at points A and B will have distribution configurations which are skewed away from the base point. The reason for this skewness stems from the resource pricing structure. A facility located at point B can serve markets toward the base point, but the facility has greater competitive advantage in the direction away from the base point. This competitive advantage of plant B is the result of higher resource costs paid by the firm located at point A. If unequal processing costs existed between A and B, these costs differentials could contribute to the degree of skewness. For example if plant B is characterized by lower processing costs than A, the market configuration for B could be extented further toward A and the boundary lines of market B expanded outward.

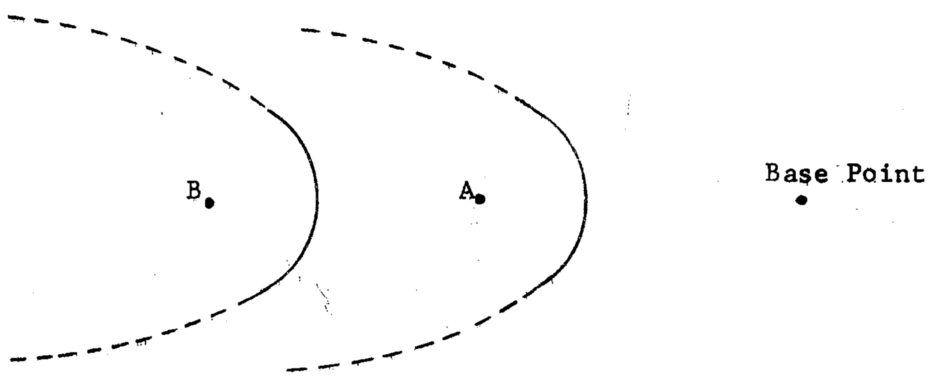

Figure 9. Distribution Delineation of Two Markets From Two Processing Facilities Under Base-Point Pricing With Equal Transportation and Processing Costs.

One of the major advantages cited for the base point pricing system is the ease with which such a system might be policed or administered. This is an important consideration in the establishment of an organization. However, if prices are misaligned by this system, serious consequences can evolve for the producer and processor. To illustrate the impacts of intermarket price alignment, consider a situation consisting of two adjoining market areas with producers producing a homogeneous product at similar production costs with processing firms operating under similar economic environments (size, competition, management, profit motive, etc.). Now assume a resource price increase in market A of 25 cents per cwt. while market B maintains the initial price structure. The 25 cent deviation between markets, if it can be maintained over an extended period of time, will give rise to approximately a one-half cent per quart differential in the finished product price between the two markets.[8]

Price alignment with the new differential, becomes an immediate concern of the fluid milk processors. As a result of the price differential, processors in market B now have the opportunity to become competitive in market A. There are two important factors to consider in evaluating the opportunity. First, movements of milk can occur providing no barriers to entry in the market exist. Second, fluid milk movements from market B to market A can continue as long as the price in market A will cover the price in market B plus the transportation costs for such movements. If these conditions are expected to be maintained, processors in market B will expand their fluid milk market into a new distribution area.

The fluid milk processors located in market A will experience increased competition from outside firms. As a result, the market share of the local firm in market A will decrease. With a decrease in volume, the per unit cost of output will increase because of the spreading out of fixed costs over a smaller output. In an effort to regain its market share, the processor in market A would have to consider some alternatives such as product differentiation, sales promotion, non-price attachments, or a possible merger with another firm to gain market power or economies of size.

Another factor to consider is the potential number of firms which might be established or located in a given market. Up to this point, only one facility per market has been assumed. A more realistic organization of the fluid milk industry would have a larger number of firms serving consumers in a given market. The general economic environment could be one of an organized oligopoly with more than one firm, no collusive activities, and no "price war" pricing practices.

Within the framework of market delineation, consider the potential location of more than one firm in a given area under the base point pricing scheme. Generally, the configuration of the procurement milksheds with more than one firm could be the same as for a single firm in a market. Net farm prices would be unchanged as long as the f.o.b. plant prices were the same. The major variations would occur in the configuration for the distribution of the final product. The location problem now involves a new dimension which includes the feasibility of locating at a new site and the number of facilities which should be located within the market.

Not all firms in the market would necessarily be the same size. Firm size proportional to some fraction of total in-area demand such as 1/2, 1/3, or 1/6 of the market could be specified. Plant sizes for export could be at a different level once the three major plants had been established. For example, assume that markets A, B, and C have demands of 20, 12, and 12 million pounds per month, respectively.

The distribution configuration and plant location may be as depicted in Figure 10. If processing at point A is such that three facilities have been established to account for local demand, a fourth export facility of 10 million pound capacity might be established to penetrate markets such as B and C. In B and C, the most efficient plants are established and are assumed to be the larger facilities (capacities of 6 million pounds per month for the largest plant and 4 million pounds for a second plant in each market). As further facility establishments in B and C are considered, the ratio of economies of the 10 million pound export plant in A to a 2 million pound plant in B or C may be sufficient to offset transfer costs to markets B and C and beyond, thus giving a distribution area in which certain islands exist where the more efficient plants have located.

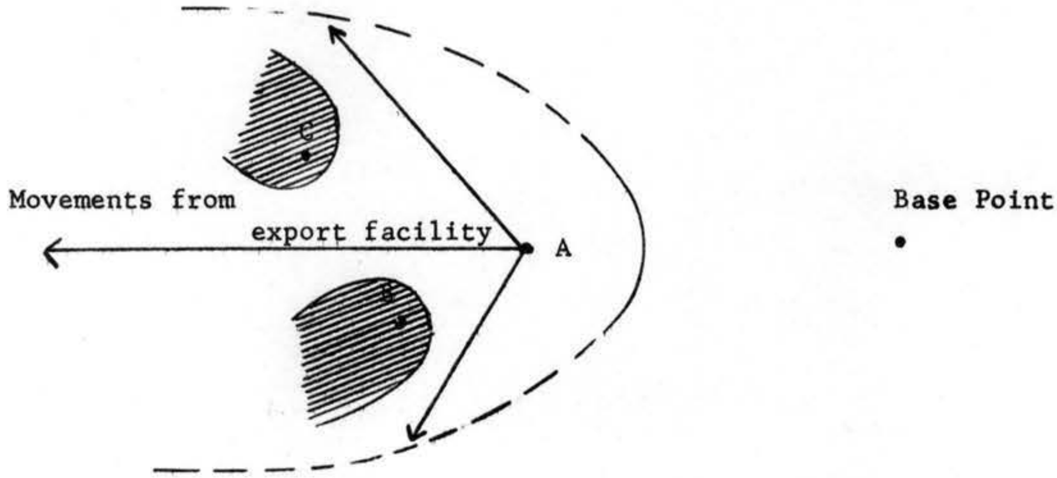

Figure 10. Distribution Delineation of Three Markets With Variations in Plant Sizes and Size of Market

Within the analysis of location there are several variables which are crucial to such analysis. These variables include the characteristics of demand, production, resource pricing and factors influencing processing costs. There are many combinations of these factors which may lead to technically feasible solutions. The purpose of the next two chapters will be to present the various data needed for the spatial analysis and the model which will make use of this information to give an optimal solution for lowest costs.

FOOTNOTES

[1]J. H. von Thunen, _The Isolated State_ (Chicago, 1960).

[2]Louis Lefeber, _Allocation In Space: Production, Transport and Industrial Location_ (Amsterdam, 1958), p. 3.

[3]Lefeber, p. 3.

[4]E. M. Hoover, _Location Theory and The Shoe Leather Industries_ (Cambridge, 1937).

[5]E. M. Hoover, _The Location of Economic Activity_ (New York, 1948).

[6]Hoover, _The Location of Economic Activity_ (New York, 1948), p. 56.

[7]E. M. Babb, "Intermarket Milk Price Relationships," Research Bulletin 760, Indiana Agricultural Experiment Station (January, 1963), pp. 1-6.

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CHAPTER III

THE MODEL

In the determination of an optimum location of a processing facility, management is faced with problems of choice. In many instances, the choices are simple and can be resolved by common sense and experience. However, given the assumptions and restrictions as specified in Chapter II, the location and optimum market organization for the fluid milk industry becomes too complex to be determined by experience and insights.

In recent years, researchers have made increased use of mathematical programming techniques to handle the various complex decision alternatives to determine the optimum alternative. Linear programming and transportation models represent mathematical programming techniques which have been used to solve the transhipment problems involved in determining an optimum market organization. Even though linear programming models can solve the transhipment problem subject to resource and consumption constraints, the model should also consider the economies of size which may exist in processing for the analysis of the study. The purpose of this chapter is to present a model which will determine an optimum solution, beginning with linear programming as a foundation and ending with the modifications necessary to describe the transport-separable model which may be used in determining the least cost marketing organization for the fluid milk industry.

The Linear Programming Model

Linear programming involves the analysis of problems in which a linear function of a number of variables is to be maximized (or minimized) when those variables are subject to a number of restraints in the form of linear inequalities.[1] Linear programming had its development in the field of military logistics. Dantzig, in an effort to assist in the over-all planning of the multitude of activities of the U. S. Air Force developed the "simplex method" of solving programming problems stated in linear terms. Extensions to, and variations of, the "simplex method" have been outlined by Dantzig,[2] by Dorfman,[3] and by Charnes, Cooper and Henderson.[4] Charnes and Cooper pioneered the application of linear programming to industrial problems of planning and production. Koopmans, Samuelson, Georgescu-Roegen, and other economists applied linear programming to Leontief's input-output models of economic systems, while Kuhn, Tucker and other mathematicians investigated important connections between linear programming and von Neumann's theory of games.[5] In the field of agriculture, linear programming has been widely used because of its flexibility and the ease of adapting it to many different problem situations.

The general linear programming problem can be described as follows: 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 maximize or minimize some linear function of the variables.[6] Mathematically, this statement means that a solution is sought which will maximize the linear function:

$$Z = \Sigma C_j X_j \qquad j = 1, 2, \ldots, n, \qquad (3.1a)$$

subject to:

$$\sum_{j=1}^{n} a_{ij}X_j \{\geq, =, \leq\} b_i, \qquad i = 1, 2, \ldots, m, \qquad (3.1b)$$

$$X_j \geq 0. \qquad j = 1, 2, \ldots, n. \qquad (3.1c)$$

For each constraint, one and only one of the signs $\geq$, $=$, $\leq$ holds, even though the sign may vary from one constraint to another. The a_{ij}, b_i, C_j are all assumed to be known constants.

As with any model, the verbal and mathematical formulations of the general linear programming problem must be accompanied by a set of assumptions. One assumption involves the necessity of linearity of all variables in the constraints and function to be optimized; thus, products of variables, powers of variables, and combinations of variables are violations of the assumption of linearity. In addition, the activities must be additive in the sense that when two or more are used, then total product must be the sum of their individual products. Another assumption concerns divisibility. It is assumed that factors can be used and commodities can be produced in quantities which are fractional units. Finiteness is also assumed. That is, there is a limit to the number of alternative activities and to input restrictions which need to be considered. Since negative inputs add nothing to the system, $X_j \geq$ for all j.

Any set of X_j which satisfies the constraints will be called a solution to the linear programming problem. Any solution which satisfies the non-negative restrictions is called a feasible solution. Any feasible solution which maximizes or minimizes the objective function is called an optimal feasible solution. The goal of solving a linear programming problem consists of finding an optimal feasible solution. In most linear programming problems there will be an infinite number of feasible solutions to the problem. Out of these solutions, only one will optimize the objective function, and this is the solution of interest.[7]

The Transportation Problem

The transportation problem is a special case of linear programming in which the objective is to minimize transportation cost in satisfying a given set of needs from a given set of sources. Mathematically, the general transportation problem can be expressed as finding $X_{ij} \geq 0$ which minimizes the objective function:

$$Z = \sum_{j=1}^{n} \sum_{i=1}^{m} C_{ij} X_{ij}, \tag{3.2a}$$

$$\sum_{j=1}^{n} X_{ij} \leq a_i, \quad i = 1, \ldots, m \tag{3.2b}$$

$$\sum_{i=1}^{m} X_{ij} = b_j, \quad j = 1, \ldots, n. \tag{3.2c}$$

The transportation problem can be conceived of as the problem of minimizing the transport costs of shipping a product from a fixed number of warehouses to the demand areas. In Equations 3.2, m is the number of warehouses, n is the number of demand areas, b_j is the number of units required at destination j, and C_{ij} and X_{ij} are respectively the unit cost between warehouse i and outlet j and the amount transferred between these two points. In the form to be used in this study, it is impossible to ship more goods from any one origin than are available at that origin, and Equation (3.2b) can be restated as:

$$\sum_{j=1}^{n} X_{ij} = X_{i1} + X_{i2} + \dots X_{in} \leq a_i, \; i = 1, \dots, m. \tag{3.3}$$

There are m constraints, one for each origin.

Each destination also must be supplied with the number of units desired. Therefore Equation (3.2c) can be restated as:

$$\sum_{i=1}^{m} X_{ij} = X_{1j} + X_{2j} + \dots + X_{mj} = b_j, \; j = 1, \dots, n. \tag{3.4}$$

The above equations specifies that the total amount received at any destination is the sum of the amounts received from each origin. The needs of the outlets can be achieved if and only if $\sum_{i=1}^{m} a_i \geq \sum_{j=1}^{n} b_j$. If C_{ij} is the cost of shipping one unit from origin i to destination j, then the total cost of the shipment is:

$$Z = \sum_{j=1}^{n} \sum_{i=1}^{m} C_{ij}X_{ij} \text{ or} \tag{3.5}$$

$$Z = (C_{11}X_{11} + C_{12}X_{12} + \dots + C_{1n}X_{1n}) + (C_{21}X_{21} + \dots + C_{2n}X_{2n}) + \dots + (C_{m1}X_{m1} + C_{mn}X_{mn}). \tag{3.6}$$

The primary objective is to find $X_{ij} \geq 0$ which satisfies the constraints of Equation (3.2a).

The linear programming problem has m + n constraints. Since all the nonzero coefficients of the X_{ij} are ones and any given X_{ij} appears in two and only two of the contraints, the constraints in the transportation problem have a particularly simple form. Because of these special properties, the transportation problem can be solved much more easily than a general linear programming problem of equivalent size.

In the preceeding discussion, both the conventional linear programming problem and the transportation problem are based upon a simple linear input-output relationship of the type $Y = KX$ or a more complicated form $Y = K_1 + K_2X$. In determining the least cost assembly and distribution organizations for the fluid milk industry, the linear programming operations are most efficient; thus, linear programming procedures will be used in that portion of the model.

Handling of Non-Linearities in Linear Programming

The typical average cost curves for processing reflect decreasing costs associated with economies of size and may be represented as nonlinear functions. The optimization of nonlinear functionals subject to linear inequalities has generally been regarded as inaccessible to the methods of linear programming and transportation problems because the optimizing points are usually interior points rather than extreme points. Therefore, if the objective involves the determination of an optimum size processing facility, some modification of the standard linear programming procedures are necessary.

Several modifications of the linear programming procedures have been used in dealing with non-linearities. Giaever and Seagraves outlined four methods for handling non-linearities in linear programming.[8] One method formulates the problem in such a way that the simplex procedure will give a solution. This very restrictive method is only applicable for diseconomies because the simplex criterion will tend to bring in first the processes representing the highest levels of output and thus has little value for nonlinear problems.[9*] The other methods require adjustments in the final tableau and apply only to economies-of-size problems. They require the substitution of adjusted coefficients to reflect economies of size into the final tableau and the problem re-run. These methods have been tested and show adequate results, but the problem size has been kept very small to accommodate the solution.

The techniques just described become very inefficient as the size of the problem increases, particularly for a problem of the magnitude of 618 rows and 22,563 columns which was developed for this study. It was necessary, therefore, to use a model which could account for the nonlinear functions and be reasonably efficient in man hours as well as in computer hours. There exists such a model, referred to by Baumol and Bushnell as one of the piecewise linear approximation models, which has been used in the petroleum industry. This model is commonly referred to as separable programming and was developed by C. E. Miller in an effort to handle specifically the nonlinearities in motor gas blending.[10] Beale, Coen, and Flowerdew describe the use of separable

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[*] W. J. Baumol and R. C. Bushnell discuss the implications of using linear approximations in the solution of nonlinear functionals. The authors suggest extreme caution in the use of linear approximations since evidence indicates the potential of enormous errors in using these types of procedures. Their analysis and suggestions refer to "strictly linear approximations". Their emphasis on this extreme form of linearization is justified by the frequency with which it has been employed. While some industrial studies, for example, do utilize piecewise linear representation of their production relationships, they are the exception rather than the rule. In an extensive search of literature, the authors found that of the published empirical programming applications, almost all employed strict linearity assumptions. Only two (both relating to the petroleum industry) involved piecewise linear approximations and only seven utilized nonlinear methods. Apparently, there is a lot of unpublished work using piecewise approximations and nonlinear programming in the planning work of the petroleum industry.

programming in determining the optimum mix of raw materials (chiefly iron ore) to be converted into liquid iron in four blast furnaces.[11] In a more recent application, Crowder used an extended production-distribution model which included the use of separable programming to handle the nonlinear processing cost functions reflecting economies of size in the determination of optimum market organizations of the Oklahoma fluid milk industry.[12]

The Separable Model

Separable programming is a technique for handling certain types of nonlinear functions within the framework of a general linear programming format. The basic procedures in separable programming are: (1) to represent the polygonal functions by means of linear equations coupled with logical restrictions; and (2) to use the simplex method on these equations, modifying the simplex method in order to impose logical restrictions.[13]

The key element of separable programming is the representation of a nonlinear function by piecewise linear segments. As an example of the separation of a nonlinear function into piecewise linear approximations, assume that the objective is to minimize the nonlinear function subject

$$F\ (Y_1,\ Y_2,\ \ldots\ Y_n) \qquad (3.7)$$

to linear constraints. The nonlinear functional F can be approximated to any degree of accuracy by substituting any number of linear transformations into a sum of functions of individual variables. If F can be written as

$$F = \sum_{i=1}^{P} f_i(X_i) \tag{3.8}$$

where

$$X_i = \sum_{k=1}^{n} a_{ik} Y_k, \tag{3.9}$$

then the f_i (and hence F) can be approximated by piecewise linear functionals.[14] Separable nonlinear functionals and the maximization of separable convex functions are discussed in more detail by Hadley.[15]

To illustrate the concept, consider the function shown in Figure 11. The function Y = f(x) might represent a typical total cost function reflecting both increasing and decreasing returns to size.

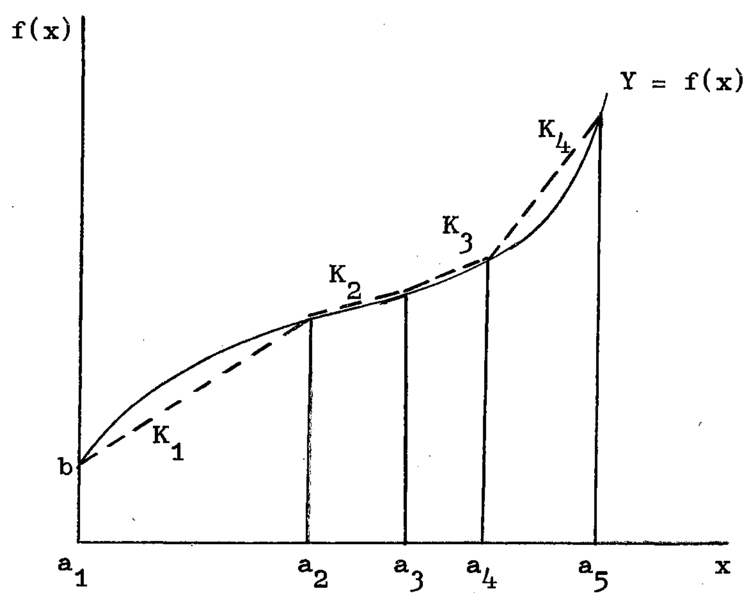

Figure 11. A Selective Representation of the Piecewise Approximation of a Total Cost Curve

In economic theory, certain points are crucial to the interpretation and analysis of economic phenomena. Assuming that critical points of this cost function are of interest, the following points could be specified in terms of special variables:[16]

$x = a_1$, the point of minimum total cost where b = fixed cost;

$x = a_2$, the inflection point;

$x = a_3$, point of minimum average variable cost;

$x = a_4$, point of minimum average total cost;

$x = a_5$, capacity point.

Consider the cost function $Y = f(x)$ as the separable function. This function is assumed to be defined for the problem for a predetermined range of values of x, starting at $x = a_1$. The special variables a_1, a_2, a_3, a_4, and a_5 have been defined for the separable function f(x). The special variable a_2 defines the first interval of length K_1 along the x axis, a_3 defines the second interval of length K_2, etc. $K_1 + K_2 + K_3 + K_4$ covers the specified range of x for which the separable function is considered to be active.

In the separable program, K_1 is the first variable to enter the analysis. K_2 is the second variable to enter the analysis but can do so only after K_1 has reached its upper limit. Thus, the cost function of Figure 11 is equivalent to a cumulative distribution function. Greater accuracy would be achieved in the analysis if a larger number of piecewise segments were utilized rather than the four (K_1 to K_4) illustrated in Figure 11.

In the determination of the optimum industry organization, the model must take into account the linear transportation functions of assembly and distribution activities plus the nonlinear cost function reflecting the economies of size associated with various sizes of processing facilities. Thus, the transportation and separable techniques must be integrated into one model to consider the economies of size of processing facilities while minimizing the assembly, processing, and distribution costs. For an integrated model of this type to be operative, assumptions regarding the constraints must be made:

(1) demand for each market is known,

(2) supply of the resource from each production area is known,

(3) specified unit costs associated with assembly and distribution activities are known and independent of volume shipped, and

(4) per unit costs associated with processing are known for each of the potential plant location sites and sizes.

Given the assumptions outlined, the objective function of the transport-separable model is as follows:

$$\text{Minimize } A = \sum_{j=1}^{n} \sum_{i=1}^{m} C_{ij}X_{ij} + \sum_{i=1}^{m} \beta(X_i)\, X_i + \sum_{f=1}^{h} \sum_{k=1}^{p} \sum_{i=1}^{m} T_{fki}S_{fki} \qquad (3.10)$$

[17]

where:

X_{ij} = quantity of product transported from processing area i to market area j.

C_{ij} = per unit cost of transferring the product from processing area i to demand area j.

βX_i = total quantity of final product processed in processing area i.

(X_i) = coefficient expressing per unit cost of processing quantity, X_i, in area i.

T_{fki} = per unit transport cost in moving resource f from resource supply area k to processing area i.

S_{fki} = quantity of resource f shipped from resource supply area k to processing area i.

The matrix format for the transport-separable model is presented in Table II. The model represents a situation in which there are two demand areas, two supply areas and two potential processing facilities. From the matrix format of Table I,

D_{ij} = the quantity of final product from plant i to demand area j.

C_{ij} = per unit cost of transporting the final product from plant i to demand area j.

S_{ij} = quantity of resource transported from supply area i to processing center j.

T_{ij} = per unit cost of transporting the resource from supply area i to processing plant j.

Plt i = existence of processing plant i.

Plt Cost i = total processing cost at plant i.

P_{ij} = special variable j for plant i.

Z_{ij} = special coefficient j reflecting level of processing at plant i.

E_{ij} = special coefficient j reflecting cost of processing at plant i.

Sources of Potential Error Within the Model

In working with piecewise linear approximations to nonlinear functionals, the researcher must select an appropriate grid size for the special variables so that excessive error is eliminated in the

TABLE II

MATRIX FOR THE TRANSPORT SEPARABLE MODEL: TWO DEMAND AREAS, TWO POTENTIAL PROCESSING FACILITIES, AND TWO SUPPLY AREAS

Right Hand Side	Type Restriction	D_{11}	D_{21}	D_{12}	D_{22}	S_{11}	S_{21}	S_{12}	S_{22}	Plt1	Plt2	Cost 1	Cost 2	Special Variables P_{01}	P_{02}	P_{03}	P_{04}	P_{11}	P_{12}	P_{13}	P_{14}
Obj	N	C_{11}	C_{21}	C_{12}	C_{22}	T_{11}	T_{21}	T_{12}	T_{22}			1	1								
Demand 1	=	1	1																		
Demand 2	=			1	1																
0	=	1		1						-1											
0	=		1		1						-1										
0	=					-1	-1			1											
0	=									-1				Z_{01}	Z_{02}	Z_{03}	Z_{04}				
0	=											-1		E_{01}	E_{02}	E_{03}	E_{04}				
0	=							-1	-1		1										
0	=										-1							Z_{11}	Z_{12}	Z_{13}	Z_{14}
0	=												-1					E_{11}	E_{12}	E_{13}	E_{14}
Supply 1	$\geq$					1		1													
Supply 2	$\geq$						1		1												
	Lower Bound													-	-	-	-	-	-	-	-
	Upper Bound													1	1	1	1	1	1	1	1

linear approximations of the nonlinear function. A grid too refined often leads to excessive computer time while achieving little accuracy. In many instances where large matrices are being dealt with, a preliminary run can target in on an appropriate special variation and a secondary run made with greater refinement around the initial special variable.

FOOTNOTES

[1]Robert Dorfman, Paul A. Samuelson, and Robert M. Solow, Linear Programming and Economic Analysis (New York, 1958), p. 8.

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[14]A. Charnes and W. W. Cooper, "Nonlinear Power of Adjacent Extreme Point Methods in Linear Programming," Econometrica 2S, January, 1956, pp. 138-140.

[15]G. Hadley, Nonlinear and Dynamic Programming, (Reading: Addison-Weseley Publishing Co., Inc., 1964), pp. 104-156.

[16]Charnes and Cooper, p. 140.

[17]Crowder, p. 71

CHAPTER IV

BASIC DATA, COST ESTIMATES AND MARKET DEMARCATION

A spatial analysis of the fluid milk industry in the United States requires data on many aspects of the industry, and the validity of any conclusions from such analysis depends in part upon the accuracy of the data selected. Market, regional and national data on fluid consumption, fluid-eligible production, per capita consumption, processing costs, interregional transportation costs of bulk and packaged milk, and the magnitude of the spatial dimension in terms of highway mileage between markets are needed. The procedures for generating the necessary data are outlined in this chapter.

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 quantity of fluid milk eligible for human consumption in many of these market areas. 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.[1] The market delineation is considered later in this chapter.

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 information reported in Sales Management, a publication which annually estimates various economic variables and business activity by state and county for the United States.[2] 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 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 half-gallon paper containers and were obtained from the Fluid Milk and Cream Report.[3] 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.[4] 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.[5] 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 Southern, Western, North Central, and Northeastern as illustrated in Figure 12. These estimates of per capita regional consumption of fluid milk reflect the composite effects of location, 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

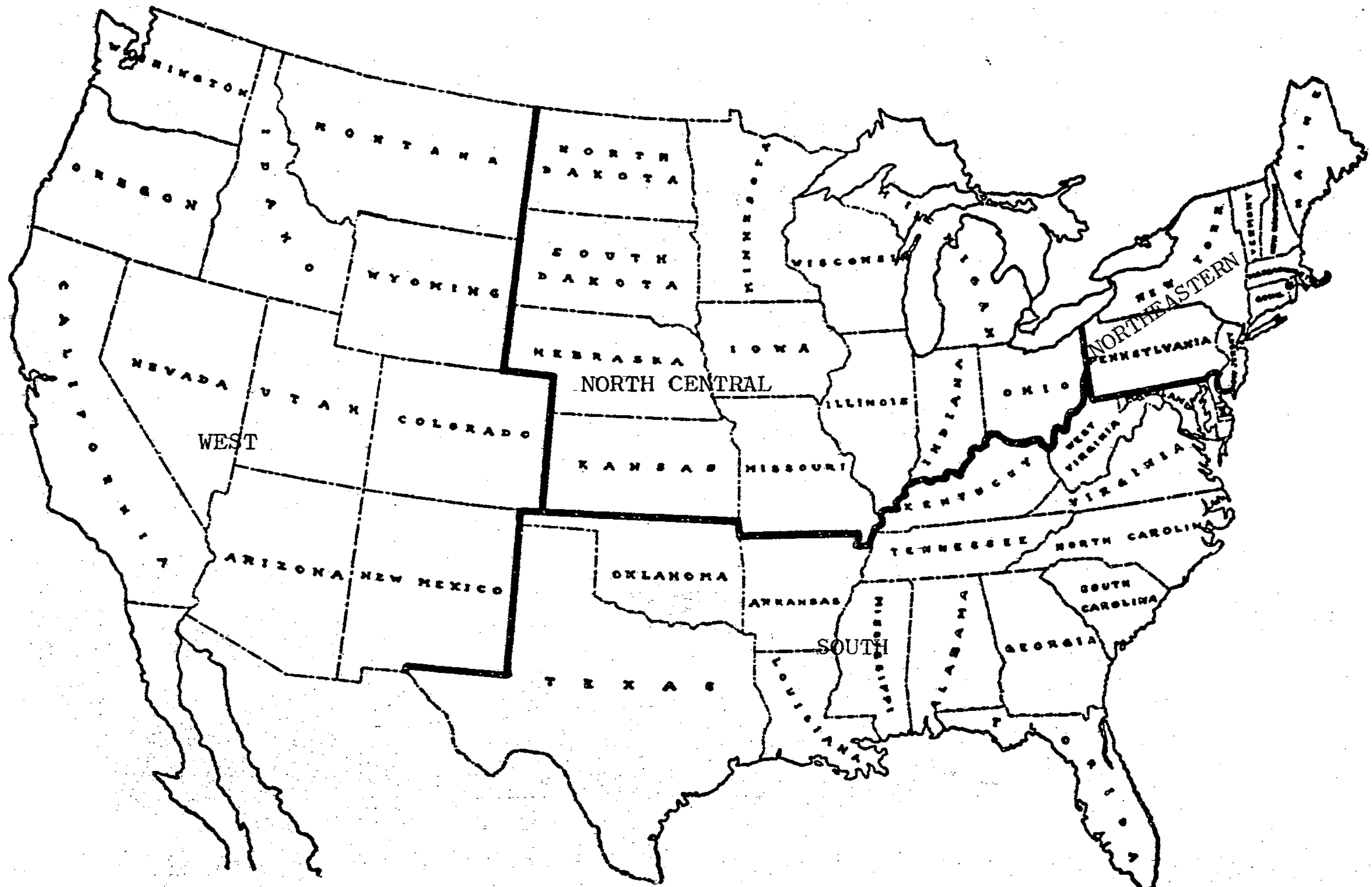

Figure 12. Regions Used in Determining Regional Consumption Estimates

Equation 4.1 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:

$$C_i = Z_k + (Z_k)(.16)(\Delta I_i) + (Z_k)(-.285)(\Delta P_i) \pm \left[Z_i + \frac{-(f_1)(Z_k)(NWP_i) + (f_2)(Z_k(WP_i)}{TP_i} \right] \tag{4.1}$$

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.[6]

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.[7]

ΔP_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.[8]

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 (.01 percent) is $0.28. Using the equivalent price for all milk, the price of milk eligible for fluid markets can be adjusted downward from 3.66 to 3.63 percent butterfat by $0.0084 (.03 X .28 = .0084). The manufacturing price can be adjusted in a similar manner except the price would increase because the manufacturing milk fat test is greater than the average test for all milk. The price of manufacturing milk would increase by $0.0644 (.23 X .28).

The adjusted prices were used in the following equation:

$$X(AC_{1j}) + (100-X)(AC_{3j}) = AC_{2j/100} \qquad (4.2)$$

where:

X = the percentage of total production eligible for human consumption.

AC_{1j} = the fat test adjusted Class I price for production area j.

(100-X) = percentage of fluid milk ineligible for consumption as fluid milk.

AC_{3j} = the fat test adjusted Class II, (manufacturing milk) price for production area j.

AC_{2j} = the average price for all fluid milk sold in market j.

The percentage (X) determined from Equation (4.2) 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.[9] 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 per mile for the 49,000 pound pay load truck. In addition to the fixed and variable truck costs, 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:

$$Y = 11.405 + .11260X \qquad (4.3)$$

where:

Y = cents per hundredweight.

11.405 = estimate of the fixed costs in cents per hundredweight.

X = one-way mileage.

.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 distributive 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 were 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:

$$Y = 6.513 + .16025X \qquad (4.4)$$

where:

Y = cents per hundredweight.

6.513 = estimate of fixed cost in cents per hundredweight.

X = one-way mileage.

.16025 = estimate of variable costs in cents per mile.

Equation (4.4) is used in this study to determine distribution costs involved in moving milk from the processing center to the distribution outlet.

Processing Costs

Processing costs are defined in this study as costs associated with the transformation of raw fluid 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.[10] 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 reflect 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 volume 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:[11]

$$PC = 11.763Q^{-.11507} \qquad (4.5)$$

where:

PC = processing cost per quart.

Q = quantity processed in quarts per day.

Equation (4.5) 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.

There is no empirical evidence of any study known to this writer which indicates the turning up of such a planning curve; however, at some point a minimum should be attained since certain costs per unit are constant and must be met. Such costs would include the cost of the container, variable labor costs, and some portion of administrative costs. Crowder had the same problem in a similar study of the Oklahoma dairy industry.[12] 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. Crowder's combined estimates of 1.8 cents per quart were selected for use in this analysis. Equation (4.5) was used for determining average processing costs for all volumes where $PC \geq K$ and K is equal to 1.8 cents per quart. The constant K is the lower limit for Equation (4.5) and represents the average processing costs used for facilities with volumes which would yield $PC < K$ if Equation (4.5) 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 (4.5) is used to represent processing costs.

Demarcation of Production and Consumption Areas

The area of study for the analysis of this problem is restricted to the 48 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 13 and 14. Codes used in identifying demand (distribution points) areas and supply (assembly points) areas are found in Table XX, Appendix I. The 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. 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.

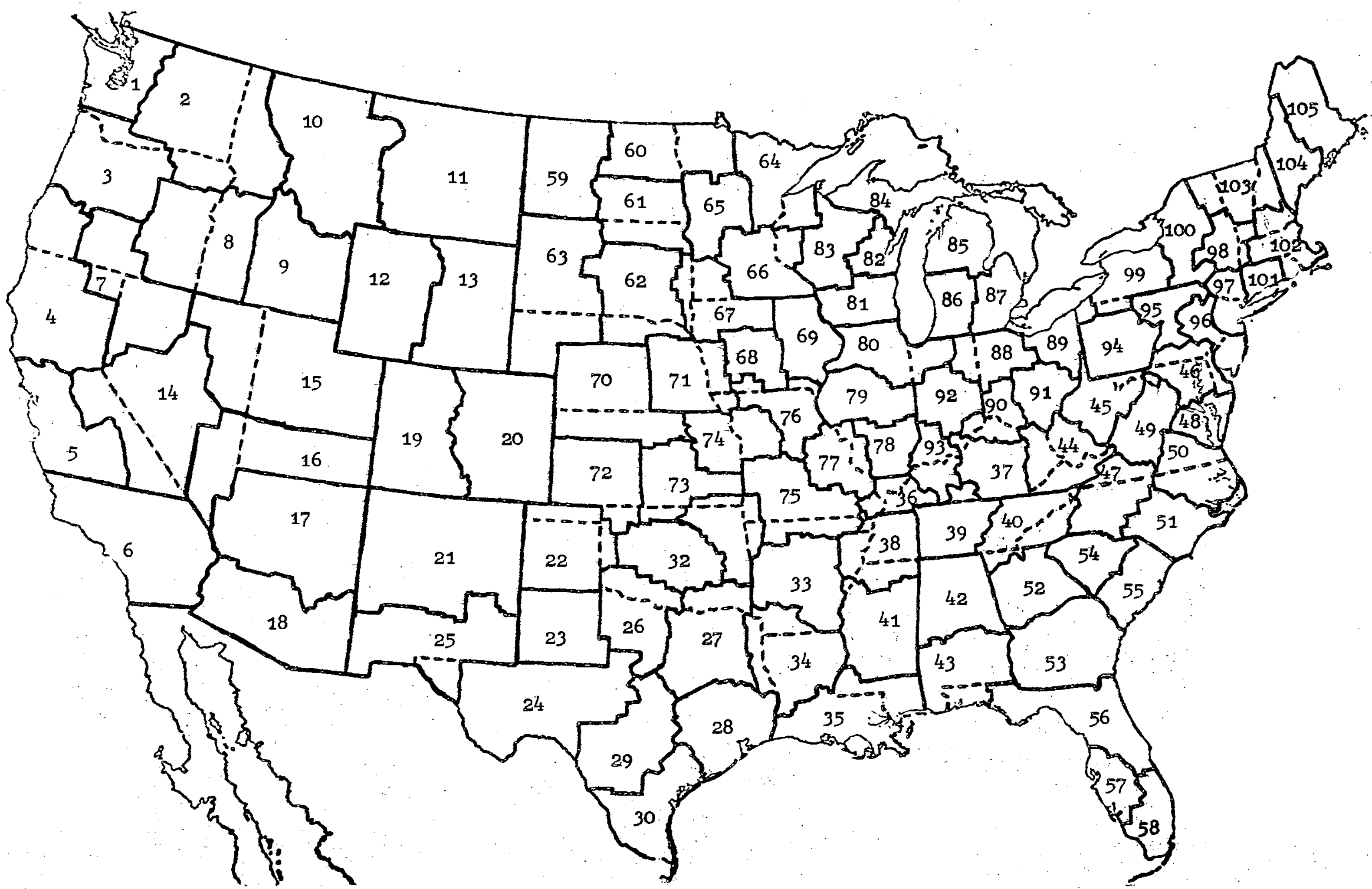

Figure 13. Demarcation of Market Areas Used in the Study

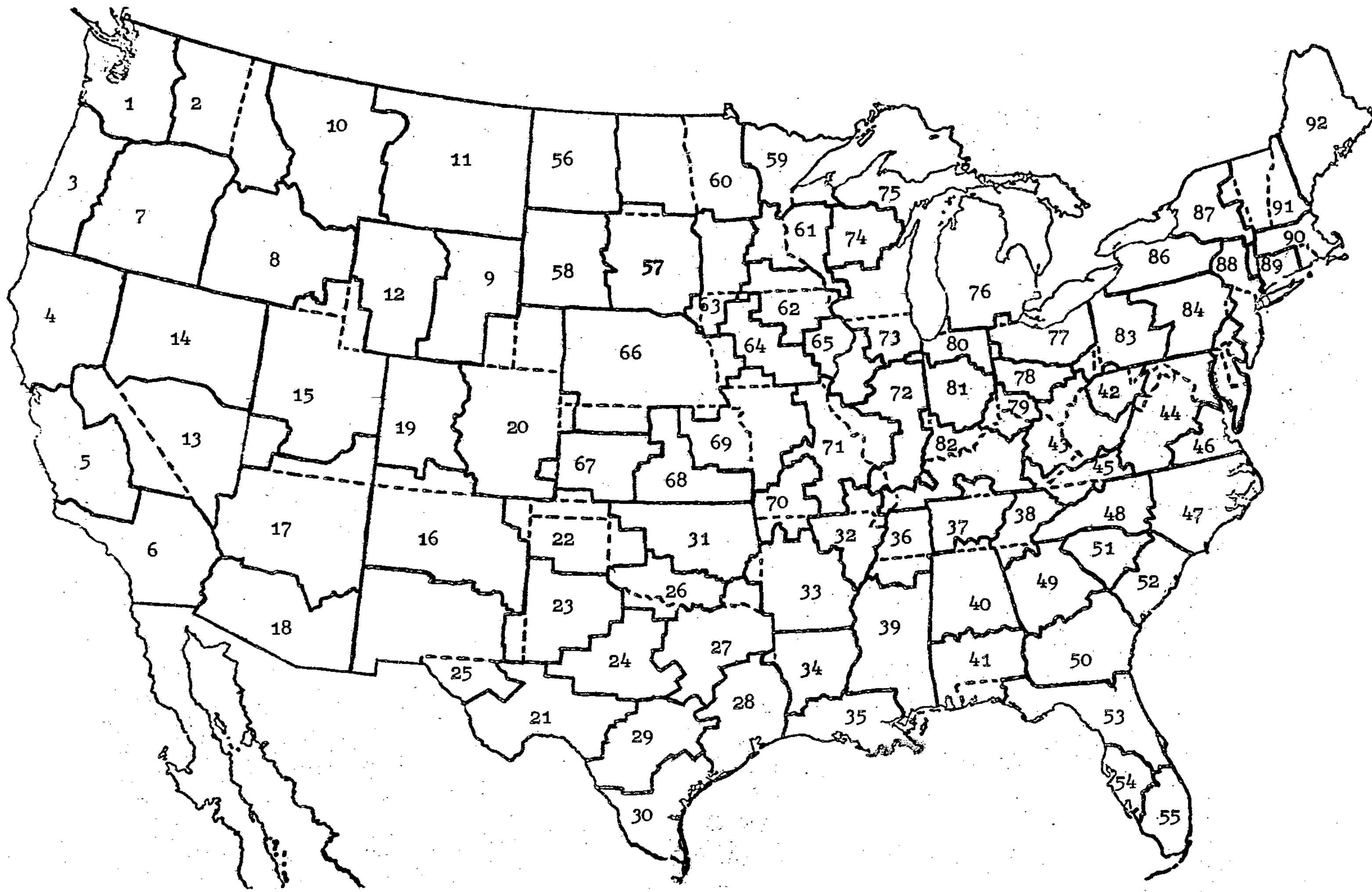

Figure 14. Demarcation of Production Areas Used in the Study

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. Giving consideration to these types of factors, the continental United States was divided into 92 production areas.

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 15.

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.[13]

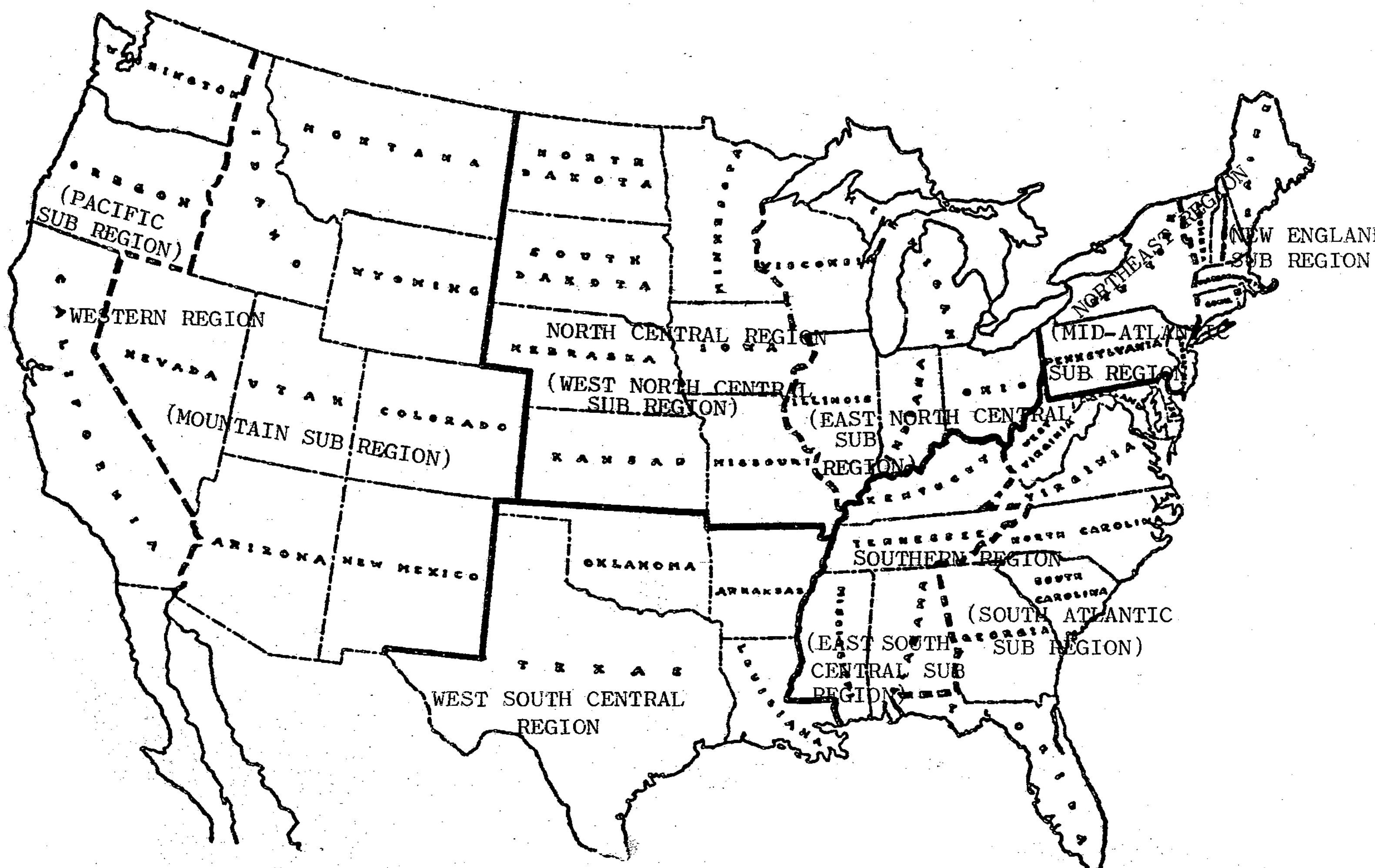

Figure 15. Regional and Sub-Regional Demarcation for Aggregated Summary Statistics

FOOTNOTES

[1]U. S. Bureau of the Census, Current Population Reports: Estimates of Population of Counties July 1, 1966, Series P-25, No. 401, 404, 407.

[2]"Per Capita Income by County and State," Sales Management, June 10, 1966, pp. D-2 - D-299.

[3]United States Department of Agriculture, SRS, Fluid Milk and Cream Report (Washington, 1966).

[4]Joseph C. Purcell, "Analysis of Demand for Fluid Milk and Fluid Milk Substitutes in the Urban South," Georgia Experiment Station, Tech. Bul. N. S. 12, Oct., 1957.

[5]United States Department of Agriculture, Fluid Milk and Cream Report, pp. 36-39.

[6]G. E. Brandow, "Interrelations Among Demands for Farm Products and Implications for Control of Market Supply," Pennsylvania Agriculture Experiment Station Bulletin 680, August, 1961, p. 17.

[7]Brandow, p. 5.

[8]K. E. Freeman and E. M. Babb, "Marketing Area and Related Issues in Federal Milk Orders," Indiana Agriculture Experiment Station Research Bulletin No. 782, pp. 19-20.

[9]Orval Kerchner, Costs of Transporting Bulk and Packaged Milk by Truck, U. S. Department of Agriculture, Marketing Research Report No. 791 (Washington: U. S. Government Printing Office, 1967).

[10]D. W. Cobia and E. M. Babb, "Determining the Optimum Size Fluid Milk Processing Plant and Sales Area," Purdue University Research Bulletin No. 778, May 1964.

[11]Cobia and Babb, p. 8.

[12]Richard T. Crowder, "Optimum Market Organization of the Oklahoma Fluid Milk Industry, 1965 and 1975," Unpublished Ph. D. dissertation, Oklahoma State University, May, 1967, pp. 54-57.

[13]Rand McNally and Company, "Rand McNally Atlas -- United States, Canada and Mexico," 42nd edition, New York, 1965.

CHAPTER V

MARKET ORGANIZATIONS USING NON-RESTRICTED MODELS

The models of this chapter are formulated to determine the minimum cost flow of fluid milk from production assembly points to distribution points in an economy completely free of regulation. The general environmental 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.

The consumption and production estimates for each area are determined on the basis of the estimating procedures discussed in Chapter IV. Costs associated with assembly and distribution activities are determined by Kerchners' fluid milk transportation functions also discussed in Chapter IV. In determining the assembly cost for a market or regions, the cost of transferring the resource of a production area to a processing facility is charged to the receiver of the resource. It is assumed that the processor is initiating the action in obtaining adequate resource supplies. 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.

Processing activities are specified for each consuming market, with each market permitted to have one 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 the point 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.

As an example of the plant sizes, consider a hypothetical market with 10 million pounds of fluid milk required to satisfy local needs. Assuming a typical average cost curve, the potential plant sizes would reflect positions on the curves as shown in Figure 16. After a plant of size IX is achieved, there are no further economies of size to be gained and there are no diseconomies. Therefore, a plant size X could be established anywhere along the total cost curve without any incidence of grid error beyond the volume for plant size IX.

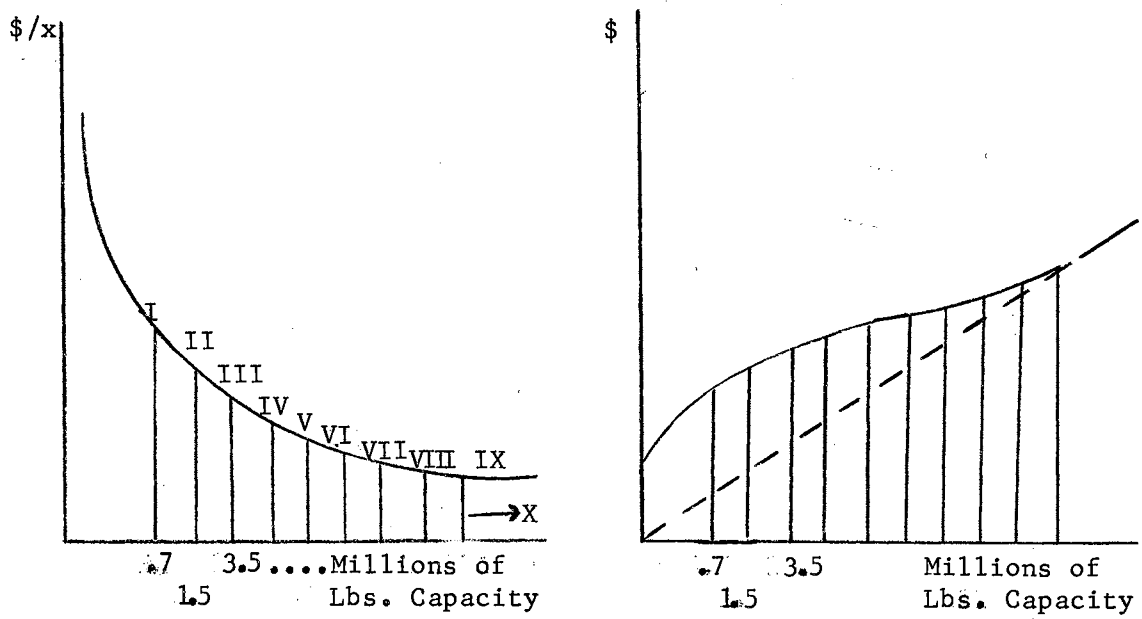

Figure 16. A Selective Representation of Potential Plant Size for a Given Market and Positions on the Average and Total Cost Curves

Given the model, basic data and assumptions, the transport-separable technique is used to determine the minimum cost of transferring the raw resource from an assembly point to a processing facility where the resource is processed into the final product and then forwarded into a distribution outlet in a market(s). Model construction reflects a marketing channel completely free of regulation. The first model discussed in the analysis is a model in which pure monopoly is achieved in a given market in the determinination of an organization in which costs are minimized. Producers are assumed to receive the same resource price in all areas and size of processing facilities is unrestricted. The second model is similar to the first model except the 1965 resource pricing structure is incorporated. The organization of the processing sectors of Models I and II will provide a benchmark from which to compare alternative organizations.

Most of the results reported reflect regional aggregations of the individual market data. References to sub-regional activities will be made only when some phenomenon within or between sub-regions appears important.

Model I -- Optimum Market Organization With Equal Resource Prices

Model I is formulated on the basis of the assumptions concerning plant sizes specified above. In addition, it is assumed that producers of the resource are paid the same f.o.b. plant price regardless of their location in the United States.

An overview of intermarket transfers of milk under the least cost spatial pattern of assembly activities serving processing facilities for the United States for Model I is shown in Figure 17. Summary statistics for the production activities of Model I by regions are presented in Table III. The quantities of raw fluid milk moving from various production assembly points to the processing facility, the quantities of unused production at the assembly points for Models I and II are listed in Table XXI, Appendix II. In addition, a complete presentation of the statistics by region for the optimum solution of Model I and II are included in Tables XXV to XXXVII of Appendix IV.

Of the 92 production areas defined for the United States, production from 76 areas is utilized in the least cost solution. These areas provide 64 processing facilities across the nation with 4,679 million pounds of milk per month with 1,830 million pounds remaining unused.

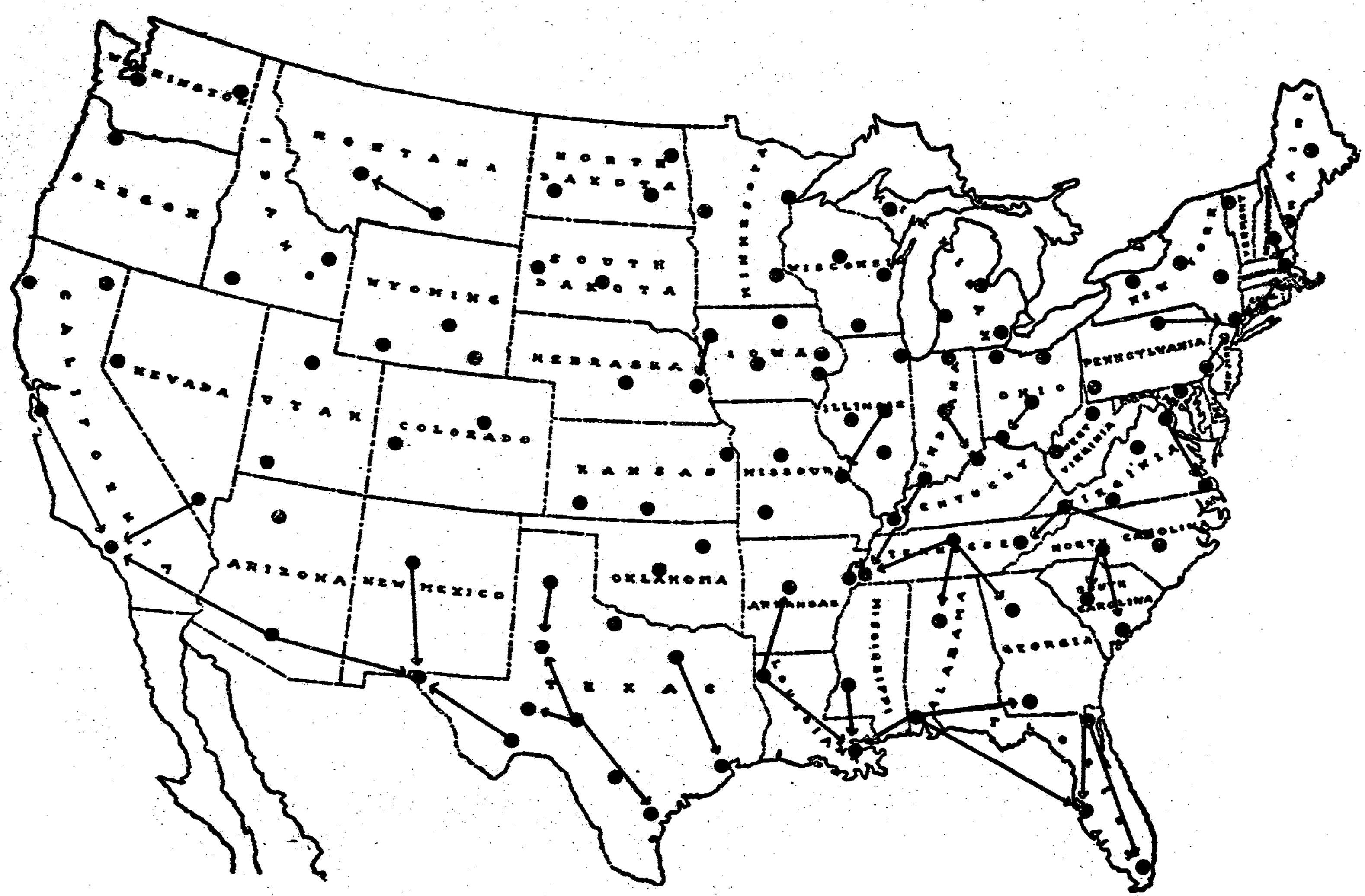

Figure 17. Optimum Flow Patterns of Milk From Production Areas to Processing Centers, Model I

TABLE III

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.)
Western	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 total quantity moving to various processing facilities, 1,138 million pounds require transportation to distant markets. Costs associated with supplying distant markets totals 3.3 million dollars and represents 6.1 percent of the total costs associated with the entire market organization.

Processing costs total 46.1 million dollars or 86.8 percent of the total organization 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 a combined capacity of 4,679 million pounds per month. At this level of operation or an average level of operation of 73.1 million pounds, processing cost per pound for the United States averages .98 cents or about 2.1 cents per quart.

Production and Assembly Activities

Of the 20 production areas in the Western region, raw fluid milk is utilized from 15. The areas supply a total of 759 million pounds of raw milk to 14 processing facilities within the region with 252 million pounds being unused. Assembly costs associated with the intermarket movements of raw fluid milk totals 338,000 dollars (Table III). Most of the assembly costs involve milk moving from San Francisco, Las Vegas, and Phoenix 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.

In the West South Central region, 12 processing facilities are established with a total capacity of 398 million pounds per month. The facilities are served by 14 of the 15 supply areas within the region. Of the total requirements needed, the West South Central region supplies all the resource except for 8 million pounds imported from the Western and Southern regions. Even though it imports some of its supply, the region has exports totaling 6 million pounds. Unused production in the region totals 24 million pounds. Total costs associated with intra-regional and interregional movements of raw fluid milk are 158,000 dollars. Although several movements make up the total cost of assembly, the major movements 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 movements 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.

In the Southern region, production is utilized in 19 of 20 production areas serving 17 processing facilities. Assembly costs for intraregional movements and imports of the resource total 803,000 dollars. Within this region, production is utilized very effectively 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 Southern 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.

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

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

Processing and Distribution

Intermarket flows of milk under the least cost distribution patterns of the final product for Model I are shown in Figure 18. Table IV represents a summary of statistics of the spatial and processing activities of Model I. A complete listing of the location of plants, quantity processed, size of plants, and costs of operation are included in Table XXII, Appendix II.

In the Western region of the United States, 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 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 dollars.

Influence of population density upon economies of size in processing is significant, as illustrated by the difference in processing costs between the Mountain and Pacific sub-regions. Processing cost per pound averages 0.98 cents for the Pacific area versus 1.18 cents

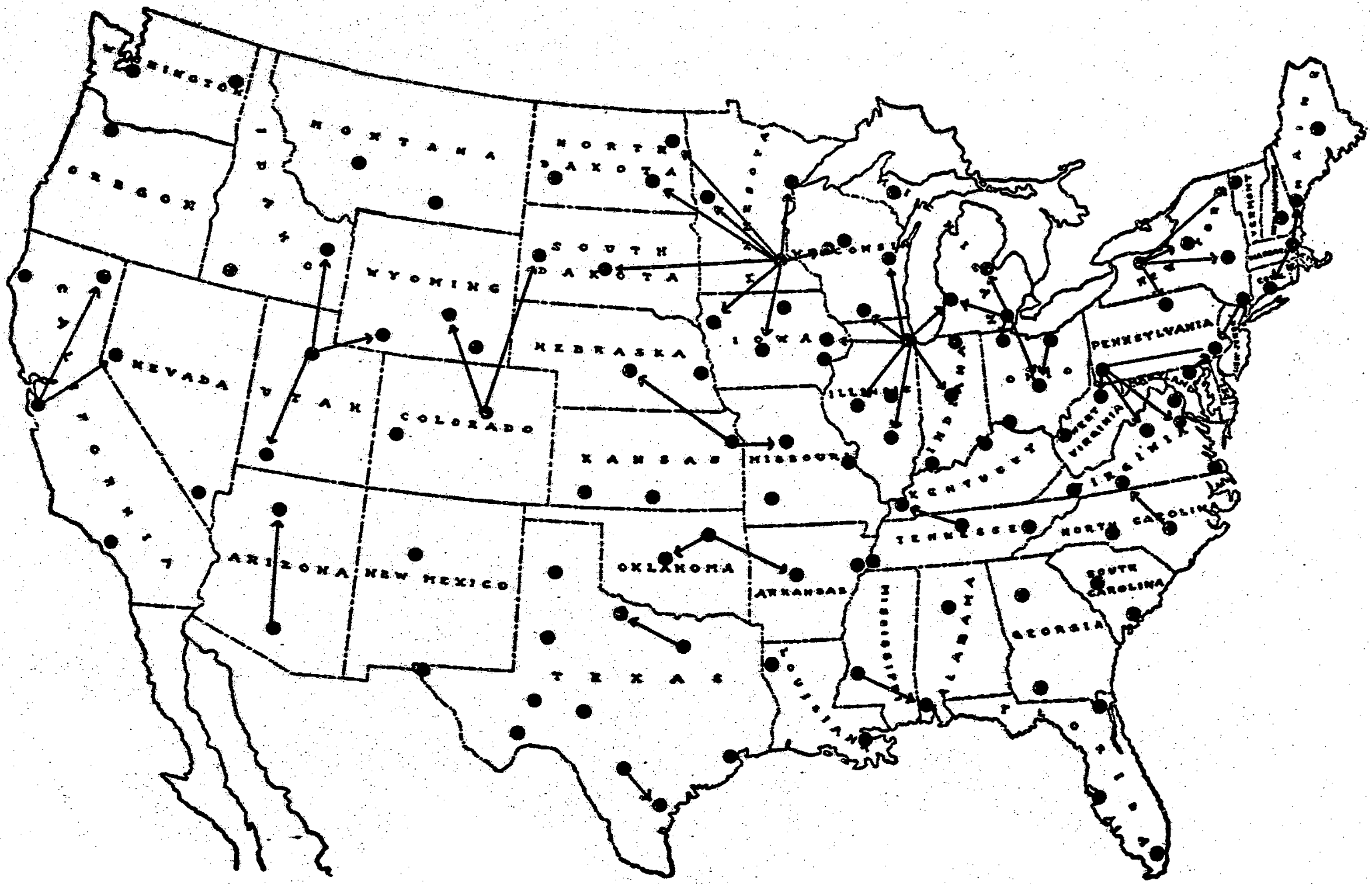

Figure 18. Optimum Flow Patterns of Packaged Milk From Processing Facilities to Market Areas, Model I

TABLE IV

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.)
Western	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	

for the Mountain area. The population density of the Pacific area with its larger more concentrated urban centers permits the location of larger processing facilities. The mountainous area is characterized by smaller, less efficient processing facilities. Table V illustrates the distribution of firms established under the assumptions of Model I. In the Pacific states, two facilities (Los Angeles and San Francisco) are established with more than 100 million pounds of processing per month. The Mountain sub-region is characterized 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.

In the West South Central region, processing of 398 million pounds per month is carried out in facilities located within the region. Processing of this quantity requires the establishment of 12 facilities with cost outlays of 4.5 million dollars or 1.14 cents per pound which is the highest per unit cost in any region. The West South Central region is not involved in any interregional transshipments (imports or exports). Intraregional movements 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 dollars.

For the Southern region, the least cost market organization indicates the utilization of 17 processing facilities (average size 46.7 million pounds) to process 793 million pounds of fluid milk per month at a total cost of 8.7 million dollars. The average processing cost of 1.09 cents per pound is relatively high, primarily because of the number

TABLE V

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	
Western	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

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 Southern region, only four serve more than their local markets. Approximately nine million pounds is processed for Northeastern markets. At the same time, Northeastern processing facilities transfer 66 million pounds to Southern markets. Interregional movements consist of Baltimore shipping packaged milk to Philadelphia. Movements within the region include Nashville (Tennessee) shipping to Paducah (Kentucky); Jackson (Mississippi) supplying Mobile (Alabama); and Raleigh (North Carolina) transporting to Danville (Virginia).

The North Central region is the largest regional consumer of fluid milk, utilizing 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 dollars or an average cost of 0.94 cents per pound. As in the Western region, the North Central region has significant processing cost differentials between the West North Central and the East North Central sub-regions. Processing costs in the East North Central states average 0.90 cents compared with 1.07 cents per pound in the West North Central states. The differentials in this region reflect the same factors as in the Western region. The East North Central area is characterized by several larger metropolitan areas with large populated areas located nearby. For example, the 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, it does not have large urban centers located nearby.

Within the North Central region three facilities are very large. These facilities 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 dollars.

In the Northeastern region, distribution costs total 1.4 million dollars for the transportation of 426 million pounds of processed fluid milk. About 66 million pounds of milk are transported into the Southern markets. Costs associated with the processing of 1,252 million pounds by five plants averaging 250.5 million pounds of capacity, total 11.1 million dollars or an average of 0.88 cents per pound. This is the lowest per unit cost for any of the five major regions. Four major facilities exist and are located at New York, Boston, Rochester (New York), and Pittsburgh. These facilities serve markets within the region except the Pittsburgh plant which ships 66 million pounds to markets in the Virginias. Specific movements consist of

Rochester supplying Williamsport (Pennsylvania), Albany (New York), Utica (New York) and Burlington (Vermont); New York shipping to Philadelphia; and Boston transporting to Portland (Maine) and Hartford (Connecticut).

Model II -- Optimum Market Organizations With the 1965 Resource Price Structure

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

The least cost organization under the assumptions of Model II utilizes the production from 64 areas to serve 59 processing facilities with 4,679 million pounds of raw fluid milk. Intermarket movements necessary to fulfill all needs across the nation totals 1,138 million pounds or about one-fourth of total consumption and requires assembly cost outlays totaling 9.1 million dollars or 15 percent of the total cost of the market functions under consideration. A summary of production and assembly activities by region and sub-region is found in

Table VI. Figure 19 illustrates the spatial dimension of intermarket transfers of raw milk.

In the Western region, production is utilized from 13 to 20 production areas supplying 13 processing facilities with 709 million pounds of raw fluid milk. An additional 2 million pounds is transported to processing facilities in the West South Central region. Assembly costs for intraregional movements of raw milk plus transfer costs for 47 million pounds imported from the production areas of the North Central region total 661,000 dollars. 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.

Production is utilized from 9 of 15 production areas serving 9 processing facilities in the West South Central region. Imports total 123 million pounds while 148 million pounds of production throughout the region is unused because of the relatively higher resource prices in 1965. Total costs associated with assembly functions within the region and for imports total 1.1 million dollars. 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.

TABLE VI

SUMMARY STATISTICS OF PRODUCTION AND ASSEMBLY ACTIVITIES, UNITED STATES AND REGIONS, MODEL II

Region	Production		Assembly Costs ($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.)				
Western	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	

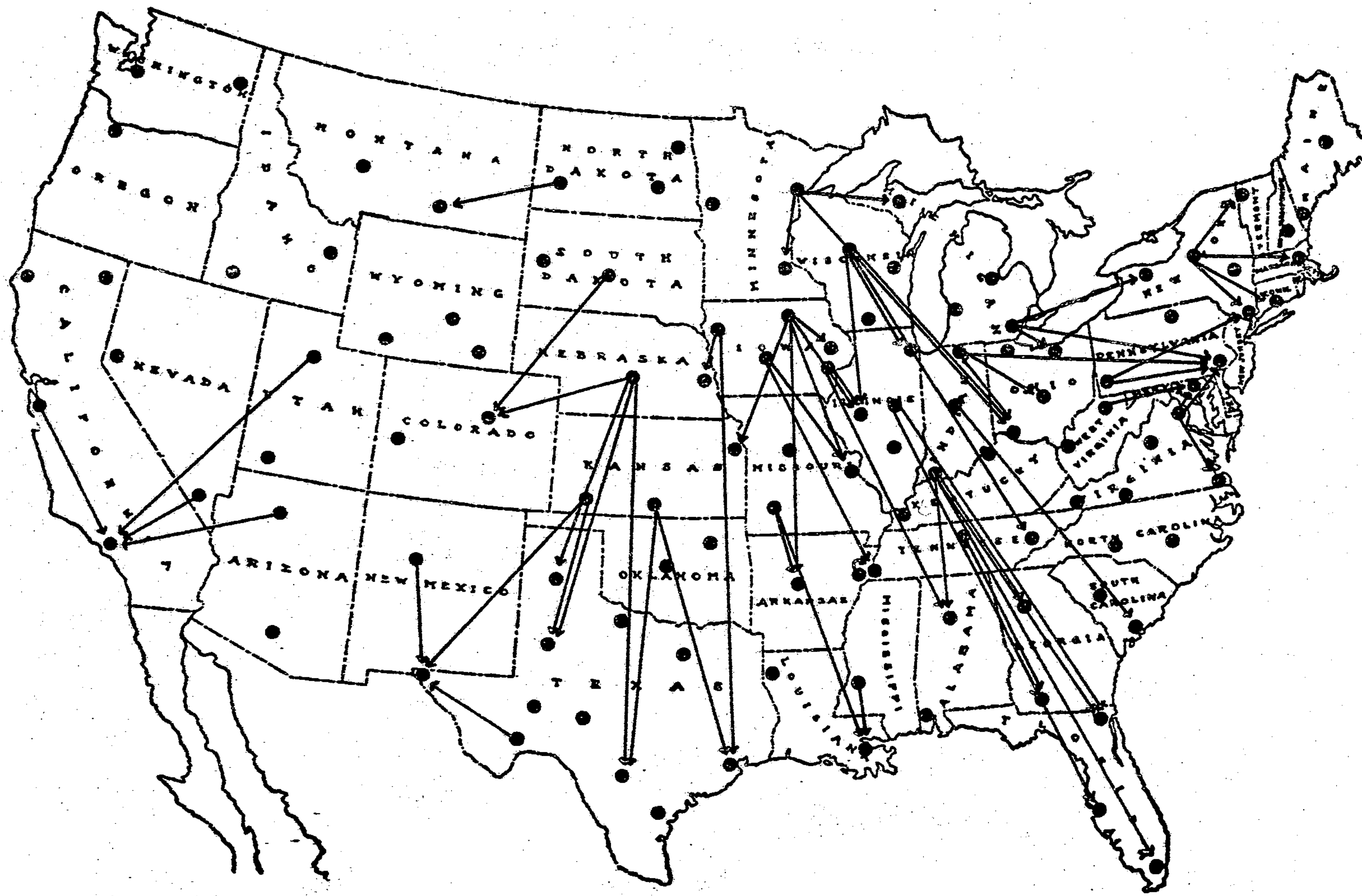

Figure 19. Optimum Flow Patterns of Milk From Production Areas to Processing Facilities, Model II

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. The transportation rate per hundredweight is $0.46; thus, the cheapest source of milk is the Indianapolis market. As a result, processors import milk from this market rather than utilize local production.

Total assembly costs associated with intraregional movements and imports total 2.1 million dollars for the Southern region. Most of the milk imported (227 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.

In the North Central region, the 1965 pricing structure reflects the comparatively low prices which have evolved under Federal order pricing of milk in this intensive 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 to 27 production areas and total production is almost completely utilized in comsumption. No imports are required but only 2 million pounds of raw milk are unused. Intraregional assembly costs total 1.9 million dollars to ship the raw fluid milk to 16 regional processing facilities.

The North Central region exports are significant and total 609 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 Southeast. In addition, production located in northern Indiana and southern Michigan moves to Northeastern facilities.

In the Northeastern region, production is used from 7 of 10 of the 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, 335 million pounds are imported and 738 million pounds are obtained from local regional production areas. Over one billion pounds of regional production is unused. The imports 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. Assembly costs total 3.4 million dollars for the intraregional and interregional movements of 683 million pounds of milk.

Processing and Distribution Activities

The processing and distribution functions of the market organization in Model II are centered around the processing of 4,679 million pounds of milk by 59 facilities and distributed to 105 consuming areas. Nationally, processing costs total 46.0 million dollars 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 dollars and account for 9 percent of the total cost. Figure 20 represents an overview of the movements of processed milk from the various facility locations to distribution points. Statistics on costs, imports, and exports by regions are presented in Table VII.

In the Western region, the number of processing facilities established totals 13. These facilities operate at an average capacity of 57.9 million pounds and a combined capacity of 753 million pounds. Costs associated with processing this quantity totals 7.7 million dollars at an average cost per pound of 1.03 cents. 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 (Table VIII). 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

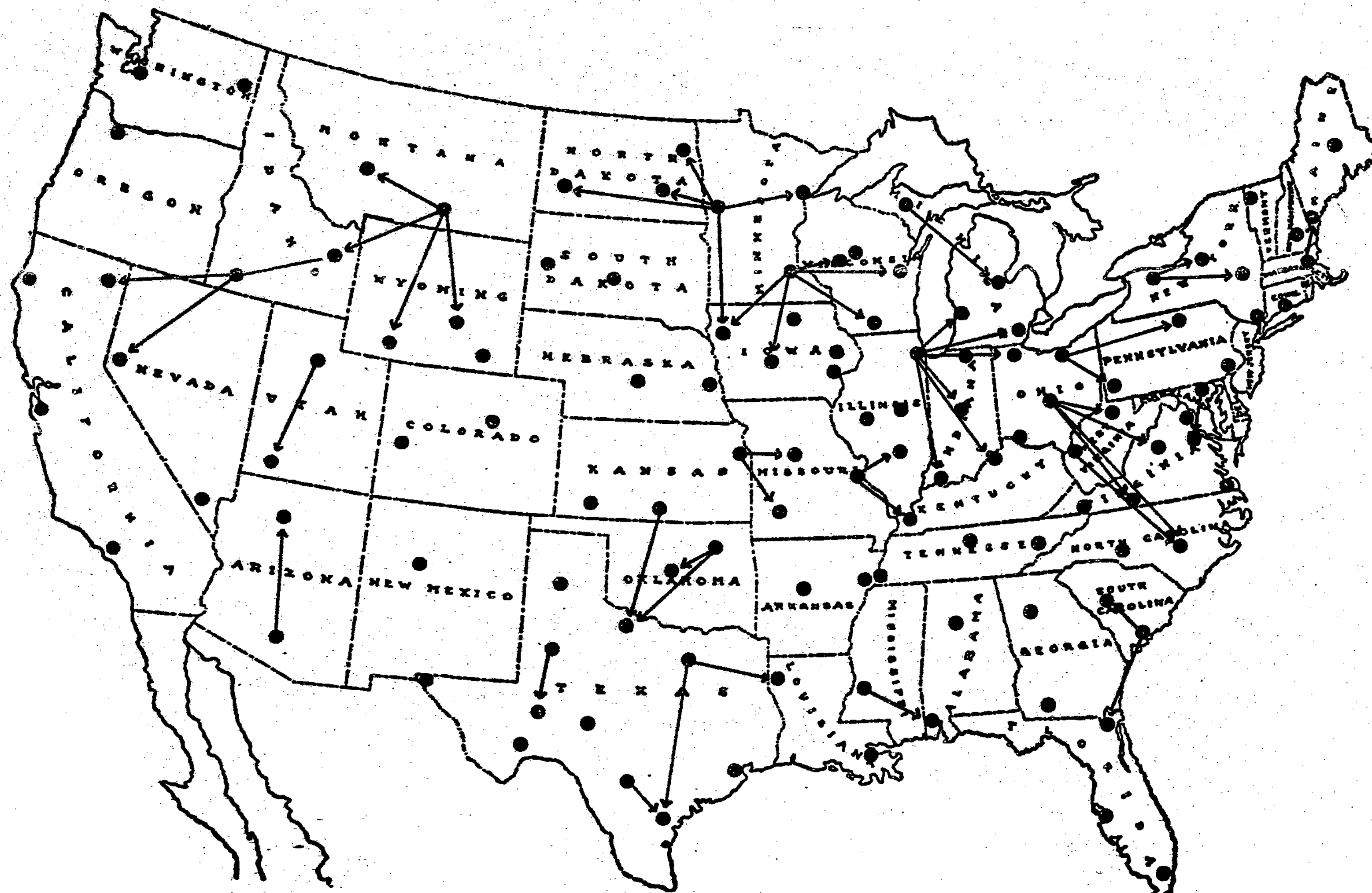

Figure 20. Optimum Flow Patterns of Packaged Milk From Processing Facilities to Market Areas, Model II

TABLE VII

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.)
Western	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
North Eastern	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	

TABLE VIII

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 Pounds: Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	Avg. Size of Facility in Millions of lbs.
Western	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

Falls (Idaho), Rock Springs (Wyoming), and Casper (Wyoming); Salt Lake City supplying Cedar City (Utah); and Phoenix serving Flagstaff (Arizona). Distribution costs for intraregional movements of 44 million pounds totals 232,000 dollars.

In the West South Central region, 11 million pounds of processed milk are required from outside the region to supplement the 387 million pounds processed within the region. The imports are from one facility in Wichita (Kansas) which supplies distribution outlets in Wichita Falls (Texas). Processing costs associated with regional facilities total 4.3 million dollars with an average unit cost of 1.11 cents per pound. Per unit costs in this region are higher than 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 West South Central region totals 89 million pounds, and costs associated with these distribution activities totals 273,000 dollars. Shipments from four facilities within the region 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 markets; Lubbock (Texas) transporting to Odessa (Texas); and San Antonio (Texas) transferring processed milk to Corpus Christi.

The Southern region processes 670 million pounds of milk at a total processing cost of 7.3 million dollars or 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 Southern region, four facilities process an additional 96 million pounds of milk above their local demands for 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 dollars.

The North Central 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 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 or a total combined capacity of 1,796 million pounds per month. Total processing costs are 16.8 million dollars or 0.93 cents per pound.

Distribution costs for intraregional and interregional market movements of processed milk totals 4.3 million dollars and represents the highest cost among all regions. Much of the distribution cost is attributed to this region's role in the exportation of processed milk to other regions. The North Central region ships 11,180, and 120 million pounds to the West South Central, Southern, and Northeastern regions, respectively.

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 Pittsburgh 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. The reasons for the difference are: (1) larger processing facilities in the East North Central states serve 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; and 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 Bay City (Michigan) market.

The Northeast region has 7 processing facilities with a volume of 1,073 million pounds per month and total processing costs of 9.9 million dollars. 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 dollars. 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 64 areas to 59 processing facilities across the nation. In supplying the resource to these facilities, an assembly cost of 9.1 million dollars is incurred and accounts for 15 percent of the total cost of the organization. Moving the final product to distribution outlets costs 5.5 million dollars and accounts for 9.1 percent of the total cost. The total cost of the optimum market organization including assembly activities is 60.6 million dollars. On a regional basis, the proportions of the total costs incurred for those activities associated with the organizations of the Western, West South Central, Southern, North Central, and Northeastern regions are 14.2, 9.3, 16.0, 38.0 and 22.5 percent respectively.

Comparisons of the Organizations of Model 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 I is designed to be a model in which maximum efficiency is the goal. Model II, on the other hand, assumes that 1965 f.o.b. plant prices are paid to farmers. Model II, therefore, reflects the past institutional influences upon the organization. Most of the farm prices which were established for 1965 reflect the actions of federal and state agencies operating in these markets. 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 possible number of 92. Apparently, the 1965 price structure with the other conditions of the Models would result in large displacements of local milk in the markets more distant from the upper Midwest. The milk would be replaced by shipment 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 six areas. 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 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 542 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. As defined in Chapter IV, 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 an organization under Model II total assembly costs for the nation would increase 184 percent from 3.2

to 9.1 million dollars. 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 dollars to 1.9 million dollars. 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 dollars. Total costs were lowest for Model II but average costs were unchanged.

Processing costs per unit were lower under Model II in two regions and higher in one region. Costs were lower by 0.03 cents per pound in the West South Central region and 0.02 cents per pound in the North Central region. Costs were higher by 0.05 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. Comparing Model I with Model II the Western, West South Central, and Southern regions experienced a decrease in firm numbers and increases in the average size of a processing facility under the assumptions of

Model II. In the Northeast, firm numbers increased and processing capacity decreased. Total processing capacity for all regions declined in Model II with the exception of the North Central region which increased its processing capacity by 319 million pounds. In the West South Central, Southern, and Northeast, regional declines in processing are the result of plants being located in the North Central region which are able to penetrate into these 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 the North Central and West South Central regions.

Distribution costs increased 1.7 million dollars 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 dollars. 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 dollars of which a substantial portion of this amount, 1.8 million dollars, was in the East North Central sub-region which borders the Northeast region.

Comparing total costs for the two models, the optimum market organization of Model I totaled 53.2 million dollars and 60.6 million for Model II. Although each region except the South had increased costs, the major increase was in the North Central region where total costs increased 6.9 million. The increase resulted primarily from additional assembly and distribution costs involved in supplying other regions.

CHAPTER VI

MARKET ORGANIZATIONS USING RESTRICTIVE MODELS

The input data and basic design of the transport-separable model used in the analyses included in the first three models of this chapter are essentially the same as in Chapter V. However, there are two major differences, one in design and one in pricing structure.

The first difference between the models relates to the number of firms that must supply a distribution outlet for packaged milk. The models in Chapter V 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 a monopoly for a given market and the firms in such an organization would be vulnerable to anti-trust action. One of the purposes of this chapter is to use a model constructed in such a way that an oligopolistic economic organization is established in the optimum market organization. The design of the model was adapted to require the establishment of at least two processing facilities in all major markets. It is possible 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. It was assumed that the small markets are of less interest to those individuals bringing forth anti-trust suits than larger markets.

The second difference in the models involves intermarket price alignment. Current price alignment in the fluid milk markets reflects the establishment of prices of milk according to a base price of milk in a surplus area plus transfer costs to more distant markets. Intermarket price-misalignment and pressures for large movements of milk could result from the use of a rigid formula for transfer costs. Therefore, the transfer costs were varied in the models 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 transfer cost per hundredweight per 100 miles from Eau Claire, Wisconsin.

The grid refinement in the special variables section of the transport-separable model is structured in such a way that in a market with demands of 75 million pounds or less, 4 potential plants can be established. 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. Four of these plants representing up to 55, 30, 10 and 5 percent, respectively, of the domestic market with a fifth plant available for establishment to compete in intermarket activity after the first four have been established. This plant may also represent a facility equivalent to 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.

In the selection of plant sizes, the models are structured so that the largest plant is the first plant to enter the solution. When this plant reaches capacity, the second largest plant is allowed to enter the market. The remainder of the firms enter into the solution in the same manner from largest to smallest as the preceeding plant reaches full capacity. The plant made available for competition in other markets is allowed to enter the solution after the other facilities have achieved their upper limits. This procedure permits the entry of smaller firms into the market and ensures that a number of firms will enter each market.

Model III -- Optimum Restricted Market Organization With a Resource Price Structure of a Base Point Price Plus Transfer Costs of 15 Cents Per Unit - Mile

The transfer cost is assumed to be 15 cents per hundredweight per 100 miles in Model III, a level consistent with late 1960 price relationships. Total costs under the least cost optimum market organization of Model III are 715 million dollars. The assembly function costs total 15.1 million dollars or 21.0 percent of the total. At these costs, the market organization consists of moving 4,679 million pounds of raw fluid milk per month 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 dollars and constitute 75.5 percent of total cost of the market functions. Distribution costs are relatively small and total 2.6 million dollars or 3.6 percent of the total.

For data on the participation of production areas in the organization, Table XXIII, Appendix III presents information (for all models) on the location of production, the processing center being served, the amount of milk being transported from points of production to processing facilities, and the amount of unused production in each production area. Table XXIV, Appendix III contains information (for all areas) on the demand area, location of processing, quantity processed, size of firm and cost of operation. In addition, Appendix IV, Tables XXV to XXXVII give detailed data on a regional and sub-regional basis regarding various aspects of the organization (for all models).

Production and Assembly Activities

In the optimum organization of the Western region, production totaling 385 million pounds of milk is utilized from 15 of the 20 production areas. 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 (Table IX).

The procurement areas indicated by the solution of Model III 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 the example cited in Figure 8 of Chapter II. 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 400 miles from Los Angeles, transportation rates are the same as for milk from San Francisco but the resource is 60 cents cheaper from production areas lying in the direction of the base point. At 500 miles, 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. Milk will move from the supply point 500 miles away because the milk will be 75 cents per hundredweight cheaper which more than offsets the 22 cent lower transport cost from San Francisco. At the 15 cent differential, therefore, milk located in San Francisco cannot be transported into Los Angeles until the source of supply is depleted in the direction of the base point.

TABLE IX

SUMMARY STATISTICS OF PRODUCTION AND ASSEMBLY ACTIVITIES, UNITED STATES AND REGIONS, MODEL III

Region	Production Used (1000 lbs.)	Production Unused (1000 lbs.)	Assembly Costs ($1,000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)
Western	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
Northeastern	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	

Both San Francisco and Los Angeles, California are the recipients of substantial quantities of milk from the North Central region, primarily from Minnesota, Nebraska, Kansas, Missouri, Wisconsin and Iowa. Supporting 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. In the other areas of the Western region, processing facilities located at Spokane, Helena (Montana), Billings (Montana), Idaho Falls (Idaho), and Boise (Idaho) are supplied 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.

Within the Western region, the Mountain sub-region transfers 93 million pounds in from the Mountain area to the Pacific Coast area. As a result of the significant quantities of milk flowing into the Western region and movements within the region, total costs associated with assembly functions are the highest of all regions. These costs total 7.1 million dollars and most of the cost, 6.5 million dollars, is associated with movements into the Western sub-region. Only 0.6 million dollars is involved for movements into the Mountain states. Figure 21 represents a diagrammatical presentation of these movements and all other intermarket movements. Unused production within the region totals 634 million pounds or approximately 63 percent of the region's total production.

In the West South Central region, intermarket movement of the resource is common as 54.0 million pounds is transferred between supply

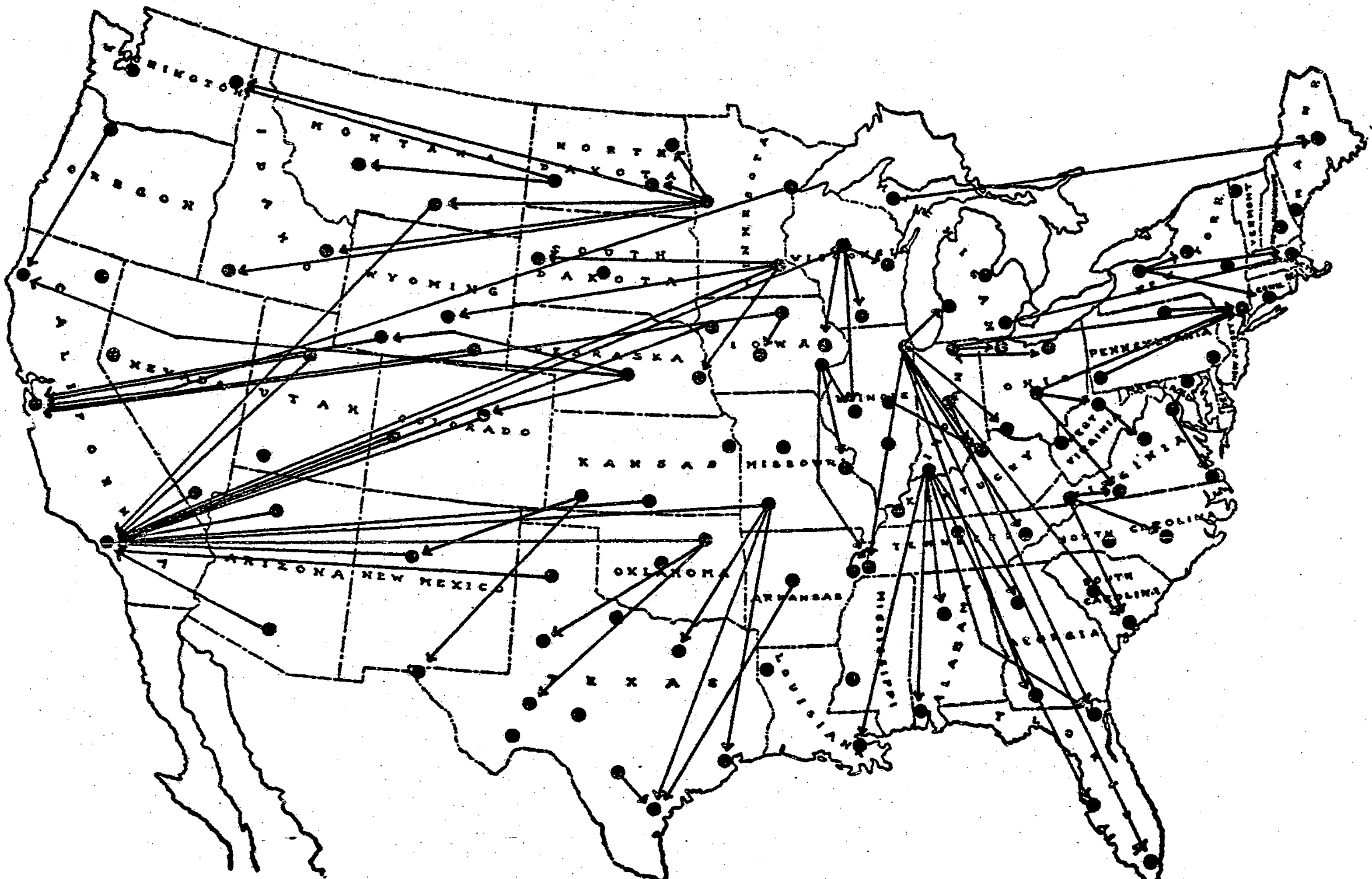

Figure 21. Optimum Flow Patterns of Milk From Production Areas to Processing Facilities, Model III

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 dollars. Milk produced in 11 of 15 production areas is utilized and serves 30 processing facilities throughout the region. Unused production remaining in reserve totals 58 million pounds.

A similar situation exists for the Southern region as for the Western region. Generally, the pricing structure of 15 cents transfer costs plus a base price is such that much of the production 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.

Approximately 331 million pounds of milk is imported from outside sources primarily from the North Central region to meet the consumption needs of the South. Among the production areas of the North Central region to transport to Southern facilities are Evansville (Indiana) serving marketings in Alabama, Georgia and northern Florida; Chicago, transporting to markets in Tennessee, Georgia and Florida; Decatur (Illinois) shipping to Louisville processing facilities; Indianapolis transferring raw milk to South Carolina and northern Florida; Columbus (Ohio) moving milk into the Virginias; and Davenport (Iowa) transporting to Memphis. Within the Southern region, milk produced in the Bristol

(Virginia) area is transported to Danville (Virginia), Raleigh (North Carolina) and Charleston (South Carolina) while Clarksburg (West Virginia) serves facilities in Charlottesville (Virginia). Even though specific instances occur where producers do not participate in the local market, the Southern region utilizes production from 13 of 20 production areas in the least cost market organization. Costs associated with the transportation of 429 million pounds of milk, including 331 million from interregional production areas, are 2.9 million dollars. Of the total product, 328 million pounds (40 percent) are not used in the processing of fluid packaged milk.

The pricing policy assumed in Model III will assure that nearly all milk produced in the North Central region will be used. Of the 27 production areas of this region, production from all 27 regions is utilized in 76 processing facilities within the region and is exported to all regions of the United States. Based on the method of allocating assembly costs, the North Central region, with an assembly cost of 1.1 million dollars, has the second lowest assembly cost among the five regions. Exports from the region total 827 million, nearly depleting all reserves as only 7 million pounds of unused production remained in the region.

This region's involvement in interregional flows of raw milk has been discussed in the regional analysis of the West, Southern and West South Central and need not be reiterated. Interregional activity of flows into the Northeastern region involves movements from production areas located in the East North Central sub-region and includes movements from Columbus (Ohio) to facilities in New York City; South Bend (Indiana) to facilities in New York City; Detroit to facilities in

Bangor (Maine). These transfers from the North Central region to the Northeastern region total 113 million pounds.

The Northeastern region also imports milk from the North Central region as mentioned above. The region also experiences some intraregional activity 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. Production is utilized from 5 of 10 production areas and 1,056 million pounds is shipped to 21 processing facilities located in 9 major consuming markets. Total assembly costs for intraregional and interregional movements of raw milk for the Northeast region totals 3.6 million dollars. 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

In the Western region of the United States, processing capacity of the region is 753 million pounds per month, and the total processing cost is 8.7 million dollars or 1.16 cents per pound. Distribution costs total 131,000 dollars (Table X). Processing functions are carried out in 55 facilities with a regional average volume of 13.7 million pounds. This region has one of the lower levels of capacity with approximately 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 a

TABLE X

SUMMARY STATISTICS OF PROCESSING AND DISTRIBUTION ACTIVITIES, UNITED STATES AND REGIONS, MODEL III

Region	Processing Costs ($1000)	Distribution Costs ($1000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)
Western	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
Northeastern	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	

facility is 5.4 million pounds compared with an average of 26.2 million pounds for facilities established in the Pacific states (Table XI).

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) (Figure 22).

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 regional processing. This interregional activity includes Kansas City supplying the Oklahoma City market; Springfield (Missouri) serving markets in Oklahoma City, and Little Rock; and St. Louis also shipping to the Little Rock market. 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 economies 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 West South Central region are established with combined capacities totaling 377 million pounds. The average size of a facility is 12.6 million pounds, the lowest level of capacity among the major regions. As a result, per unit costs of

TABLE XI

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	
Western	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
Northeastern	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

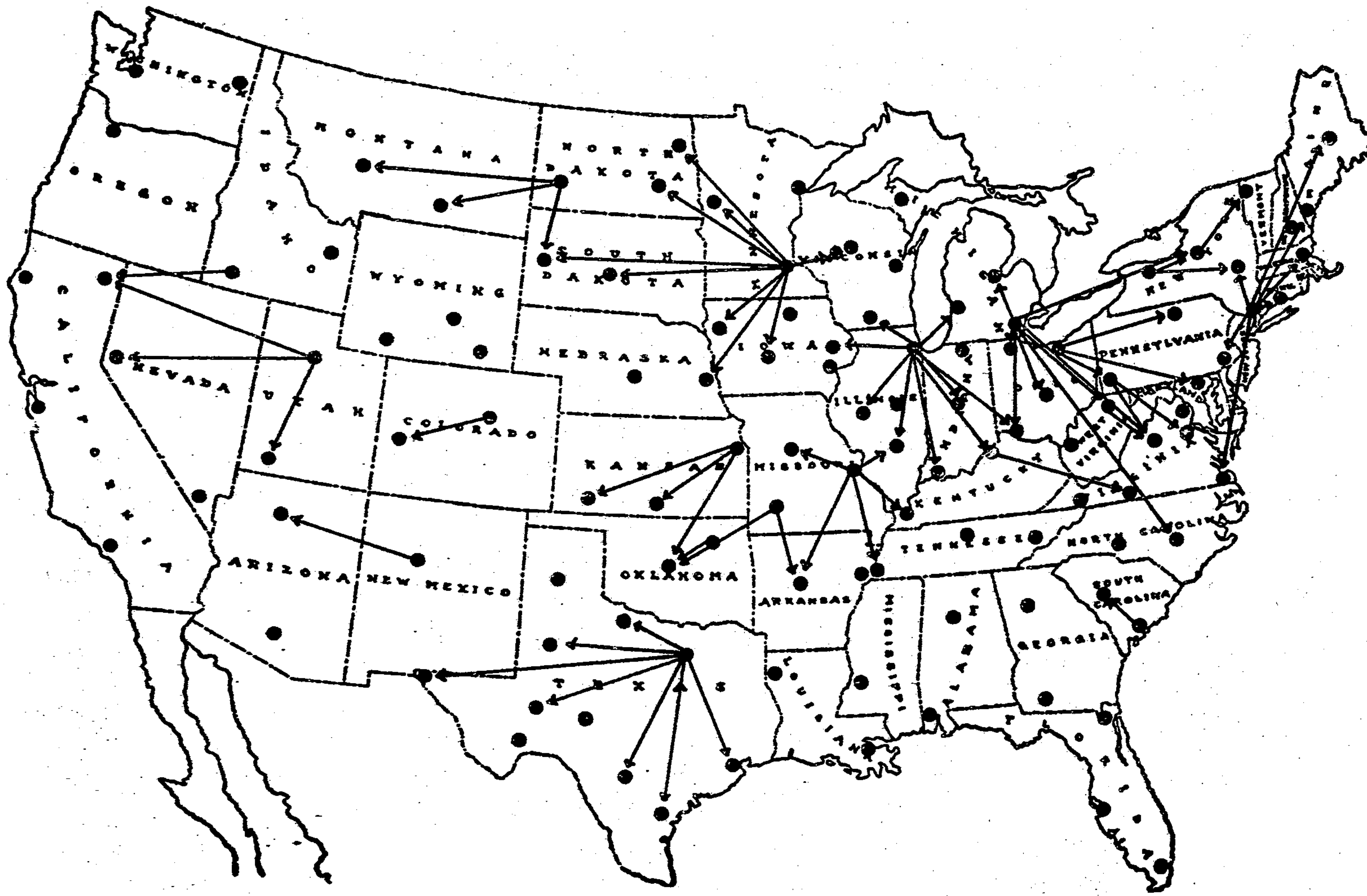

Figure 22. Optimum Flow Patterns of Packaged Milk From Processing Facilities to Market Areas, Model III

processing is the highest of all regions at 1.27 cents per pound. Aggregate processing costs for the region are 4.8 million dollars. Distribution costs are associated only with shipments within the region since no exporting is involved from the region. These costs total 170,000 dollars and represent the cost for intermarket movements of 42 million pounds.

Processing functions in the Southern region consist of 770 million pounds of milk being processed in 55 facilities at a total cost of 9.7 million dollars or 1.26 cents per pound. 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).

In the North Central region, 76 firms are established with processing capacity totaling 1,608 million pounds. Total costs corresponding to the processing functions total 18.6 million dollars at an average cost per pound of 1.16 cents. The distribution costs associated with the intraregional and interregional movements of milk total 1.5 million dollars.

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 intraregional and interregional 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, Michigan, Wisconsin, and Iowa markets; and Minneapolis shipping to markets in the Dakotas, Nebraska, Iowa, Wisconsin and Minnesota.

Within the Northeastern region, processing facilities have a total capacity of 1,169 million pounds. This capacity is an aggregate for 21 facilities operating at an average per pound cost of 1.05 cents or a total cost for the regional processing organization of 12.3 million dollars. Facilities established in this region are the largest of any region and average 50.8 million pounds per facility. As a result, per unit costs are the lowest of any region.

Total distribution costs associated with intermarket activity totals 703,000 dollars. 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 dollars. 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 dollars to the total cost, respectively.

Model IV -- Optimum Restricted Market Organization With Resource Price Structure of a Base Point Price Plus Transfer Costs of 9 Cents Per Unit - Mile

Model IV is designed to determine the optimum market organization when a resource pricing scheme is used which reflects a $3.60 base price paid to farmers f.o.b. plant plus a differential of 9 cents per hundredweight per hundred miles from Eau Claire (Wisconsin). The other assumptions, model organization, basic data, and techniques are the same as in the previous model.

The least cost market organization of the fluid milk industry under the assumptions of Model IV are such that a total organizational cost of 62.1 million dollars is incurred. Contributing to the organizational cost are costs associated with assembly activities totaling 5.5 million dollars in which 1.3 billion pounds of milk are involved in intermarket transport activities. Total capacity of plants established is 4,679 million pounds with total processing cost outlays of 53.9 million dollars or 1.15 cents per pound. The distribution costs associated with the least cost organization is 2.7 million dollars 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

The Western region establishes 55 processing facilities which utilize production from 19 of 20 production areas. To serve these facilities, 432 million pounds of milk are transferred from regional points of production to processing facilities. Local regional production is supplemented with 36 million pounds of milk produced in the North Central region. Costs associated with the assembly activities are 934,000 dollars. Surplus production remaining in the region totals 296 million pounds (Table XII). Los Angeles is the major recipient of raw fluid milk imports from production areas 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 Lubbock (Texas) supplies. Figure 23 represents a diagrammatical presentation of the flow patterns from production areas to processing facilities.

In the West South Central region, production is utilized from 12 of 15 production areas in which 30 processing facilities make use of 365 million pounds of 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

TABLE XII

SUMMARY STATISTICS OF PRODUCTION AND ASSEMBLY ACTIVITIES, UNITED STATES AND REGIONS, MODEL IV

Region	Production: Used (1000 lbs.)	Production: Unused (1000 lbs.)	Assembly Costs ($1,000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)
Western	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 → ESA 27,639 ENC → MA 64,099
Northeastern	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	

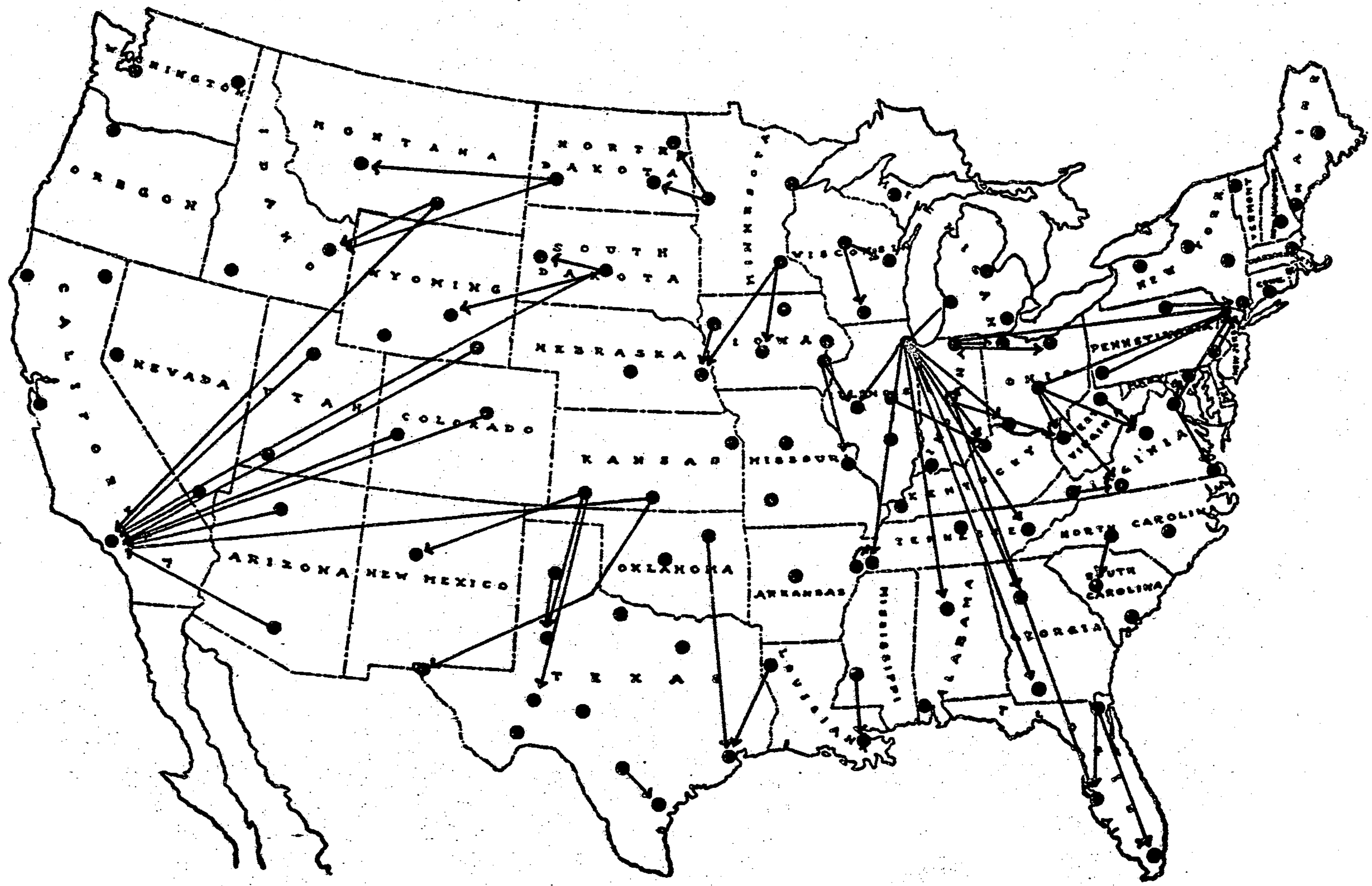

Figure 23. Optimum Flow Patterns of Milk From Production Areas to Processing Facilities, Model IV

212,000 dollars. Within the production areas of the region, 53 million pounds of production remain in reserve.

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).

The Southern region utilized 689 million pounds of raw fluid milk produced in 19 of 35 of its production areas with an additional 90 million pounds imported from the North Central and Northeastern regions. Costs associated with assembly activities total 1.1 million dollars for 308 million pounds which require intermarket movement. Unused production in the region 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 located in the region export milk. These exports include Jackson (Mississippi) shipping to New Orleans and Washington, (D.C.) supplying facilities in New York City plus intraregional movements to Baltimore and Norfolk (Virginia).

The major exporting region is the North Central region with 190 million pounds of regional production moving to all four of the other regions. Production is utilized from 26 of 27 production areas serving 77 local processing facilities with 1,602 pounds of milk per month. Production remaining unused totals 579 million pounds, the largest amount of unused production for the five major regions. Assembly costs total 899,000 dollars 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) shipping to Cleveland and Toledo.

The Northeastern region utilizes 1,080 million pounds of production from all of its production areas. An additional 94.3 million pounds is imported from the Southern and Northern 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 dollars. 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 Philadelphia shipping to New York City.

Processing and Distribution Activities

Intermarket movements of milk for which the organization of the Western region is responsible, totals 16 million pounds and involves no exports of processed milk. Distribution of the final product from points of processing to intermarket destinations accounts for distribution costs of 110,000 dollars in transport charges (Table XIII). 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 includes Helena and Billings (Montana) importing from Dickinson (North Dakota); and Casper (Wyoming) importing from Minneapolis. Figure 24 exhibits the spatial flow pattern of the various intermarket movements.

In the Western region, 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. With the plants operating at various capacities, the total costs are 8.9 million dollars. The average plant capacity is 13.7 million pounds and the average per unit cost is 1.19 cents (Table XIV).

In the West South Central region processors establish 30 processing facilities with a combined capacity of 377 million pounds. Facilities

TABLE XIII

SUMMARY STATISTICS OF PROCESSING AND DISTRIBUTION ACTIVITIES, UNITED STATES AND REGIONS, MODEL IV

Region	Processing Costs ($1000)	Distribution Costs ($1000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)	
Western	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
Northeastern	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		

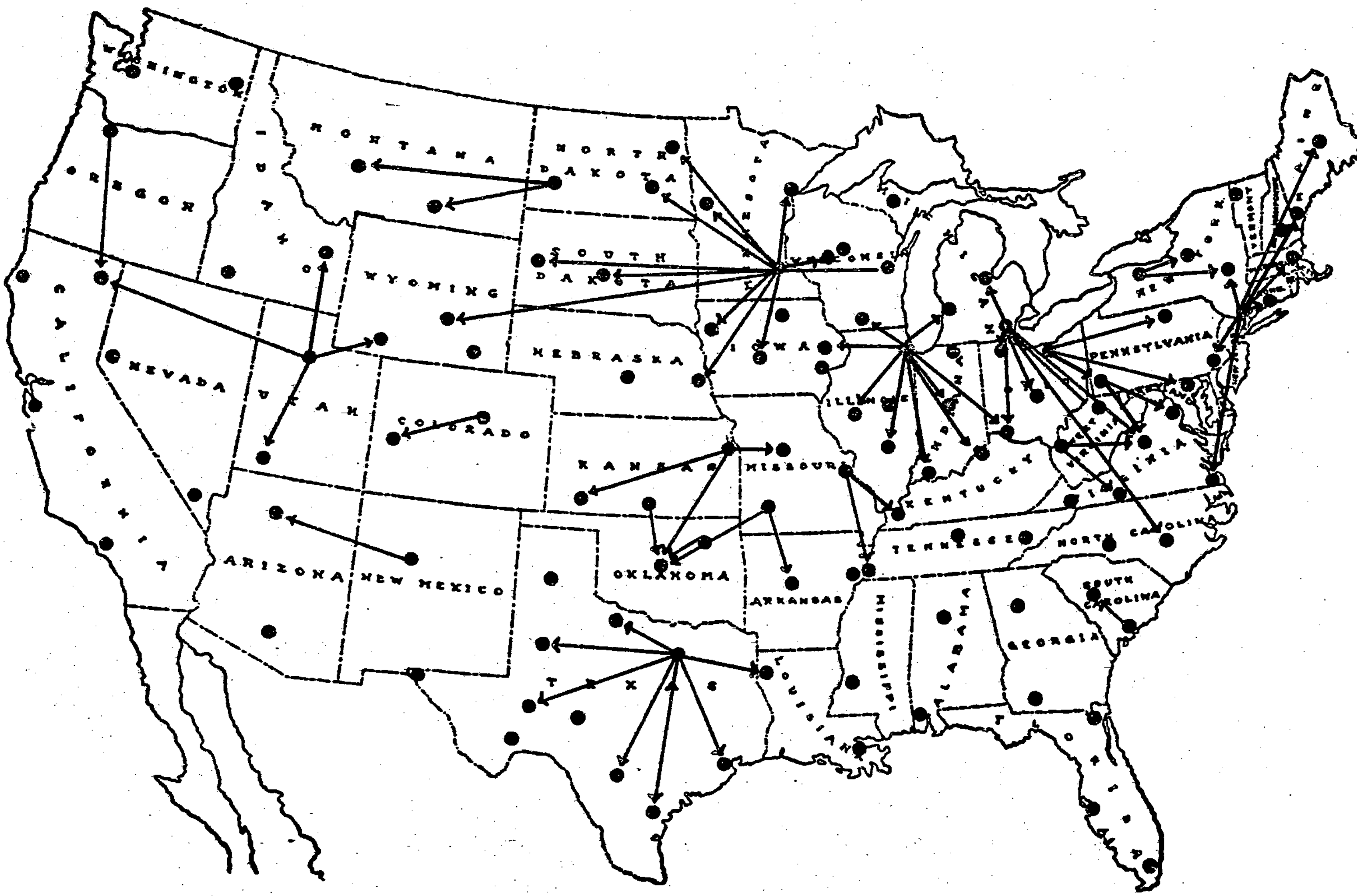

Figure 24. Optimum Flow Patterns of Packaged Milk From Processing Facilities to Market Areas, Model IV

TABLE XIV

DISTRIBUTION OF FIRMS BY SIZE AND REGION, 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 Processing Facility in Millions of lbs.
			Under 3	3 to 10	10 to 25	25 to 50	50 to 100	100 to 200	200 +	Total	
Western	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
Northeastern	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

established in this region are the smallest of all regions averaging 12.6 million pounds per plant. The facilities operate at a total monthly expenditure of 4.7 million dollars and an average cost per pound of 1.26 cents. Intermarket distribution of the final product to central distribution outlets totals 40 million pounds and originates from Tulsa and Dallas. The Dallas-based facilities involves supplemental movement to eight of nine Texas distribution outlets and also serves the Shreveport (Louisiana) market. Tulsa transports the final product to Oklahoma City. Distribution charges for intermarket movements within the West South Central region are 163,000 dollars. The Oklahoma City market attracts processed milk from interregional origins of Wichita (Kansas), Kansas City and Springfield (Missouri). Springfield (Missouri) also serves Little Rock.

The Southern region is an importer of processed milk with 78 million pounds moving into the region from the Northeastern and North Central regions. Interregional movements include: St. Louis shipping to Paducah (Kentucky) and Memphis; Chicago supplying Louisville; Detroit serving Clarksburg (West Virginia), Charlottesville (Virginia) and Raleigh (North Carolina); and Cleveland transporting to Pittsburgh, Baltimore, and Williamsport (Pennsylvania). In addition to these supplemental imports, the region is operating with a combined capacity of 772 million pounds within 54 processing facilities. The operation of these facilities at this level generates an aggregate cost of 9.7 million dollars at an average of 1.26 cents per pound. The region has the least amount of intraregional distribution of the final product with only two markets involved in penetrating new markets. 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 dollars.

The North Central region established the largest number of facilities of any region within the analysis, 77 facilities. These facilities have an average volume of 20.8 million pounds and a total capacity of 1,602 million pounds. Total operating expenses are 18.3 million dollars or an average cost of 1.14 cents per pound. Intermarket activity, both within the region and to other regions, consists of 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 the 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 dollars.

Processing in the Northeastern region has the lowest per unit cost of all regions. On a per pound basis, average processing costs are 1.05 cents per unit. This represents a per unit cost of 0.11 cents lower than any other region. This lower cost reflects the influence of the economies generated by large facilities within the Mid-Atlantic sub-region where the average facility processes 61.7 million pounds per month. In this sub-region, per unit costs are 1.04 compared with 1.12 for the New England sub-region. Facilities located in New York City and Rochester (New York) utilize the largest processing facilities possible within the organization. New York City, with its exporting facility, can serve many markets that would require the establishment of less efficient plants; however, the population concentration and the compactness of the geographical area allow the expansion of these facilities to accommodate regional markets.

Operating at 1,175 million pounds of capacity, regional facilities generate a total monthly cost of 12.2 million dollars. 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. These interregional movements have been pointed out earlier as to points of origin and destination. Distribution costs associated with 280 million pounds of intermarket shipments originating in the Northeastern region are 950,000 dollars.

Facilities in the Northeastern region which are involved in intra-regional 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.

Total organization costs for all market activities represented in the analysis were 62.1 million dollars. The regional organizations of the West, West South Central, Southern, North Central and Northeastern regions contribute 10.0, 5.1, 11.0, 20.5 and 15.5 million dollars, respectively, to the total cost of the entire organization.

Model V -- Optimum Restricted Market Organization With Equal Resource Prices

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 (base-point pricing is not practiced). The basic structure, data and operative conditions of the model as in the previous models of this chapter.

The least cost market organization for the fluid milk industry utilizes 4,679 million pounds of production from 89 of 92 production regions. Of the total production utilized, 1,179 million pounds require movements to accommodate the needs of processing facilities. Costs associated with movements from production areas to processing facilities total 3.6 million dollars per month. The optimum organization calls for the establishment of 250 facilities with an aggregate capacity of 4,679 million pounds. Operating at an average capacity of 18.8 million pounds, 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 total monthly cost of 1.9 million dollars.

Production and Assembly Activities

The least cost organization in the Western region of the United States utilizes production from 18 of 20 of the production areas, serving 54 processing facilities within the region (757 million pounds of production) while maintaining reserves of unused production totaling 257 million pounds (Table XV). Intermarket transportation of 370 million pounds requires cost outlays of 414,000 dollars. Figure 25 illustrates diagrammatically the intermarket movements in the optimum solution of the model. The region is a net exporting region with 2 million pounds of production being exported from Albuquerque to El Paso.

Some intermarket shipments 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 in Helena (Montana) and Reno (Nevada) transports milk to Alturas (California).

The West South Central region is characterized by an organization in which production is utilized from all 15 of its production areas. Production from these areas serves 30 processing facilities operating with a combined capacity of 380 million pounds. In addition to domestic needs, the region experiences a net inflow of imports over exports of 23 million pounds of milk. Within the region, Texas production requires some relocation to supply processing facilities as production

TABLE XV

SUMMARY STATISTICS OF PRODUCTION AND ASSEMBLY ACTIVITIES, UNITED STATES AND REGIONS, MODEL V

Region	Production Used (1000 lbs.)	Production Unused (1000 lbs.)	Assembly Costs ($1,000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)
Western	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
Northeastern	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	

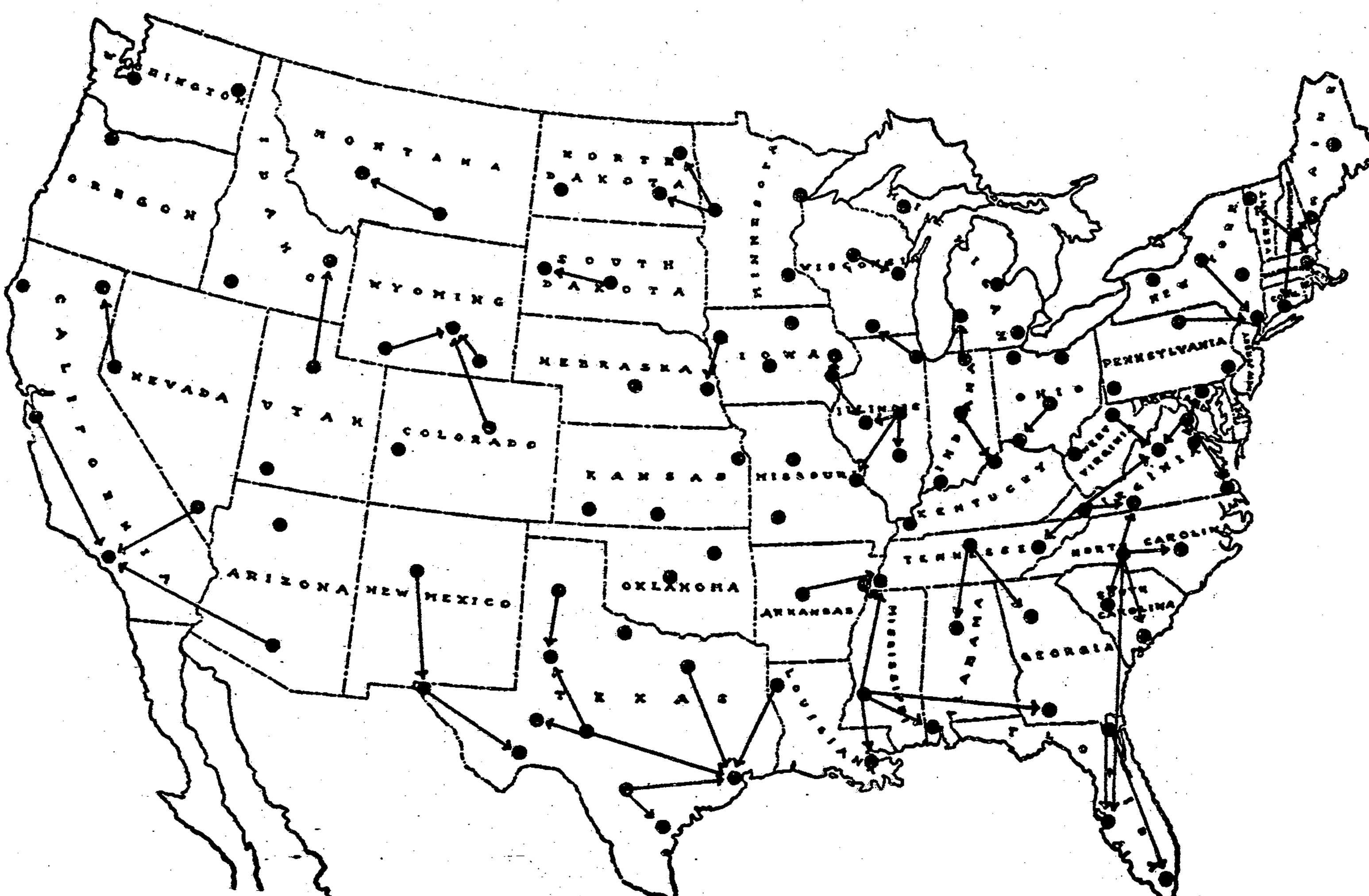

Figure 25. Optimum Flow Patterns of Raw Milk From Production Areas to Processing Facilities, Model V

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.

Production in the Southern region is used quite extensively as all 20 of the region's production areas supply a proportion of their production to 60 facilities located throughout the South. 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 is 863,000 dollars.

Intraregional movements from location of production to location of consumption involve six southern 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).

In previous models, the North Central region was responsible for significant quantities of raw fluid milk being transported out of the region; however, under the assumptions of this model, facilities located in only one interregional market is supplied from this region. The flow consists of 35 million pounds of fluid milk shipped to Louisville from Indianapolis. Production within the region is utilized from 26 of 27 production areas supplying 75 regional processing facilities (Table XV) with 1,512 million pounds of fluid milk. Unused production totals 859 million pounds or 36 percent of the total production.

Intermarket movements totaling 190 million pounds of milk within the region requires transportation outlays of 456,000 dollars. Intermarket movements of milk within the region 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.

The least cost organization, as it relates to production and assembly, involves all 10 of the Northeast's production areas at some level supplying 31 processing facilities with an aggregate capacity of 1,201.7 million pounds. The region is involved in no importing or exporting activities. Intermarket shipments of 548 million pounds are required within the region to assure an adequate supply to all processing facilities. These shipments cost 1.8 million dollars in transport charges. 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.

Transportation of raw fluid milk from production areas to processing facilities includes: New York City imports from Utica (New York) and Williamsport (Pennsylvania); and Concord (New Hampshire) exports to Burlington (Vermont), Portland (Maine), Boston and Hartford.

Processing and Distribution Activities

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 XVI). This entire capacity is utilized in meeting region demands with the exception of .9 million pounds moving from processing facilities at Phoenix (Arizona) to El Paso (Texas). At this level of operation, total cost per month for processing functions totals 8.9 million dollars and an average per unit cost of 1.19 cents. These facilities operate at an average volume level of 14.0 million pounds. Intermarket transportation of the final product is required with 23 million pounds moving between intraregional markets and to export markets. Costs of distribution associated with these movements total 111,000 dollars (Table XVII).

Intermarket movements from locations of processing to distribution outlets which require transportation 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

TABLE XVI

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	
Western	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
Northeastern	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 XVII

SUMMARY STATISTICS OF PROCESSING AND DISTRIBUTION ACTIVITIES, UNITED STATES AND REGIONS, MODEL V

Region	Processsing Costs ($1000)	Distribution Costs ($1000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)	
Western	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
Northeastern	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		

Alturas (California); Phoenix transporting fluid milk to El Paso and Flagstaff (Arizona); Denver supplementing distribution outlets in Casper (Wyoming) Spokane (Washington) serving Helena (Montana) (Figure 26).

The West South Central region has processing facilities at two locations which are involved in intramarket transfers of processed milk in the optimum organization. These facilities include: Tulsa supplying the Oklahoma City market; and the Dallas facilities shipping to the Texas markets of Wichita Falls, Lubbock, Odessa, San Antonio, Corpus Christi and Houston plus movements to Oklahoma City and Shreveport (Louisiana). These movements constitute 41 million pounds and the transportation and the associated distribution cost totals 161,000 dollars.

Within the West South Central region, 30 processing facilities are operative with capacities totaling 380 million pounds. Processing facilities in this region are the smallest of all regions and average 12.7 million pounds per facility. Processing costs associated with this organization totals 4.8 million dollars per month at an average cost per pound of 1.27 cents. 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. Import movements include: Wichita (Kansas) supplying Oklahoma City; and Springfield (Missouri) transporting to Little Rock. The region is involved in no export activities.

In the Southern region, the optimum market organization involves the establishment of 60 processing facilities with a combined total capacity of 831 million pounds. Operating at an average level of 13.8

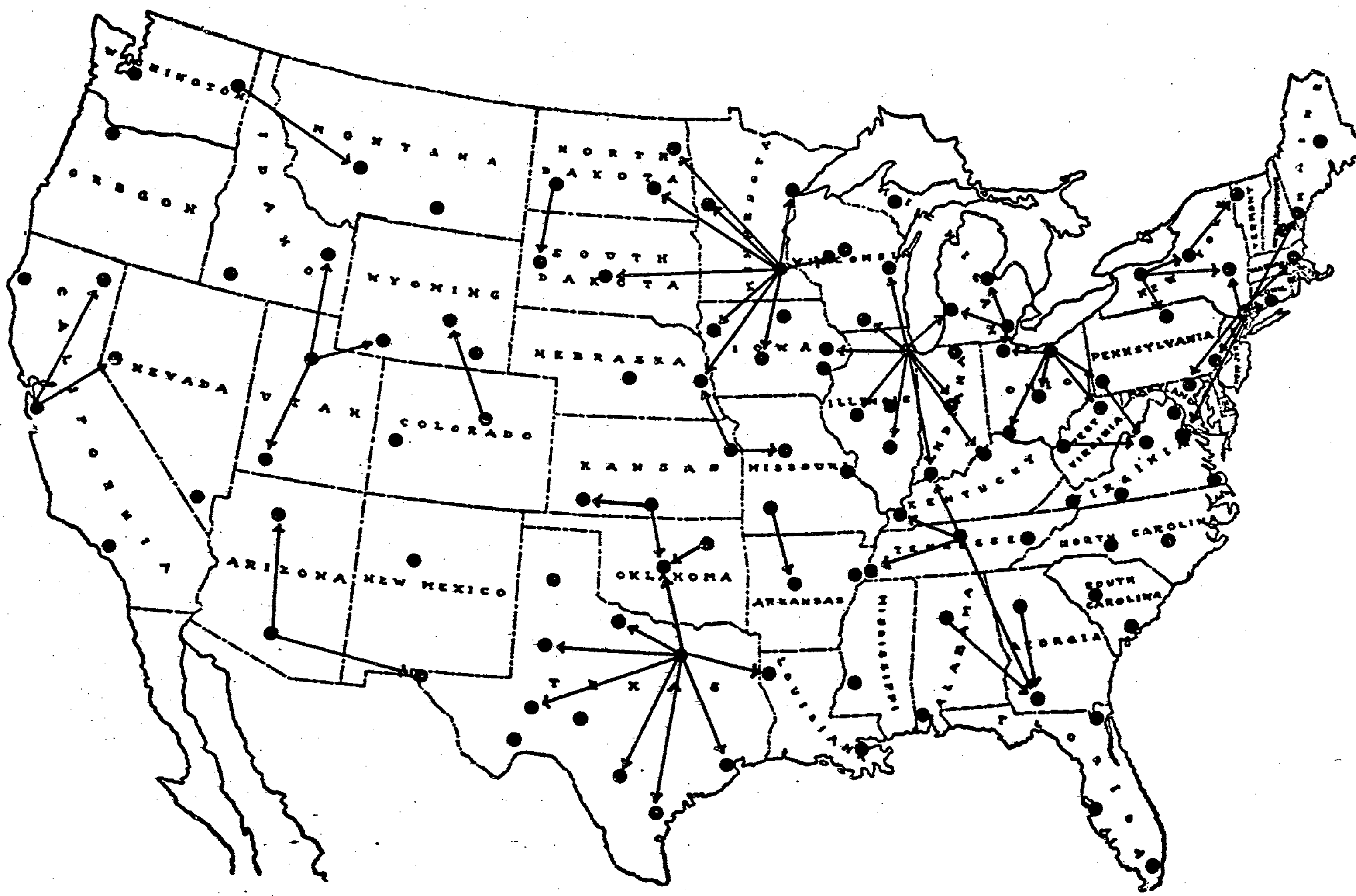

Figure 26. Optimum Flow Patterns of Packaged Milk From Processing Facilities to Market Areas, Model V

million pounds, these firms generate a total monthly cost of 10.5 million dollars or an average cost per pound of 1.26 cents. In addition to the levels of processing within the region, Southern markets have a net flow into the region of 19 million pounds from facilities located in the North Central and Northeastern regions. Exports from these regions 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 intermarket 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 totals 116,000 dollars.

The North Central region is characterized by an optimum organization in which 75 processing facilities are established. These facilities are operative at an average capacity of 20.2 million pounds and an average per pound cost of 1.17 cents. As a result of the organization of the industry in this region, distribution costs of 986,000 dollars are required for transporting processed fluid milk into central distribution outlets. 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.

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

In the Northeastern region, the optimum organization consists of 31 processing facilities operating with total processing cost outlays of 12.9 million dollars at an average cost per pound of 1.07 cents. Facilities established in this region operate at the largest average volume of all regions, 40.1 million pounds. 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. This quantity, however, is supplemented by imports totaling eight million pounds. Total intraregional and interregional transshipments which originate at processing facilities located within the region total 169 million pounds. Distribution costs associated with these movements add 502,000 dollars to the total cost of the market organization.

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.

Total costs for all the combined activities of the optimum organization are 9.5, 5.1, 11.4, 19.1 and 15.2 million dollars for the Western, West South Central, Southern, North Central, and Northeastern regions, respectively. Total costs for the optimum market organization for the nation is 60.3 million dollars.

Model VI -- Minimum Cost Flow Model Using 1965 Resource Prices and 1963 Market Structure

Model VI was formulated to determine the minimum cost flow through the marketing channels of the market organization as it existed in 1963 with the 1965 farm price structure. 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 but for given capacities. The capacities reflect the distribution and average size of firm in the 1963 organization. Firm numbers and employment figures used to compute capacities were obtained from the census of manufacturing.[1] Processing was restricted to processing local demand, and an additional 20 percent over domestic needs was allowed to serve 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 1963. All other assumptions, basic data on production and consumption, and cost functions are consistent with the previous models.

Producers of 69 of the 92 production areas allocated 4,679 million pounds for processing facilities in the optimum market organization of Model VI. To adequately supply all processors 1,907 million pounds were transported from local production areas to distant processors. Costs of assembly related to these movements was 11.6 million dollars or approximately 14 percent of the total organizational costs. The processing functions were performed in 4,595 facilities (average size 1.0 million pounds) at cost outlays of 71.4 million dollars or 85 percent of the total marketing costs. To meet the demand requirements of all markets, 225 million pounds of packaged milk were involved in intermarket activity. Distribution costs were 755,000 dollars and represented approximately one percent of the total costs of the organization.

Production and Assembly Activities

Producers in the Western region provide 693 million pounds (68 percent of the region's total production) for movement into processing facilities (Table XVIII). This production is obtained from 16 of the 20 production areas. 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 (Figure 27). Imports originate in the North Central region and include: Dickinson (North Dakota) supplying Helena (Montana), Billings (Montana) and Idaho

TABLE XVIII

SUMMARY STATISTICS OF PRODUCTION AND ASSEMBLY ACTIVITIES, UNITED STATES AND REGIONS, MODEL VI

Region	Production: Used (1000 lbs.)	Production: Unused (1000 lbs.)	Assembly Costs ($1,000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)
Western	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
Northeastern	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
Total	4,678,710	1,830,423	11,647	911,370	911,370	

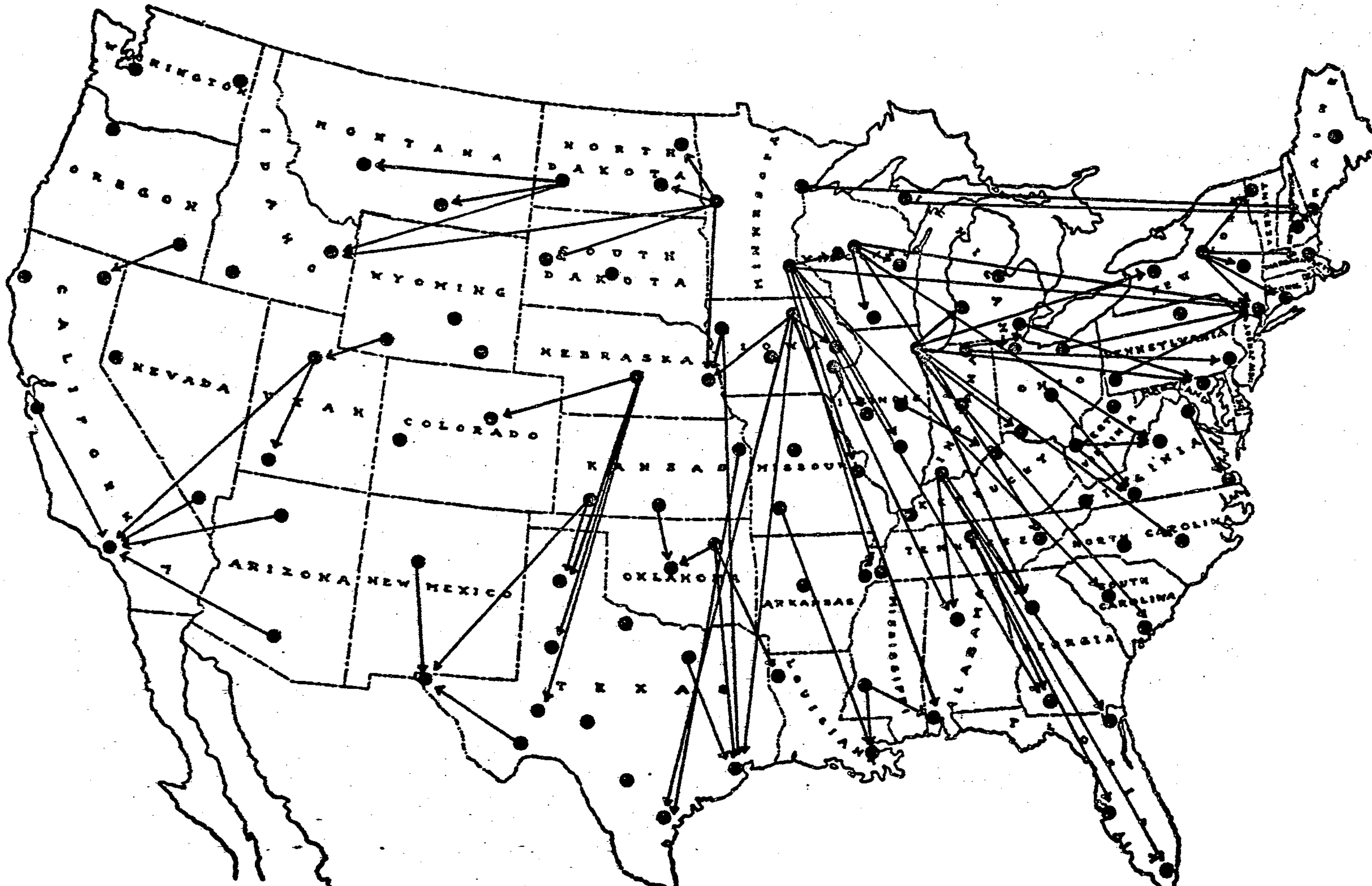

Figure 27. Optimum Flow Patterns of Raw Fluid Milk From Production Areas to Processing Facilities, Model VI

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 dollars.

The West South Central region allocates 63 percent (262 million pounds) of its production from 10 of 15 production areas to serve processing 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 dollars in assembly costs.

Producers in the Southern region are affected significantly by the relatively high prices of 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 of resources with 22 million pounds exported and 415 million pounds shipped into the region. Export activities consist of Jackson (Mississippi) shipping to New Orleans. 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 dollars.

Production in the North Central region is nearly all utilized; only 2 million pounds are unused. Resources are used from 26 of 27 production areas and total 2,404 million pounds. Of this total utilization, 881 million or 27 percent is exported to interregional markets in the form of raw fluid milk. Interregional movements have been discussed except for the Northeast. Exports into the Northeastern region 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 dollars.

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 all other regions. The largest percentage results in part from the relatively higher resource 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 1963 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 dollars.

Processing and Distribution Activities

Within the Western region 645 processing facilities operate at 753 million pounds of capacity or an average of 1.2 million pounds per plant. Total processing costs are 10.7 million dollars and average 1.43 cents per pound, the lowest per unit processing cost of any region. Intraregional movements of the final product total 13 million pounds 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 Flagstaff (Arizona). Distribution costs associated with these movements total 51,000 dollars (Table XIX).

TABLE XIX

SUMMARY STATISTICS OF PROCESSING AND DISTRIBUTION ACTIVITIES, UNITED STATES AND REGIONS, MODEL VI

Region	Processing Costs ($1000)	Distribution Costs ($1000)	Imports (1000 lbs.)	Exports (1000 lbs.)	Export Region and Quantity (1000 lbs.)
Western	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
Northeastern	18,290	33	27,119	0	
Mid-Atlantic	13,740	29	27,119	8,259	MN → NE 8,259
New England	4,550	4	8,259	0	
Total	71,382	755	41,022	41,022	

Figure 28 represents a diagrammatical presentation of the flow patterns of the least cost solution of Model VI. The general lack of movement of packaged fluid milk is the influence of two factors. 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 1963 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.

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 dollars. 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 dollars.

The Southern region imports 11 million pounds of processed milk from the North Central region. St. Louis ships to Paducah (Kentucky) and Columbus (Ohio) transportings to Clarksburg (West Virginia). The processing of 839 million pounds of regional production involves 587 firms. Total processing costs are 6.1 million dollars and the average per pound cost is 1.54 cents. Intraregional shipments of 4 million pounds include Baltimore serving Richmond (Virginia) and Charleston

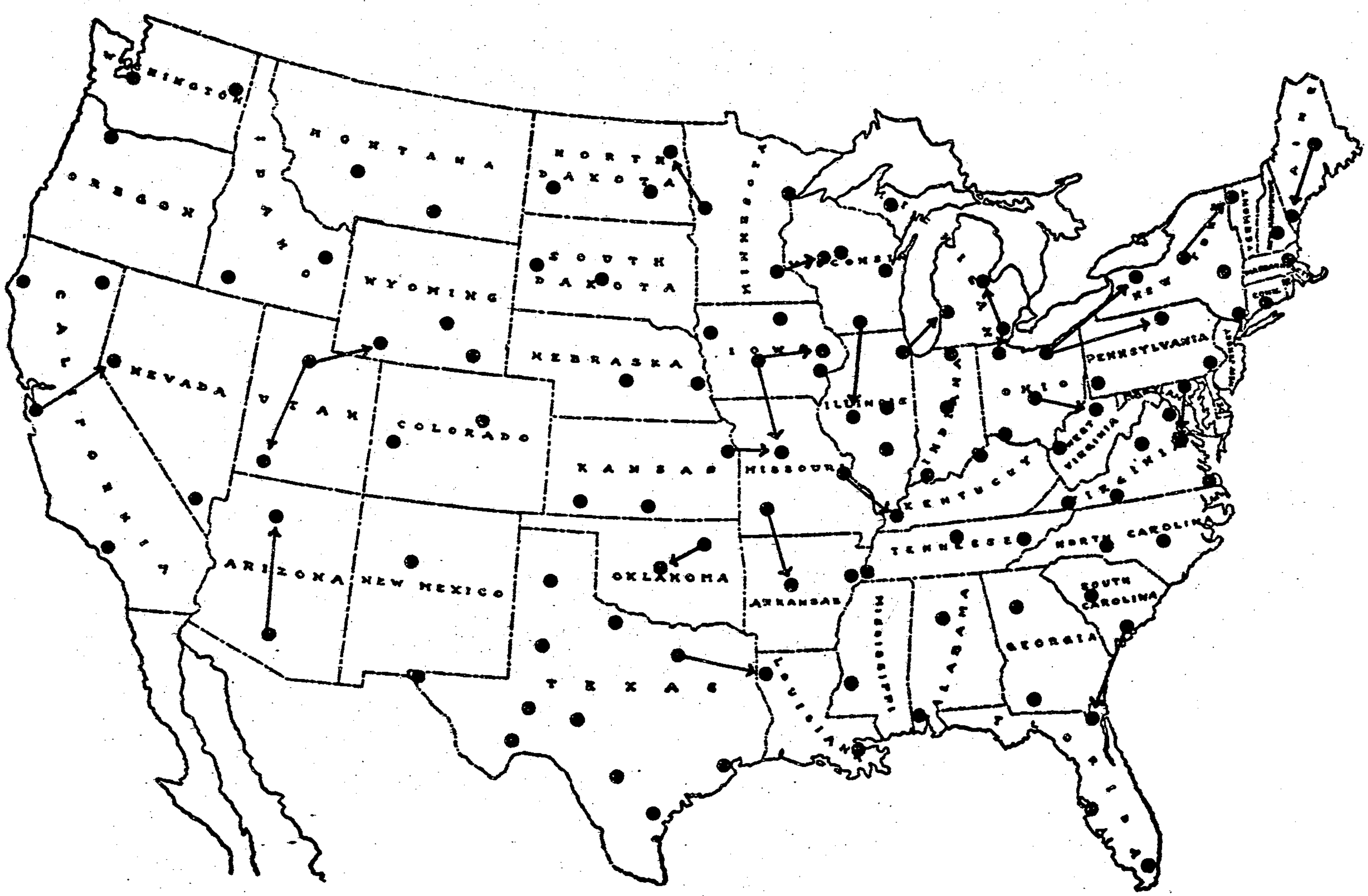

Figure 28. Optimum Flow Patterns of Packaged Milk From Processing Facilities to Market Areas, Model VI

(South Carolina) supplying Jacksonville (Florida). Distribution costs associated with intraregional movements and imports total 57,000 dollars.

Processing in the North Central operates at a level of 1,523 million pounds. Total processing costs are 23.4 million dollars and the per pound cost is 1.53 cents. The processing is carried out in 1,524 facilities averaging 1.0 million pounds of milk per month. 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 involves: Moorehead (Minnesota) 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 dollars.

The Northeastern region processes 1,168 million pounds in 1,608 facilities at total cost outlays of 18.3 million dollars or 1.57 cents per pound. Regional processing is supplemented by 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 is 33,000 dollars.

Total costs for all the market activities of the optimum organization are 11.6, 17.2, 7.4, 25.2 and 22.4 million dollars for the Western, West South Central, Southern, North Central, and Northeastern regions, respectively. Total cost for the optimum market organization for the nation is 83.8 million dollars.

Effects of Alternative Levels of Transfer Costs

Three models were formulated to determine market organizations under alternative resource pricing structures. These models were developed because they depicted the type of pricing techniques used in the industry. An analysis of the organizations based on these pricing alternatives is particularly important in the production and assembly sectors of the industry. The adoption of a pricing policy which did not reflect actual production conditions could jeopardize the competitive position of producers in certain geographical areas.

The models compared were similar with the exception of transfer costs. Since the only difference between models involves resource pricing, the comments made here will emphasize the influences upon the production and assembly sectors due to their direct relationship. 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, were not greatly different with or without an adjustment of consumption to price. The comparisons for Model IV are included in Appendix V.

Figure 29 illustrates the export-import position of each region by model. Under the assumptions of Model III (15 cent transfer cost), only two regions were involved in exporting raw fluid milk. The North Central region dominated interregional movements transporting 826

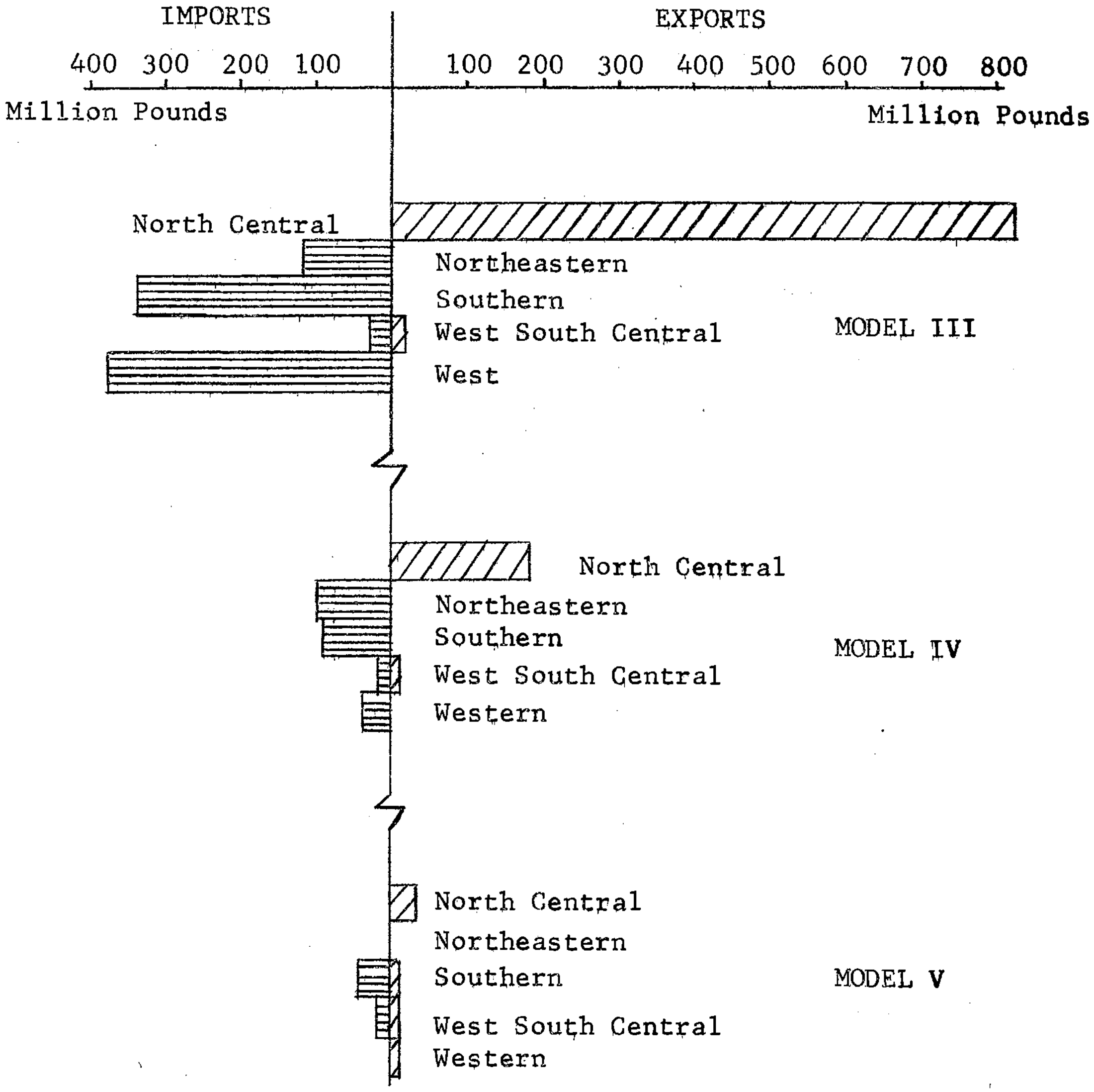

Figure 29. Quantities of Raw Fluid Milk Imported and Exported by Region, Models III, IV and V

million pounds to distant markets. The West South Central region exported 19 million pounds. The Northeastern, Southern, West South Central and Western regions imported 113, 331, 27, and 373 million pounds, respectively.

Interregional flows decreased to 234 million pounds under the assumptions of Model IV (nine cent transfer cost). Exports from the North Central region declined to 189 million pounds. The Southern and West South Central accounted for exports totaling 39 and 6 million pounds, respectively. Imports of 94, 90, 15 and 35 million pounds were required by the Northeastern, Southern, West South Central, and Western regions, respectively.

The organization of Model V (no base-point pricing schemes...resource prices are the same in all production areas) reflected the most efficient use of resources among regions. Exports declined to 54 million pounds and consisted of movements from the North Central (35 million pounds), Southern (9 million pounds), West South Central (8 million pounds) and Western (2 million pounds) regions. These exports flowed into the Southern (43 million pounds) and the West South Central (11 million pounds) regions.

Quantities of unused production by regions also varied as alternative resource pricing schemes were assumed. Generally the trend was toward decreased quantities of excess production in all regions as Model III to V were considered with the exception of the North Central region (Figure 30). The North Central region experienced increases in unused production from 7 to 579 to 859 million pounds under the assumptions of Model III, IV and V, respectively. On the other hand, the Western region's unused production decreased from 634 million pounds to

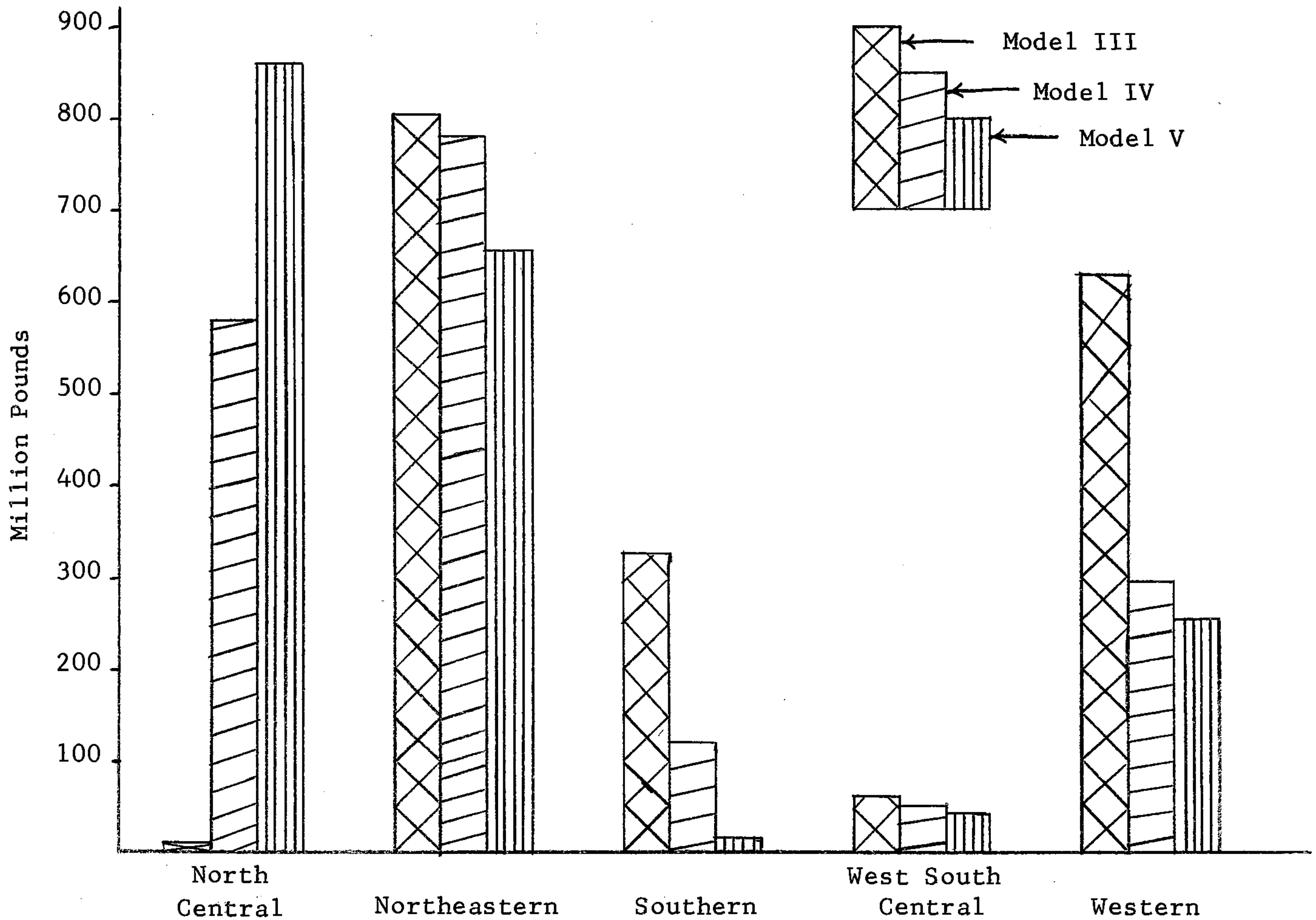

Figure 30. Quantities of Unused Production by Region, Models III, IV and V

296 million pounds in Model IV and to 257 million pounds in Model V. Similar decreases were evident in the Southern, West South Central and Northeastern regions.

The number of production areas involved in the optimum market organization reflected similar results. In Model V, production was utilized from 89 of the 92 production regions. But, as pricing differentials were increased to nine cents, the number of production areas in the organization declined to 86 and at the 15 cent differential, further declines were experienced to 71.

The cost components (assembly, processing, distribution and total costs) associated with Models III, IV and V are illustrated in Figure 31. The most volatile cost component in the organizations was the assembly costs. As a result of altering transfer costs between models and associated shifts in quantities of intermarket movements, assembly costs were 15.1, 5.5 and 3.6 million dollars for Models III, IV and V, respectively.

The processing and distribution sectors of the market organizations were not nearly as sensitive to changes in resource pricing as the production and assembly activities. Processing costs totaled 54.2, 53.9 and 54.8 million dollars for Models III, IV, and V. Distribution costs totaled 2.6, 2.7, 1.9 million for Models III, IV and V.

A comparison of total organizational costs also reflected changes between models. Total costs were 71.8, 62.1 and 60.3 million dollars under the assumptions of Models III, IV and V, respectively. If assembly costs were subtracted from these totals, the remainders, representing other marketing functions, totaled 56.7, 56.6, and 56.7 million dollars for Models III, IV and V, respectively. This reflects the

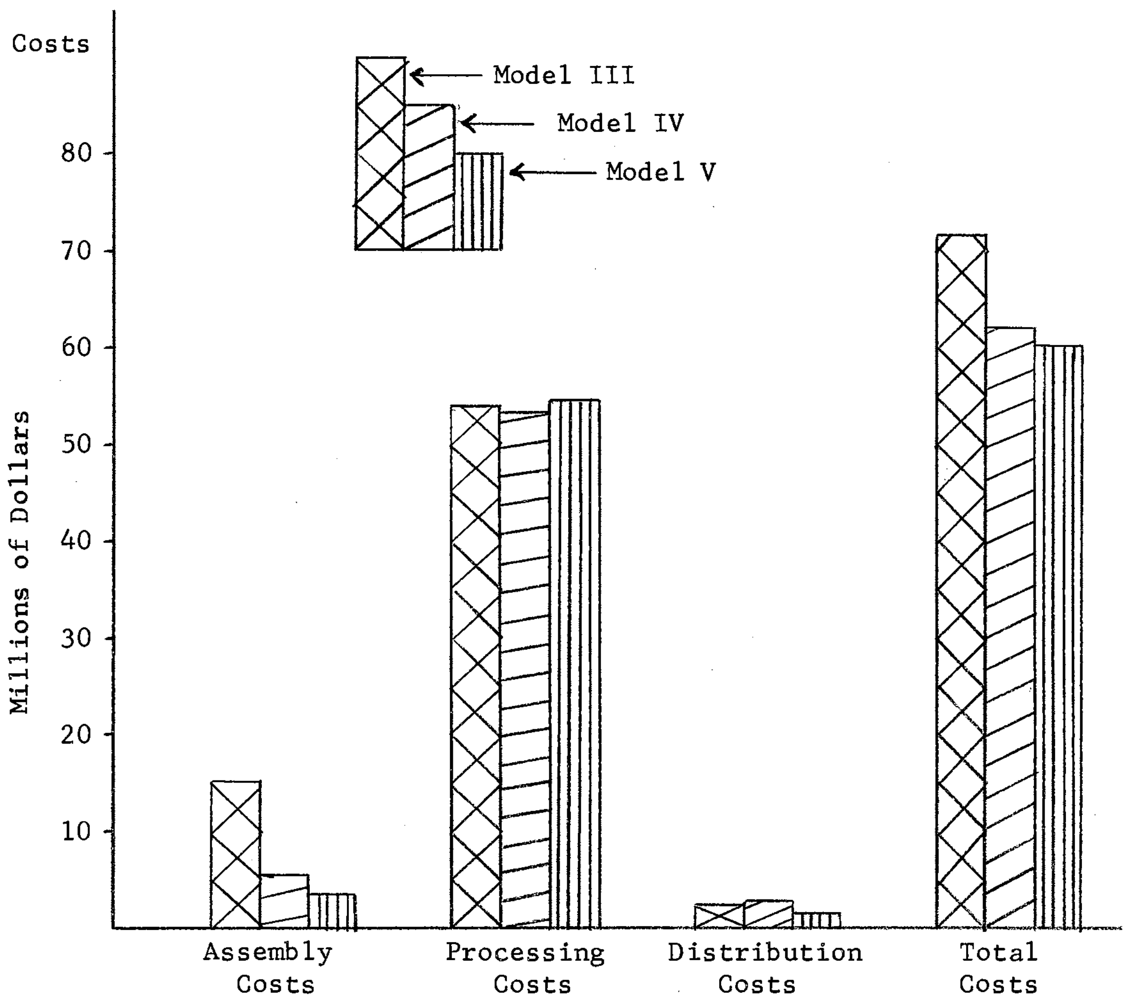

Figure 31. Assembly, Processing, Distribution and Total Costs, Models III, IV and V

stability in the processing and distribution sectors subject to changes in resource pricing levels. Most variations in total organizational costs were the result of the sensitivity of assembly functions to resource price changes.

In general, the production and assembly activities were 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 increased, the production in many distant markets from the base point was 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 cents per hundredweight per hundred miles); (2) as the differential was increased, resource procurement areas became increasingly skewed toward the base point; (3) as the differential increased, producers in the North Central region benefited 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 increased, the transportation industry benefited 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 indicated the displacement of production in distant areas by production in the Mid-Western states. A policy reflecting a pricing structure as the one experienced 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).

The justification of a pricing structure as those illustrated in Models III, IV and V is that variations in production costs exist across the United States. Transfer costs can only be effectively used up to the cost of transportation costs. As a result, a 15 cent differential is too high because it exceeded the transport cost. On long distance shipments transport costs were approximately 10 cents per hundredweight. The 9 cent differential was under the transport costs and approached the total cost figure when a constant pricing structure was used. The most desirable differential would depend upon the actual production costs of the various areas of production.

Effects of Market Restrictions

Models I and V

The purpose of this section is to examine the variations in the spatial organization which occur when assumptions regarding the economic environment were pro-monopoly versus pro-oligopoly. It has been argued that if regulatory action is taken which prevents the monopolization of an industry in a given market, the spatial organization will be influenced. More specifically, the location of processing facilities may shift as a result of more firms being forced into the organization of an industry. Models I and V were constructed such that this type of comparison could be made. These models were similar except Model I had no restrictions involving size of processing facility while Model V was restricted to the establishment of more processing facilities in any given market.

Models I and V 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.

Model I was characterized by an organization in which 64 processing facilities were established. In Model V the number of firms increased by 186 to 250 facilities. The distribution of firms by size classification is illustrated in Figure 32. In Model I, the most commonly established facility was in the 25-50 million pound range (22 facilities were established within this range). The most common sized facility established in Model V was in the 10-25 million pound range (91 facilities were established). Of the total firms established in Model V (250), 201 of these facilities were less than 25 million pounds.

Firm capacities averaged 73.1 million pounds in Model I compared with 18.8 million pounds in Model V. Processing functions were carried out at costs of 0.98 cents per pound versus 1.17 cents per pound for Models I and V, respectively.

Distribution activities were also influenced by the organization. Quantities involved in intermarket transfers totaled 1,152 and 578 million pounds for Models I and V, respectively. Transportation costs associated with these movements declined from 3.8 million dollars in Model I to 1.9 million dollars in Model V. Decreases experienced in distribution activities and costs of Model V were the result of increased processing in local areas. Firms were restricted in size and the necessary economies needed to offset transport costs to distant

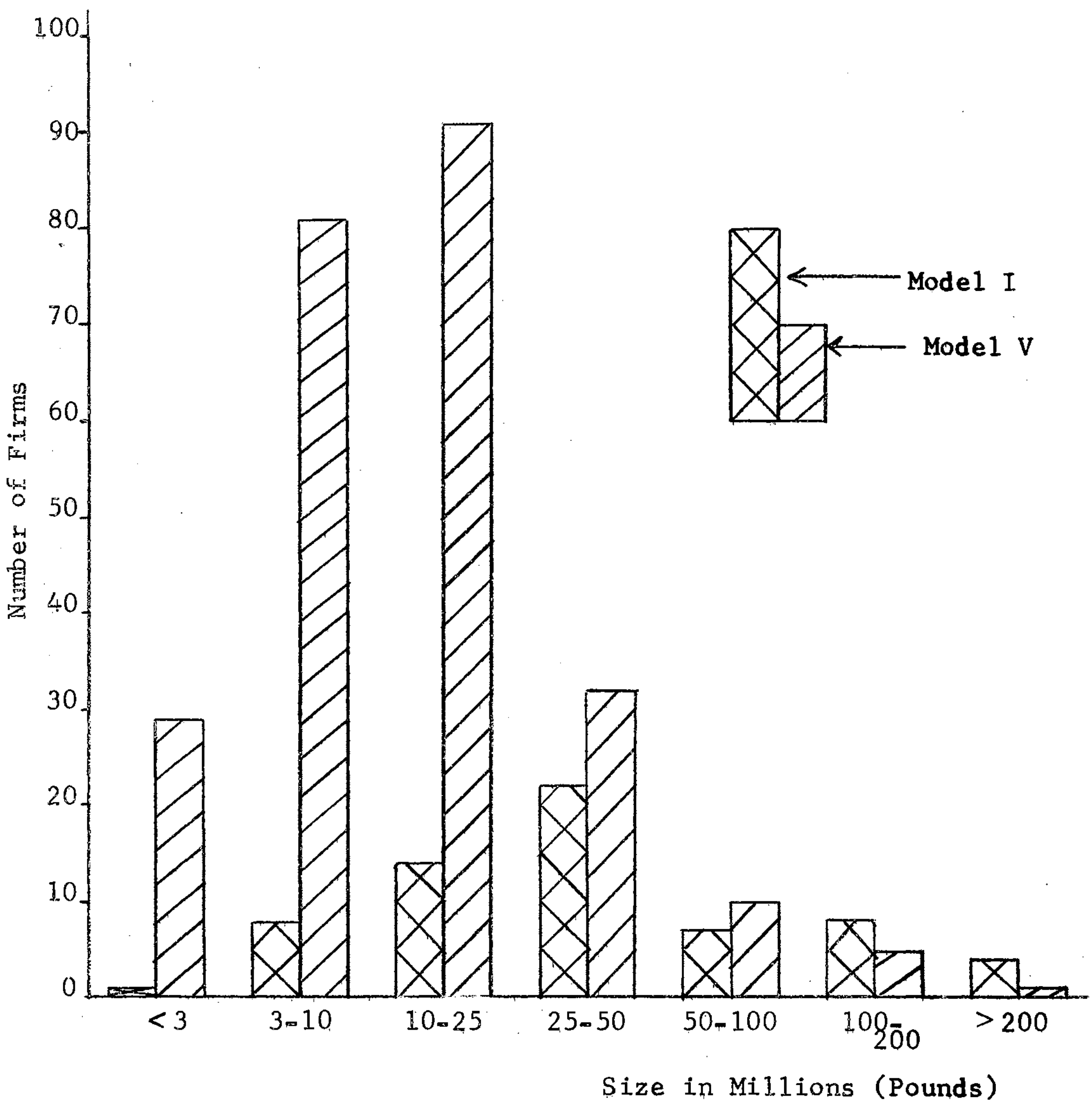

Figure 32. Distribution of Firm Size, Models I and V

markets were not attained. However, an interesting phenomenon occurs in the flow patterns of packaged milk. In Model I, 49 markets imported packaged milk. In Model V, 69 markets were involved in the importation of packaged milk but total intermarket movements were approximately 50 percent of those in Model I. This was apparently the influence of the structure of the processing industry in Model V. Under the assumptions of Model V, most markets established 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 was enough to offset transport costs. For example, the Dallas facility served one additional distant market in Model I. In Model V, Dallas served 10 additional markets from its export facility. The ratio of processing costs between the large export facility in Dallas versus the alternative potential establishment was enough to justify the transport costs.

Total organization costs were 53.2 million dollars in Model I compared with 60.3 million in Model V (Figure 33). Processing costs varied from 46.1 million dollars (87 percent of the total cost) in Model I to 54.8 million dollars (91 percent of the total cost) in Model V. Assembly costs were relatively stable and totaled 3.2 and 3.6 million dollars in Models I and V, respectively. Distribution costs totaled 3.8 million dollars in Model I compared with 1.9 million dollars 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 occurred:

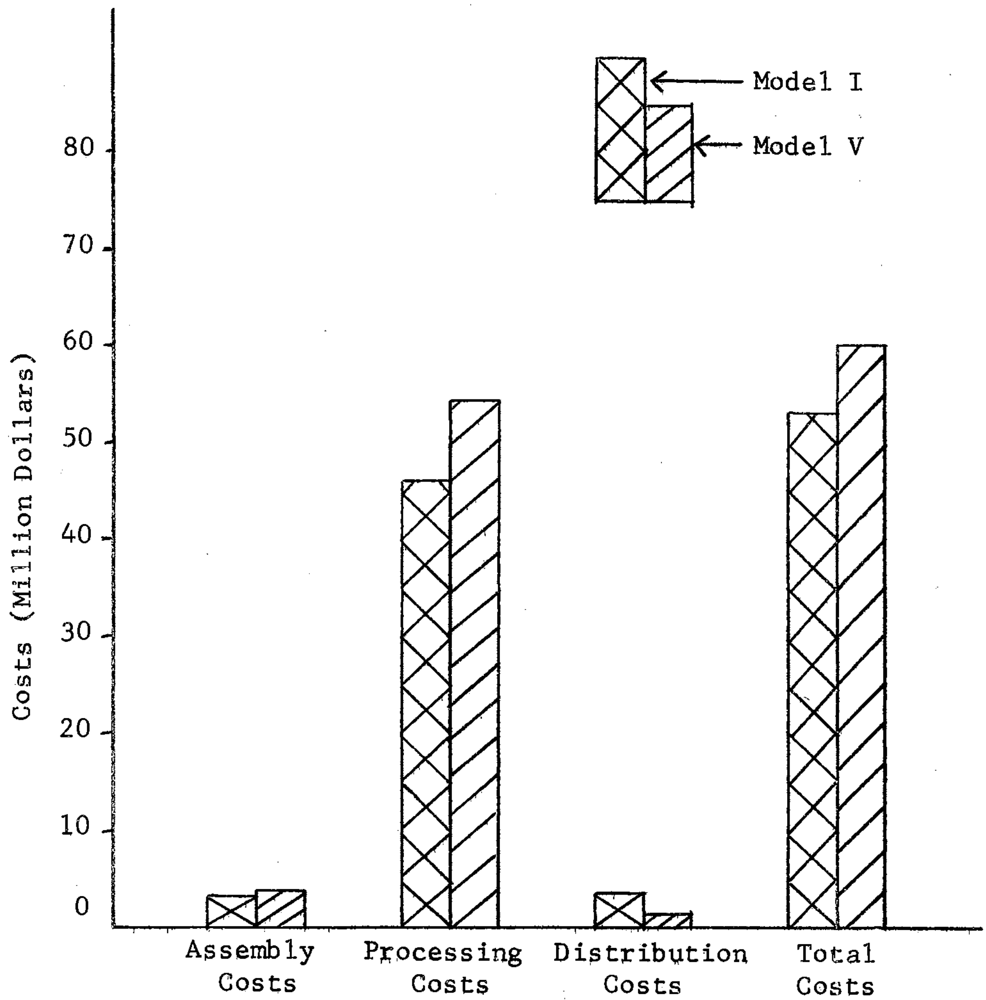

Figure 33. Assembly, Processing, Distribution and Total Costs, Models I and V

(1) the location of processing did shift and become more localized; (2) the organization was characterized by smaller less efficient firms and therefore higher processing costs; and (3) more markets were penetrated in the restricted model (due to the ratio of per unit processing costs between markets) versus the unrestricted model but participation in these markets was not as concentrated as in the unrestricted model.

Models II, III and VI

The purpose of this section is to compare the influences of variations in the processing sector upon the optimum market organization. Three models (II, III and VI) were formulated to incorporate three levels of concentration in the processing sector. The resource pricing structure was similar in all three models except in Model III where the prices of resources in distant markets tended to deviate from the actual pricing pattern. Since the major variation was induced into the processing sector, most comments will be made regarding that sector.

Firms in the optimum organization totaled 59 in Model II, 237 in Model III, and 4,595 in Model VI. Average processing capacities were 73.1, 19.6, and 1.1 million pounds for Models II, III and VI, respectively. Figure 34 illustrates the average capacities of firms established by region and model. The organization of Model II was unrestricted in the processing sector; Model III was restricted in the processing sector to insure the establishment of more firms into the organization; and Model VI exhibited the number of firms existing in the actual organization. The largest facilities established were in the Northeastern region (average capacity 153 million pounds) followed by the North Central, Western, Southern and West South Central regions.

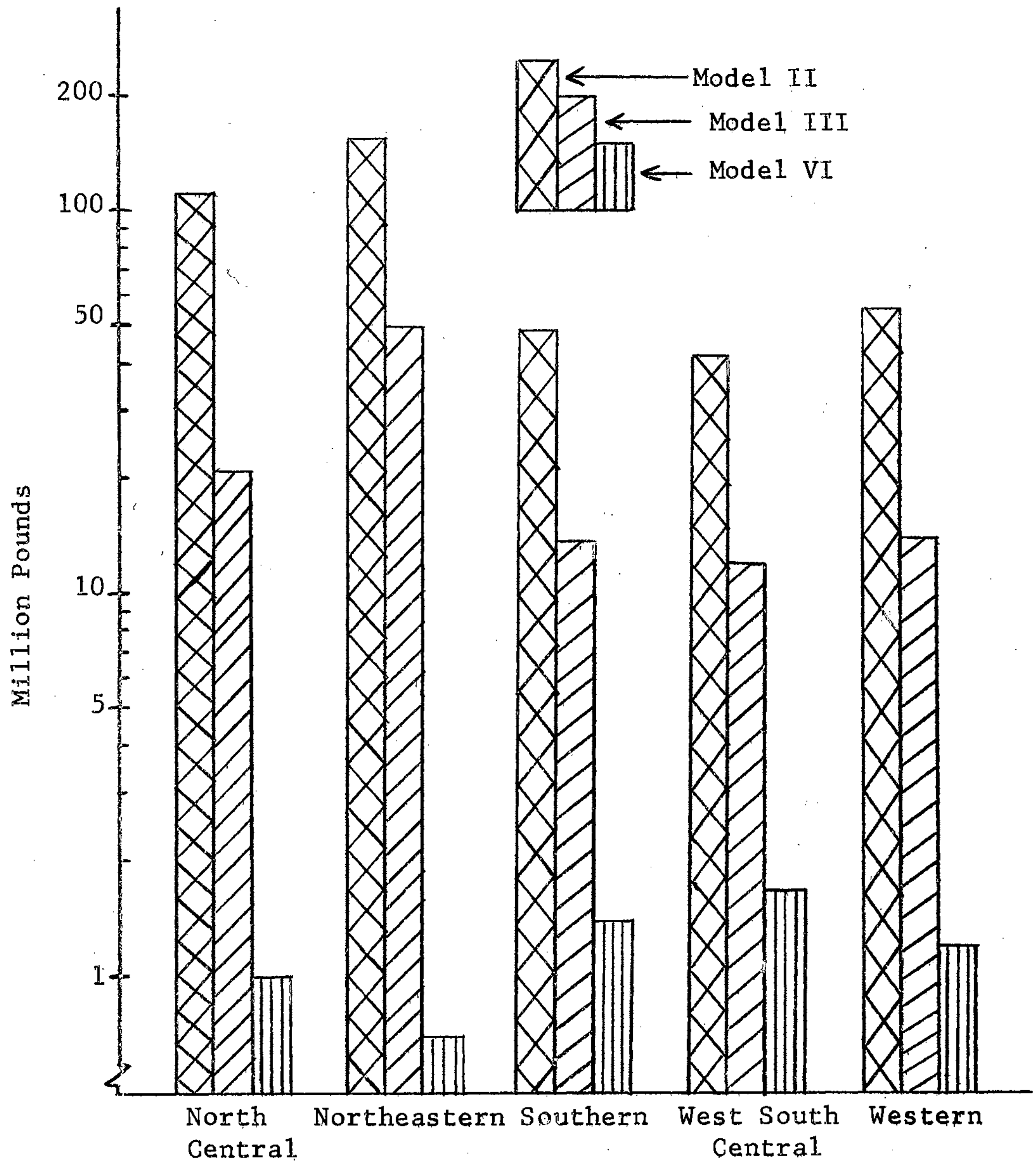

Figure 34. Average Size of Processing Facility Established by Region, Models II, III and VI

The restrictions imposed by Model III lowered the average size of facility to 19.6 million pounds. The Northeastern region still had the largest facilities averaging 50.8 million pounds. Under the assumptions and restrictions of Model III, average firm sizes decreased to 1.1 million pounds. Note that the largest firms are located in the West South Central, Southern and Western regions. The Northeastern region has the lowest processing capacity. This reversal compared with the results of the previous models may be the result of marginal processors being phased out of the industry or perhaps the lack of potential market expansion in the sparse population of these regions where it became difficult to establish small local facilities.

Processing costs reflected the variation in average sizes of firms in the models. Costs of processing increased in all regions as models became more restrictive. Total processing costs were 46.0, 54.2 and 71.4 million dollars in Models II, III and VI, respectively (Figure 35).

Processing tended to become more localized as the models became more restrictive. For example, the North Central region has the 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 the North Central region were large (average size 112 million pounds) and transshipments of the final product to distant markets were economically justified. However, as the models became more restrictive, facilities located in the North Central region were unable to attain the economies of size as in Model II. In Model VI, the average size of facility in this region was approximately one million pounds. As a result, processing became more localized as in the Southern region where increases were experienced from 670 million

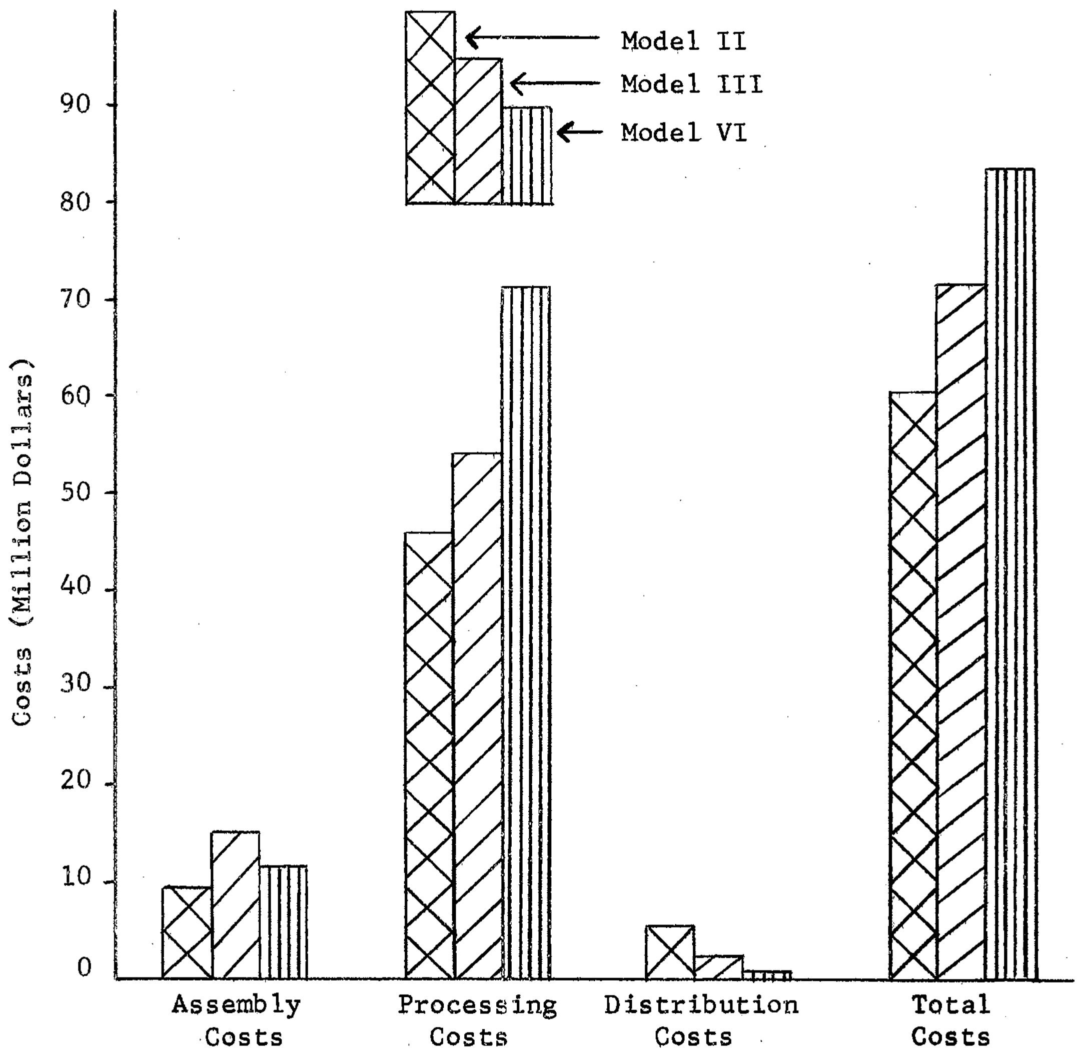

Figure 35. Assembly, Processing, Distribution and Total Costs, Models II, III and VI

pounds in Model II to 839 million pounds in Model VI. The gains experienced in Southern processing were in many instances at the expense of processors in the North Central region.

Distribution costs decreased in all regions as the models became more restrictive. Costs of distribution decreased from 5.5 million dollars in Model II, to 2.6 million in Model III to .8 million dollars in Model VI. The magnitude of the movements associated with these costs were 1,248, 698 and 225 million pounds for Models II, III and VI, respectively.

Assembly costs varied among the models, and in Model III totaled 15.1 million dollars. The higher costs were the result of the pricing structure which tended to have prices which were higher in the more distant markets than actually existed in 1963. Assembly costs totaled 9.1 and 11.6 million dollars in Models II and VI.

Total organizational costs increased as the models became more restrictive because of the establishment of smaller, less efficient facilities in the processing sector. Total costs were 60.6 million in Model II, 71.8 in Model III, and 83.8 in Model VI.

The comparisons above illustrate variations in the processing sector which lead to organizational and cost changes. It becomes obvious that full advantage of economies of size has not been fully achieved. Those models in which processing was unrestricted would give the greatest cost savings. Yet, the possibility of anti-trust action would make this alternative unattractive to processors. If processors could operate at these capacities free of legal intervention, consumers may be discriminated against as the result of the processor equating marginal costs and marginal revenues resulting in increased prices to consumers.

The type of processing organization illustrated in Model III is desirable from both standpoints. It protects the consumer because the number of firms maintains a competitive atmosphere and eases the pressures for legal actions against the processors.

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 dollars 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. Therefore, the farmer should receive some of these savings in the form of higher prices. In addition, the consumer should benefit from these savings in the form of lower retail prices.

FOOTNOTES

[1] Bureau of the Census, Location of Manufacturing by Industry, Country and Employment Size Part I (1963), pp. 33-42.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The fluid milk processing industry is characterized by a constantly changing economic environment. The industry has experienced decreases in firms processing fluid milk products and in 1963 there were approximately one-third the number operating as in 1948. Changes have been the result of new innovative ideas in marketing, processing and merchandising of fluid milk. Increased importance of efficiency has led to mergers and the consolidation of firms has also led to a decrease in firm numbers.

The major objective of the study was the determination of optimum market organizations under alternative economic conditions reflecting varying degrees of competition in the processing sector and adjusting resource prices to determine possible changes in the market structure which might increase efficiency in the marketing system.

In the analysis, the United States was divided into 105 demand areas which represented some of the more populated areas of the country. Sources of resource supplies were made available at 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 was determined using relevant variables in estimating 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 sources of supply 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 reflect 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 model formulations were utilized in the analysis: (1) models in which the processing functions were not restricted under alternative pricing schemes; (2) models in which the processing functions were limited by firm size and numbers under alternative pricing schemes; and (3) a model in which the least cost flow pattern was determined while using the existing 1963 organization and 1965 resource prices.

Model I was formulated to determine the least cost market organization when resource prices paid to farmers were equal in all production areas and the processing sector was unrestricted relative to firm size. The goal of this model was maximum efficiency. In the optimum organization, 76 production areas served 64 processing facilities 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 dollars. Processing functions were carried out in facilities averaging 73.1 million pounds in capacity. Average costs were 0.98

cents per pound and an aggregate processing cost of 46.1 million dollars. Distribution costs associated with movements of 1,152 million pounds of packaged milk to distribution outlets totaled 3.8 million dollars. Total organizational costs were 53.2 million dollars.

Model II was similar to Model I except actual 1965 resource prices were included. In the optimum organization, production was utilized from 64 production areas serving 59 processing facilities. Intermarket movements of raw fluid milk totaled 1,819 million pounds and required an assembly cost outlay of 9.1 million dollars. Processing functions were performed in facilities averaging 79.3 million pounds at costs of 46 million dollars or 0.98 cents per pound. Intermarket movements of final product totaled 1,248 million pounds at costs of 5.5 million dollars. Total organizational costs were 60.6 million dollars.

The primary differences in the organizations of Models I and II was that the incorporation of 1965 resource 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 provide alternative organizations to avoid anti-trust and institutional restraints. The models also incorporated a base point pricing scheme.

The organization of Model III involved the oligopoly economic environment and a transfer cost in the resource market approaching the level currently in use. 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 dollars. Processing functions were carried out in facilities averaging 19.6 million pounds at a total cost of 54.2 million dollars or 1.16 cents per pound. Intermarket movements of packaged milk totaled 698 million pounds at costs of 2.6 million dollars. Total organizational costs were 71.8 million dollars.

The results of Model III were very similar to Model II. Procurement areas were skewed toward the base point and distribution configurations became skewed away from the base point. The one difference occurred in the processing sector where the re-structuring of the processing sector caused processing costs to be substantially increased (8.2 million dollars over Model II) because smaller, less efficient firms were forced into the organization.

Model IV was formulated to determine the optimum organization conditions similar to Model III except a nine cent transfer cost was assumed in the determination of resource pricing. 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 resource market.

Model V represented the most efficient market organization of the restricted models. Resource prices were assumed to be the same in all areas of production. In the optimum organization, production was utilized from 89 production areas which served 249 processing facilities. Assembly costs totaled 3.6 million dollars for intermarket movements of raw milk totaling 1,189 million pounds. Processing functions were performed at total costs of 54.8 million dollars. Supplying all markets required intermarket movements of processed milk totaling 578 million pounds. Costs associated with these movements were 1.9 million dollars. Total organizational costs were 60.3 million dollars.

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 7 million dollars more than the maximum efficiency organization of Model I. These additional costs would be the increased cost of maintaining a competitive industrial economy.

Model VI was formulated to determine the minimum cost flow under the existing market structure and the 1965 resource pricing structure. In the optimum solution production was utilized from 69 production areas serving 4,595 processing facilities. Intermarket movements of raw fluid milk consisted of 1,907 million pounds being transported at costs totaling 11.6 million dollars. Processing costs totaled 71.4 million dollars. Only 225 million pounds of the final product were transported to distant markets at costs of 755,000 dollars. Total organizational costs were 83.8 million dollars.

The least cost organization of the industry as it existed in 1963 (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 costs processing costs were very small between markets resulting in the localization of processing and no evident skewness in the distribution sector.

Conclusions

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 the same resource pricing structure, 23.1 million dollars could be saved in the total organization and greater saving totaling 24.3 million dollars would result in the processing sector if maximum efficiency were the goal of an economy.

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. Yet, savings could still be realized over the existing organization totaling 21.7 million dollars (assuming a similar resource pricing structure). Firm numbers declined by more than 4300 firms. Further organizational savings were realized as the resource pricing structure became the same in all areas of production.

Various assumptions were made regarding the resource pricing structure. The analysis revealed that policy makers should be very cautious about the direction of change if adjustments are required in base point pricing patterns. At a 15 cent transfer cost, considerable transfer of resources was experienced. The results indicated potential shifts or relocation of production if these prices would persist with no institutional or legal controls on the flow.

At the nine cent differential, utilization of production was more localized and approached the most efficient organization in which no differentials persisted. The justification for base point pricing differentials is the persistent spread of production costs between areas. If these costs persist, base point pricing schemes may be justified. The variations in the pricing structure should, however, be reflections of actual cost variations. It should be noted that these cost variations may be a function of past pricing strategies which have inflated actual costs because marginal producers have been able to remain in production because of these strategies.

The hypothetical market organization illustrated potential cost savings as firm numbers decreased. Throughout the analysis, the traditional assumption has been made that producers pay 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 should be passed on to the farmers because the distances he has to ship his milk has expanded.

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

Limitations

Several limitations of the analysis and model construction merit discussion. One of the main limitations of the study was the inability to incorporate all marketing functions into the analysis. The models determined the least costs associated with the movement of raw milk from predetermined assembly points to processing facilities where the milk was processed and shipped as the final product to predetermined distribution outlets. No attempt was made to incorporate costs associated with the assembly of milk at the farm level nor incorporate costs associated with any distribution activities beyond the single distribution outlet. These functions accounted for approximately 30 percent of the total marketing bill. For example, in December, 1969 the estimated retail price per half gallon was 56.0 cents for the nation. Class I prices paid to producers was 30 cents per half gallon. The remaining 26 cents can be assumed to be costs associated with the various marketing services and profit margins. The existing market organization under optimum conditions required approximately 7.7 cents per half gallon or 30 percent of the present levels.

Other limiting factors in the analysis were: (1) the estimation of fluid-eligible milk based on total production and adjusted using Class I, II and average prices, (2) 1965 processing costs were estimated using a function based on 1961 input costs under the assumptions that new technologies offset increased input prices, (3) the processing cost function was extended to include volumes beyond the supporting data used in the regression for the determination of the cost function, (4) the analysis was a partial equilibrium analysis with no consideration given to other production alternatives, (5) the magnitude of the study was costly in terms of computer time and inflexible in the utilization of more alternatives, and (6) variations in retail price levels between markets were not considered which could alter the distribution patterns of the organizations in the analysis of this study.

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APPENDIX I

CODES SPECIFIED FOR ASSEMBLY AND DISTRIBUTION POINTS FOR ALL MODELS

TABLE XX

CODES USED IN IDENTIFYING DEMAND (DISTRIBUTION POINTS) AND SUPPLY (ASSEMBLY POINTS) AREAS

Code	Demand: Distribution Points and Location of Processing	Code	Supply: 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

(continued)

TABLE XX (Continued)

Code	Demand: Distribution Points and Location of Processing	Code	Supply: Points of Assembly
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
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	Centrailia, 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

TABLE XX (Continued)

Code	Demand: Distribution Points and Location of Processing	Supply: Code	Supply: Points of Assembly
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 II

PRODUCTION, ASSEMBLY, PROCESSING AND DISTRIBUTION ACTIVITIES IN THE OPTIMUM MARKET ORGANIZATIONS OF THE UNITED STATES FLUID MILK INDUSTRY, MODELS I AND II

TABLE XXI

PRODUCTION AND ASSEMBLY ACTIVITIES FOR INDIVIDUAL MARKETS IN THE OPTIMUM MARKET ORGANIZATION OF THE UNITED STATES FLUID MILK INDUSTRY, MODELS I AND II

Supply Area	MODEL I Location of Processing	MODEL I Quantity Transferred	MODEL I Unused Production	MODEL II Location of Processing	MODEL II Quantity Transferred	MODEL II Unused Production
1	1	49,761,200	80,097,820	1	49,761,200	80,097,820
2	2	23,157,220	1,015,030	2	23,157,220	1,015,030
3	3	41,073,450	27,620	3	41,073,450	27,620
4	4	22,795,720	66,265,970	4	22,795,720	66,265,970
5	5	175,187,920	50,945,740	5	166,805,000	70,713,760
5	6	56,647,250	---	6	45,262,160	---
6	6	206,951,840	0	6	206,951,840	0
7	N.P.*	0	12,541,880	N.P.	0	12,541,880
8	8	6,493,370	18,079,590	8	21,699,600	2,874,360
9	N.P.	0	1,821,030	N.P.	0	1,821,030
10	10	3,517,180	0	N.P.	0	3,517,180
11	10	6,640,070	---	N.P.	0	13,032,510
11	11	6,164,000	228,440			
12	N.P.	0	2,439,970	N.P.	0	2,439,970
13	6	7,416,360	0	6	7,416,360	0
14	N.P.	0	6,386,540	N.P.	0	6,386,540
15	15	38,961,040	2,867,660	6	12,612,030	---
15				15	29,216,660	0
16	25	2,406,500	---	25	2,406,500	---
16	21	15,937,620	0	21	15,937,620	0
17	N.P.	0	155,380	6	155,380	0
18	6	1,382,330	---	18	37,922,920	2,234,620
18	18	37,922,930	---			
18	25	852,290	---			

TABLE XXI (CONTINUED)

Supply Area	MODEL I Location of Processing	MODEL I Quantity Transferred	MODEL I Unused Production	MODEL II Location of Processing	MODEL II Quantity Transferred	MODEL II Unused Production
19	19	5,461,170	3,360,020	19	5,461,170	3,360,020
20	20	53,065,040	5,682,560	20	20,494,090	38,253,510
21	25	978,760	0	25	978,760	0
22	22	9,616,200	0	N.P.	0	19,158,860
22	23	4,749,220	---			
23	23	7,900,610	0	23	7,900,610	0
24	23	1,489,390	4,604,970	N.P.	0	17,523,100
24	24	10,294,450	---			
25	25	9,836,350	0	25	9,836,350	0
26	N.P.	0	19,158,860	N.P.	0	19,158,860
27	27	78,435,810	421,380	27	93,917,500	0
27	28	15,060,310	---			
28	28	41,346,490	0	28	41,346,490	0
29	29	34,905,720	0	29	34,905,720	0
30	30	17,850,080	0	N.P.	0	17,850,080
31	31	55,594,270	0	31	55,594,270	0
32	38	6,301,060	0	38	6,301,060	0
33	33	19,450,000	0	33	19,450,000	0
34	33	377,920	---	N.P.	0	28,802,620
34	34	26,615,800	0			
34	35	1,808,910	---			
35	35	49,984,080	0	N.P.	0	49,984,080
36	38	20,909,790	0	38	20,909,790	0
37	38	8,209,220	---	39	29,174,320	0
37	39	38,707,070	0	53	18,498,640	---
37	52	5,080,420	---	57	6,183,840	---
37	42	1,860,090	---			

TABLE XXI (CONTINUED)

Supply Area	MODEL I Location of Processing	MODEL I Quantity Transferred	MODEL I Unused Production	MODEL II Location of Processing	MODEL II Quantity Transferred	MODEL II Unused Production
38	40	25,509,670	0	40	25,509,670	0
39	35	1,292,440	---	35	1,292,440	---
39	41	55,871,570	0	41	55,871,570	0
40	42	41,802,580	0	N.P.	0	41,802,580
41	53	12,171,230	---	N.P.	0	21,321,910
41	57	3,467,800	---			
41	35	5,682,870	---			
42	N.P.	0	19,335,230	46	19,335,230	0
43	45	33,072,000	11,716,290	45	44,788,290	0
44	50	30,363,710	0	50	44,582,090	0
44	46	128,654,660	---	46	113,177,140	---
45	40	17,196,300	25,483,550	N.P.	0	43,546,970
45	51	867,120	---			
46	50	14,218,380	0	N.P.	0	14,218,380
47	51	29,942,510	0	N.P.	0	29,942,510
48	54	6,566,860	0	N.P.	0	72,153,050
48	55	4,483,250	---			
48	57	1,310,190	---			
48	51	59,792,740	---			
49	52	44,220,060	0	N.P.	0	44,220,060
50	53	19,707,870	0	N.P.	0	19,707,870
51	54	22,181,090	0	N.P.	0	22,181,090
52	55	15,244,750	0	N.P.	0	15,244,750
53	56	39,146,440	0	N.P.	0	41,057,020
53	57	1,405,840	---			
53	58	504,740	---			
54	57	25,461,350	0	57	25,461,350	0

TABLE XXI (CONTINUED)

Supply Area	MODEL I Location of Processing	MODEL I Quantity Transferred	MODEL I Unused Production	MODEL II Location of Processing	MODEL II Quantity Transferred	MODEL II Unused Production
55	58	39,661,400	0	58	39,661,400	0
56	59	6,048,000	18,331,590	11	24,379,590	0
57	N.P.	0	18,375,770	20	2,897,870	---
57				62	15,477,900	0
58	63	1,637,250	0	N.P.	0	1,637,250
59	N.P.	0	12,684,650	66	4,044,560	0
59				84	727,550	---
59				90	7,912,540	---
60	N.P.	0	50,568,620	65	50,568,620	0
61	66	163,386,830	49,860,190	66	213,247,020	0
62	N.P.	0	70,826,770	79	12,012,580	0
62				77	19,732,240	---
62				74	4,422,050	---
62				69	32,272,030	---
62				33	2,387,870	---
63	71	31,899,400	6,039,430	28	6,039.430	0
63				71	31,899,400	---
64	68	16,389,840	0	77	7,544,800	0
64				38	8,845,040	---
65	N.P.	0	42,974,330	79	31,063,940	0
65				42	11,910,380	---
66	N.P.	0	71,385,950	20	19,315,640	---
66				22	9,616,200	---
66				23	15,400,270	---
66				29	14,554,990	---
66				70	12,498,850	0
67	72	6,812,050	1,985,070	23	1,132,790	0

TABLE XXI (CONTINUED)

Supply Area	MODEL I Location of Processing	MODEL I Quantity Transferred	MODEL I Unused Production	MODEL II Location of Processing	MODEL II Quantity Transferred	MODEL II Unused Production
67				25	852,290	---
67				72	6,812,050	---
68	73	23,998,820	22,000,290	29	2,184,550	0
68				28	9,020,880	---
68				73	34,793,670	---
69	74	79,865,170	1,115,700	74	80,980,860	0
70	75	18,036,600	40,013,390	33	574,120	0
70				35	57,475,870	---
71	77	64,314,490	0	77	64,314,490	0
72	77	687,630	31,518,540	53	13,380,460	0
72				56	18,825,720	---
73	80	498,075,200	0	80	498,075,200	0
74	N.P.	0	169,849,360	80	139,204,100	0
74				79	1,578,260	---
74				90	11,870,710	---
74				40	17,196,300	---
75	84	8,176,990	13,726,480	84	21,903,470	0
76	87	287,209,420	10,928,970	89	84,208,000	0
76				96	59,575,460	---
76				99	154,354,920	---
77	89	173,642,610	0	89	173,642,610	0
78	90	21,016,640	76,860,950	91	97,877,590	0
79	90	54,081,790	0	90	54,081,790	0
80	N.P.	0	91,016,940	90	1,233,380	0
80				91	81,516,520	---
80				96	8,267,030	---
81	37	38,765,592	24,453,410	55	63,219,320	0

TABLE XXI (CONTINUED)

Supply Area	MODEL I Location of Processing	MODEL I Quantity Transferred	MODEL I Unused Production	MODEL II Location of Processing	MODEL II Quantity Transferred	MODEL II Unused Production
82	93	21,590,930	64,908,100	52	49,300,480	---
82	38	635,830	---	56	5,577,350	0
82				58	504,740	---
82				42	31,752,290	---
83	94	187,319,000	3,938,810	96	4,626,890	21,949,530
83				97	164,681,390	---
84	95	286,472,560	12,444,600	N.D.	0	298,917,160
85	97	92,585,060	0	96	92,585,060	0
86	99	192,329,960	256,386,450	N.P.	0	448,716,400
87	N.P.	0	290,550,430	102	134,296,140	0
87				101	13,770,710	---
87				97	125,698,140	---
87				103	16,785,440	---
88	97	168,511,430	0	97	168,511,430	0
89	102	10,475,410	0	101	58,906,360	0
89	97	48,430,950	---			
90	102	62,381,180	0	102	62,381,180	0
91	102	196,497,810	0	N.P.	0	196,497,810
92	105	7,325,760	45,042,620	105	7,325,760	45,042,620

*N.P. = No Processing

TABLE XXII

PROCESSING AND DISTRIBUTION ACTIVITIES FOR INDIVIDUAL MARKETS IN THE OPTIMUM MARKET ORGANIZATION OF THE UNITED STATES FLUID MILK INDUSTRY, MODELS I AND II

	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

TABLE XXII (CONTINUED)

Demand Area	MODEL I Processing Center	Quantity	Size of Plant	Cost	MODEL II Processing Center	Quantity	Size of Plant	Cost
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	---	---
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	---	---

TABLE XXII (CONTINUED)

Demand Area	MODEL I Processing Center	MODEL I Quantity	MODEL I Size of Plant	MODEL I Cost	MODEL II Processing Center	MODEL II Quantity	MODEL II Size of Plant	MODEL II Cost
48	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	---	---
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	12,211,320	---	---	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	15,445,950	---	---
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

TABLE XXII (CONTINUED)

Demand Area	MODEL I Processing Center	Quantity	Size of Plant	Cost	MODEL II Processing Center	Quantity	Size of Plant	Cost
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		
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	---	---

TABLE XXII (CONTINUED)

Demand Area	MODEL I Processing Center	MODEL I Quantity	MODEL I Size of Plant	MODEL I Cost	MODEL II Processing Center	MODEL II Quantity	MODEL II Size of Plant	MODEL II Cost
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 III

PRODUCTION, ASSEMBLY, PROCESSING AND DISTRIBUTION ACTIVITIES IN THE OPTIMUM MARKET ORGANIZATIONS OF THE UNITED STATES FLUID MILK INDUSTRY, MODELS III, IV, V AND VI

TABLE XXIII

PRODUCTION AND ASSEMBLY ACTIVITIES FOR INDIVIDUAL MARKETS IN THE OPTIMUM MARKET ORGANIZATION OF THE UNITED STATES FLUID MILK INDUSTRY, MODELS III, IV, V, AND VI

Supply Area	MODEL III			MODEL IV			MODEL V			MODEL VI		
	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production
1	1	49,761,200	80,097,820	1	49,761,200	80,097,820	1	49,761,200	80,097,820	1	49,761,200	80,097,820
2	2	5,776,110		2	23,157,220	1,015,030	2	23,314,480	857,770	2	23,157,220	80,097,820
3	3	41,073,450		3	41,101,070	0	3	41,073,450	27,620	3	41,073,450	27,620
3	4	27,620										
4	N.P.	0	89,061,680	4	22,795,720	66,265,970	4	22,795,720	66,265,970	4	22,795,720	66,265,970
5	5	87,036,300		5	166,805,000	115,975,920	5	170,187,920	55,945,740	5	143,231,380	96,911,060
5							6	56,647,250	---	6	42,638,470	---
6	N.P.	0	206,951,840	6	206,951,840	0	6	206,951,840	0	6	206,951,840	0
7	N.P.	0	12,541,880	N.P.	0	12,541,880	N.P.	0	12,541,880	7	4,502,500	8,039,380
8	N.P.	0	24,573,950	8	6,494,370	18,079,590	8	6,494,370	18,079,590	8	6,494,370	18,079,590
9	5	1,821,030		6	1,821,030	0	13	1,821,030	0	N.P.	0	1,821,030
10	10	3,517,180		10	3,517,180	0	10	3,517,180	0	N.P.	0	3,517,180
11	6	13,032,510		6	3,207,290	---	10	6,482,820	---	N.P.	0	13,032,510
11				11	6,000,000	0	11	6,164,000	385,700			
11				9	3,825,220	---						
12	5	2,439,970		12	2,439,970	0	12	2,000,000	0	12	2,439,970	0
12							13	439,970	---			
13	6	7,416,360		6	7,416,360	0	6	7,416,360	0	6	7,416,360	0
14	N.P.	0	6,386,540	14	3,880,420	2,506,120	14	2,000,000	1,386,540	N.P.	0	6,386,540
14							7	3,000,000	---			
15	15	35,000,000		15	33,995,950	0	15	35,000,000	4,867,660	15	27,415,990	---
15	6	1,010,930		6	7,832,740	---	9	1,961,040	---	6	12,605,520	0
15	5	5,817,760								16	1,807,180	---
16	6	3,509,970		21	18,344,120	0	21	15,937,620	0	21	15,937,620	0
16	21	14,834,150					25	2,406,500	---	25	2,406,500	---
17	6	155,380		6	155,380	0	N.P.	0	155,380	6	155,380	0
18	6	6,764,620		6	6,764,620	---	6	1,382,330	---	18	37,922,930	2,234,620
18	18	33,392,920		18	33,392,920	0	18	38,775,210	0			
19	6	3,821,190		6	3,821,190	---	19	5,461,170	3,360,020	19	5,461,170	3,360,020
19	19	5,000,000		19	5,000,000	0						
20	6	49,251,350		6	15,578,830	---	13	739,000	---	20	8,836,970	49,910,630
20	20	9,496,250		20	43,168,770	0	20	44,834,860	13,164,740			
21	N.P.	0	978,760	N.P.	0	978,760	25	978,760	0	25	978,760	0

TABLE XXIII (CONTINUED)

	MODEL III			MODEL IV			MODEL V			MODEL VI		
Supply Area	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production
22	6	4,749,220		22	9,616,200	0	22	9,616,200	0	N.P.	0	14,365,410
22	22	9.616,200		23	4,749,220	---	23	4,749,220	---			
23	23	7,900,610		23	7,900,610	0	23	7,900,610	0	23	7,900,610	0
24	N.P.	0	17,523,100	N.P.	0	17,523,100	23	350,170	10,392,120	N.P.	0	17,523,100
24							24	6,000,000	---			
24							28	780,810	---			
25	25	9,836,350		25	9,836,350	0	25	9,836,350	0	25	9,836,350	0
26	N.P.	0	19,158,860	N.P.	0	19,158,860	26	7,000,000	12,158,860	26	13,378,930	5,779,930
27	27	93,917,500		27	93,917,500	0	27	93,603,230	0	27	78,068,240	0
27							28	314,270	---	28	15,849,260	---
28	28	41,346,490		28	41,346,490	0	28	41,346,490	0	28	22,360,550	18,985,940
29	29	29,000,000		29	29,000,000	0	29	29,000,000	0	29	32,152,120	2,753,600
29	30	5,905,720		30	5,905,720	---	28	3,755,810	---			
29							30	2,149,920	---			
30	N.P.	0	17,850,080	30	14,094,280	3,755,810	30	17,850,080	0	N.P.	0	17,850,080
31	6	7,494,880		28	8,789,460	---	31	37,000,000	18,593,270	28	10,979,940	---
31	23	5,099,390		31	37,000,000	9,804,810				32	1,127,630	---
31	24	6,000,000								31	29,882,270	0
31	31	37,000,000								34	13,604,430	---
32	38	6,301,060		38	6,301,060	0	38	6,301,060	0	38	6,301,060	0
33	30	1,450,000		33	18,000,000	1,450,000	38	1,450,000	---	33	19,450,000	0
33	33	18,000,000					33	18,000,000	0			
34	34	26,615,800		28	2,864,050	---	28	4,802,620	---	N.P.	0	28,802,620
34				34	25,938,570	0	34	24,000,000	0			
35	35	49,984,080		35	49,984,080	0	35	49,984,080	0	N.P.	0	49,984,080
36	38	20,909,790		38	20,909,790	0	38	20,909,790	0	38	20,909,790	0
37	39	29,174,320		39	29,174,320	24,682,480	39	45,000,000	879,440	39	29,174,320	0
37							52	5,779,940	---	53	18,498,640	---
37							42	2,197,420	---	57	6,183,840	---
38	40	25,509,670		40	25,509,670	0	40	25,509,670	0	40	25,509,670	0
39	41	27,786,640		35	8,784,220	---	38	4,339,150	---	35	21,716,910	---
39				41	27,786,640	13,830,130	53	9,292,130	---	41	27,786,640	---
39				43	6,763,010	---	35	8,784,220	---	43	7,660,450	---
39							41	27,786,640	198,840			
39							43	6,763,010	---			
40	42	41,802,580		42	41,802,580	0	42	41,802,580	0	N.P.	0	41,802,580

TABLE XXIII (CONTINUED)

Supply Area	MODEL III			MODEL IV			MODEL V			MODEL VI		
	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production
41	43	21,321,910		43	21,321,910	0	43	21,321,910	0	N.P.	0	21,321,910
42	44	18,000,000		44	18,000,000	0	44	18,000,000	0	44	19,335,230	0
42	49	1,335,230		49	1,335,230	---	49	1,335,230	---			
43	45	44,788,290		45	44,788,290	0	45	44,788,290	0	45	33,072,000	0
43										47	9,524,640	---
43										49	2,191,650	---
44	50	26,681,620		50	26,781,620	0	50	30,363,710	0	50	44,582,090	0
44	46	102,000,000		46	102,000,000	---	50	7,000,000	---	46	114,436,280	---
44				97	30,236,760	---	49	7,654,660	---			
44							46	114,000,000	---			
45	55	3,818,910		47	43,546,970	0	40	17,196,300	13,005,650	N.P.	0	43,546,970
45	47	10,728,060					47	4,334,920	---			
45	51	29,000,000					49	9,010,100	---			
46	50	14,218,380		50	14,218,380	0	50	14,218,380	0	N.P.	0	14,218,380
47	N.P.	0	29,942,510	51	29,942,510	0	51	29,942,510	0	N.P.	0	29,942,510
48	N.P.	0	72,153,050	54	3,818,910	68,334,140	54	6,566,860	0	N.P.	0	72,153,050
48							55	4,483,250	---			
48							57	4,778,000	---			
48							47	54,341,430	---			
48							51	1,983,500	---			
49	52	44,220,060		52	48,220,060	0	52	44,220,060	0	N.P.	0	44,220,060
50	N.P.	0	19,707,870	53	19,707,870	0	53	19,707,870	0	N.P.	0	19,707,870
51	54	22,181,090		54	22,181,109	0	54	22,181,090	0	N.P.	0	22,181,090
52	N.P.	0	15,244,750	N.P.	0	15,244,750	55	15,244,750	0	N.P.	0	15,244,750
53	N.P.	0	41,057,020	56	39,146,440	0	56	39,146,440	0	N.P.	0	41,057,020
53				57	1,405,840	---	57	1,405,840	---			
53				58	504,740	---	58	504,740	---			
54	N.P.	0	25,461,350	57	25,461,350	0	57	25,461,350	0	57	25,461,350	0
55	N.P.	0	39,661,400	58	39,661,400	0	58	39,661,400	0	58	39,661,400	0
56	2	11,204,340		9	3,174,780	---	59	6,906,430	17,473,160	9	2,010,330	---
56	10	6,482,820		10	6,482,820	---				10	10,157,250	---
56	59	6,692,420		59	6,369,250	8,352,740				11	6,164,000	---
56										59	6,048,000	0
57	6	10,375,770		13	5,000,000	---	62	8,000,000	6,013,030	13	5,136,260	---
57	62	8,000,000		6	1,013,030	---	63	4,362,750	---	62	8,619,470	0
57				62	8,000,000	0				63	4,620,040	---

TABLE XXIII (CONTINUED)

Supply Area	MODEL III			MODEL IV			MODEL V			MODEL VI		
	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production	Location of Processing	Quantity Transferred	Unused Production
57				63	4,362,750	---						
58	63	1,637,250		63	1,637,250	0	63	1,637,250	0	N.P.	0	1,637,250
59	5	473,320		64	7,000,000	5,684,650	64	7,000,000	5,684,650	104	473,320	0
59	64	12,211,320										
60	2	6,176,780		60	8,000,000	---	60	8,000,000	---	9	5,287,560	---
60	8	9,093,950		61	8,000,000	---	61	8,000,000	---	60	6,713,980	---
60	9	7,297,900		65	6,000,000	28,568,620	65	6,000,000	28,568,620	61	8,443,540	---
60	11	6,000,000								65	12,106,620	0
60	60	8,000,000								71	15,778,520	---
60	61	8,000,000								63	2,238,390	---
60	65	6,000,000										
61	13	5,136,260		66	112,000,000	90,525,680	66	108,671,680	104,575,330	66	88,911,000	0
61	6	62,748,010		71	9,061,170	---				79	30,276,210	---
61	66	112,000,000		68	1,610,160	---				78	17,056,650	---
61	71	29,000,000								77	10,220,380	---
61	63	4,362,750								38	8,850,400	---
61										54	28,747,950	---
61										53	13,380,460	---
61										83	1,773,150	---
61										97	14,036,170	---
62	5	69,216,610		N.P.	0	70,826,770	N.P.	0	70,826,770	28	5,890,210	0
62	68	1,610,016								30	6,964,170	---
62										71	8,217,930	---
62										69	29,329,990	---
62										43	20,424,470	---
63	6	26,938,830		71	19,938,830	---	71	18,000,000	---	28	1,326,840	---
63	67	11,000,000		67	18,000,000,	0	67	18,000,000	1,938,830	71	16,120,880	---
63										67	20,491,110	0
64	68	16,389,340		68	16,389,840	0	68	16,389,840	0	68	16,389,840	0
65	79	4,220,150		79	698,050	0	79	13,974,330	0	42	42,974,330	0
65	77	34,685,551		77	13,276,270	---	69	29,000,000	---			
65	38	4,068,670		69	29,000,000	---						
66	12	2,446,480		24	3,676,550	---	70	12,498,850	58,887,100	20	33,870,630	---
66	4	22,768,810		70	12,498,850	55,210,550				22	8,483,410	---
66	20	33,672,520								23	6,238,610	---
66	70	12,498,850								24	10,294,450	---

TABLE XXIII (CONTINUED)

Supply Area	MODEL III Location of Processing	MODEL III Quantity Transferred	MODEL III Unused Production	MODEL IV Location of Processing	MODEL IV Quantity Transferred	MODEL IV Unused Production	MODEL V Location of Processing	MODEL V Quantity Transferred	MODEL V Unused Production	MODEL VI Location of Processing	MODEL VI Quantity Transferred	MODEL VI Unused Production
66										70	12,498,850	0
67	25	3,163,650		23	350,170	---	72	6,000,000	2,797,120	22	1,132,790	---
67	21	5,633,470		24	2,323,450	---				25	852,290	---
67				21	2,123,500	---				72	6,812,050	0
67				72	4,000,000	0						
68	6	32,999,110		6	17,835,460	---	73	37,000,000	8,999,110	32	22,000,290	---
68	73	13,000,000		25	3,163,650	---				73	23,998,820	0
68				73	25,000,000	---						
69	74	80,980,860		74	80,980,860	0	74	80,980,860	0	30	14,773,800	---
69										74	66,207,060	0
70	6	6,429,430		75	26,655,100	31,394,890	75	22,448,590	35,601,400	75	20k998,590	0
70	27	1,322,770								35	37,051,400	---
70	28	9,653,510										
70	30	12,644,280										
70	75	28,000,000										
71	77	64,314,490		77	64,314,490	0	77	64,314,490	0	77	64,314,490	0
72	37	32,206,170		37	32,306,170	0	79	11,025,670	11,492,870	37	32,206,170	0
72							78	9,000,000	---			
72							77	687,630				
73	86	28,000,000		86	28,000,000	---	80	357,000,000	101,075,200	86	2,633,560	---
73	80	357,000,000		80	357,000,000	45,929,400	81	40,000,000	---	80	284,974,560	0
73	90	9,918,210		79	24,301,950	---				92	26,534,430	---
73	37	2,793,830		90	9,918,210	---				90	21,016,640	---
73	38	1,720,480		37	2,793,830	---				52	20,150,480	---
73	40	17,196,300		38	5,789,150	---				51	31,926,010	---
73	53	31,879,100		40	5,230,920	---				46	14,034,540	---
73	56	9,401,150		52	5,080,520	---				97	96,804,980	---
73	58	40,166,140		53	12,171,230	---						
73				42	1,860,090	---						
74	6	35,700,210		81	65,000,000	87,416,380	82	10,000,000	159,849,360	37	6,559,740	0
74	79	21,386,930		82	17,432,980	---				40	17,196,300	---
74	69	29,000,000								81	86,271,350	---
74	81	65,000,000								82	18,762,220	---
74	82	18,762,220								49	30,255,270	---
74										97	10,804,480	---
75	84	8,176,990		84	8,176,990	13,726,480	84	8,176,990	13,726,480	84	8,176,990	0

TABLE XXIII (CONTINUED)

Supply Area	MODEL III Location of Processing	MODEL III Quantity Transferred	MODEL III Unused Production	MODEL IV Location of Processing	MODEL IV Quantity Transferred	MODEL IV Unused Production	MODEL V Location of Processing	MODEL V Quantity Transferred	MODEL V Unused Production	MODEL VI Location of Processing	MODEL VI Quantity Transferred	MODEL VI Unused Production
75	105	7,000,000								104	13,726,480	---
76	87	248,000,000		87	248,000,000	50,138,390	87	248,000,000	50,138,390	87	197,907,360	0
76	102	50,138,390								88	22,492,430	---
76										46	4,041,560	---
76										99	73,697,040	---
77	89	173,642,610		89	173,642,610	0	89	173,642,610	0	89	162,713,170	0
77										97	10,929,440	---
78	91	26,000,000		91	26,000,000	0	90	9,918,210	---	91	48,725,870	0
78	44	1,211,710		45	1,211,710	---	91	40,885,570	47,073,810	47	49,151,720	---
78	47	42,271,940		47	9,453,030	---						
78	97	28,393,930		49	975,630	---						
78				97	60,237,210							
79	90	54,081,790		90	54,081,790	0	90	54,081,790	0	90	54,081,790	0
80	88	32,000,000		88	32,000,000	23,797,810	86	28,000,000	63,016,940	88	17,288,410	0
80	89	31,357,390		89	31,357,390	---				96	73,728,520	---
80	97	27,659,550		97	3,861,740	----						
81	92	24,000,000		92	24,000,000	0	92	24,000,000	4,219,320	92	39,545,720	0
81	55	22,475,950		40	11,965,380	---	37	35,000,000	---	55	23,673,600	---
81	56	16,743,370		45	22,475,950	---						
81				57	4,778,000	---						
82	93	20,000,000		93	20,000,000	67,134,860	93	20,000,000	67,134,860	93	21,590,930	0
82	52	5,080,420								52	29,150,000	---
82	56	13,001,920								56	35,200,840	---
82	57	31,645,190								58	504,740	---
82	35	8,784,220								42	688,350	---
82	42	1,860,090										
82	43	6,763,010										
83	97	105,257,800		97	105,257,800	---	94	96,000,000	95,257,800	97	89,615,430	---
83	94	86,000,000		94	86,000,000	0				94	101,066,700	575,670
84	97	284,341,390		97	286,917,160	---	97	286,917,160	---	N.P.	0	289,917,160
84	95	12,000,000		95	12,000,000	0		12,000,000	0			
85	96	92,000,000		96	92,000,000	0	96	92,585,060	0	96	92,585,060	0
85				97	585,060	---						
86	102	124,861,610		99	119,000,000	329,716,400	99	119,000,000	329,716,400	N.P.	0	448,716,400
86	101	40,000,000										
86	99	119,000,000										

TABLE XXIII (CONTINUED)

Supply Area	MODEL III Location of Processing	MODEL III Quantity Transferred	MODEL III Unused Production	MODEL IV Location of Processing	MODEL IV Quantity Transferred	MODEL IV Unused Production	MODEL V Location of Processing	MODEL V Quantity Transferred	MODEL V Unused Production	MODEL VI Location of Processing	MODEL VI Quantity Transferred	MODEL VI Unused Production
86	100	23,000,000										
87	N.P.	0	290,550,430	100	23,000,000	267,550,430	97	118,387,630	---	102	117,076,640	0
87							100	37,000,000	135,162,800	101	13,770,710	---
87										97	68,189,020	---
87										98	33,431,620	---
87										100	49,556,400	---
87										103	8,526,040	---
88	97	168,511,430		97	168,511,430	0	97	168,511,430	0	97	168,511,430	0
89	N.P.	0	58,906,360	101	36,000,000	22,906,360	101	58,906,360	0	101	58,906,360	0
90	N.P.	0	62,381,180	102	62,381,180	0	102	62,381,180	0	102	62,381,180	0
91	N.P.	0	196,497,810	102	81,618,820	114,878,990	104	15,000,000	53,785,350	104	1,554,550	194,943,250
91							102	112,618,820	---			
91							101	6,093,640	---			
91							103	9,000,000	---			
92	N.P.	0	52,368,380	105	7,000,000	45,368,380	105	7,325,760	45,042,620	105	8,790,910	43,577,470

TABLE XXIV

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

	MODEL III				MODEL IV				MODEL V				MODEL VI			
Demand Area	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	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	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	1	49,761,200	49,761,200	762,342
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	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	1=23,000,000 2=14,000,000 3= 4,073,000	520,300	3	41,073,450	1=23,000,000 2=14,000,000 3= 4,073,000	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	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	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= 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	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	2,871,640	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	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	372,397,780	272,397,780	3,282,393
7	9	2,599,590	---	---	3	27,620	---	---	7	3,000,000	1= 3,000,000	46,100	7	4,502,500	4,502,500	72,220
7	15	1,902,910	---	---	15	4,474,880	---	---	5	1,502,300	---	---				
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	8	6,494,370	1= 4,000,000 2= 2,000,000 3= 494,370	100,280	8	6,494,370	6,494,370	106,374
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	105,540	9	1,961,040	1= 1,961,040	31,650	9	7,297,900	7,297,900	115,891
9					15	297,900	---	---	15	5,336,860	---	---				

TABLE XXIV (CONTINUED)

Demand Area	MODEL III Processing Center	MODEL III Quantity	MODEL III Size of Plant	MODEL III Cost	MODEL IV Processing Center	MODEL IV Quantity	MODEL IV Size of Plant	MODEL IV Cost	MODEL V Processing Center	MODEL V Quantity	MODEL V Size of Plant	MODEL V Cost	MODEL VI Processing Center	MODEL VI Quantity	MODEL VI Total Quantity Processing	MODEL VI 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	10,000,000	1= 6,000,000 2= 4,000,000	144,590	10	10,157,250	10,157,250	175,517
10	59	157,250	---	---	59	157,250	---	---	2	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	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	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	2,000,000	1= 2,000,000	32,230	12	2,439,970	2,439,970	43,163
12					15	6,510	---	---	15	446,480	---	---	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	3,000,000	1= 3,000,000	46,100	13	5,136,260	5,136,260	90,039
13					66	136,260	---	---	20	2,136,260	---	---				
14	15	3,880,420	---	---	14	3,880,420	1= 2,000,000 2= 1,000,000 3= 880,420	64,960	14	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	1=13,000,000 2= 8,000,000 3= 2,000,000 4=12,000,000	456,120	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	6,370,000	---	---	15	6,370,000	---	---	15	4,562,820	---	----
16													16	1,807,180	1,807,180	29,023
17	21	4,530,000	---	---	21	4,530,000	---	---	18	4,530,000	---	---	18	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	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	5,000,000	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	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	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	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

TABLE XXIV (CONTINUED)

Demand Area	MODEL III Processing Center	MODEL III Quantity	MODEL III Size of Plant	MODEL III Cost	MODEL IV Processing Center	MODEL IV Quantity	MODEL IV Size of Plant	MODEL IV Cost	MODEL V Processing Center	MODEL V Quantity	MODEL V Size of Plant	MODEL V Cost	MODEL VI Processing Center	MODEL VI Quantity	MODEL VI Total Quantity Processing	MODEL VI Cost
			4= 168,770				4= 168,770				4= 1,843,860					
21	21	15,937,620	1= 9,000,000 2= 6,000,000 3= 1,000,000 4= 4,467,620	289,650	21	15,937,620	1= 9,000,000 2= 6,000,000 3= 1,000,000 4= 4,467,000	289,650	21	15,937,620	1= 9,000,000 2= 6,000,000 3= 937,620	223,360	21	15,937,620	15,927,620	256,755
22	22	9,616,200	1= 5,000,000 2= 3,000,000 3= 1,616,200	144,640	22	9,616,200	1= 5,000,000 2= 3,000,000 3= 1,616,200	144,640	22	9,616,200	1= 5,000,000 2= 3,000,000 3= 1,616,200	144,640	22	9,616,200	9,616,200	152,513
23	23	13,000,000	1= 8,000,000 2= 5,000,000	182,120	23	13,000,000	1=13,000,000	182,120	23	13,000,000	1=13,000,000	182,120	23	14,139,220	14,139,220	227,076
23	27	1,139,220	---	---	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	6,000,000	1= 6,000,000	85,150	24	10,294,450	10,294,450	165,638
24	27	4,294,450	---	---	27	4,294,450	---	---	27	4,294,450	---	---				
25	27	1,073,900	---	---	27	1,073,900	---	---	18	852,290	---	---	25	14,073,900	14,073,900	223,775
25	25	13,000,000	1= 8,000,000 2= 5,000,000	182,120	25	13,000,000	1= 8,000,000 2= 5,000,000	182,120	25	13,221,610	1= 8,000,000 2= 5,000,000 3= 221,610	185,690				
26	27	13,378,930	---	---	27	13,378,930	---	---	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 2=23,000,000 3= 7,000,000 4=29,240,260	1,137,940	27	65,056,870	1=36,000,000 2=23,000,000 3= 7,000,000 4=27,917,500	1,124,000	27	65,056,870	1=36,000,000 2=23,000,000 3= 7,000,000 4=27,603,230	1,120,690	27	65,056,870	78,068,240	1,149,945
28	27	5,406,800	---	---	27	3,406,800	---	---	27	5,406,800	---	---	28	56,406,800	56,406,800	850,615
28	28	51,000,000	1=31,000,000 2=20,000,000	611,120	28	53,000,000	1=31,000,000 2=20,000,000 3= 2,000,000	590,630	28	51,000,000	1=31,000,000 2=20,000,000	611,120				
29	27	3,152,120	---	---	27	3,152,120	---	---	27	3,152,120	---	---	29	32,152,120	32,152,120	481,960
29	29	29,000,000	1=18,000,000 2=11,000,000	370,690	29	29,000,000	1=18,000,000 2=11,000,000	370,690	29	29,000,000	1=18,000,000 2=11,000,000	370,690				
30	27	1,737,970	---	---	27	1,737,970	---	---	27	1,737,970	---	---	30	21,737,970	21,737,970	318,027
30	30	20,000,000	1=12,000,000 2= 8,000,000	267,030	30	20,000,000	1=12,000,000 2= 8,000,000	267,030	30	20,000,000	1=12,000,000 2= 8,000,000	267,030				
31	31	24,901,890	1=14,000,000 2= 9,000,000 3= 2,000,000	491,590	31	24,901,890	1=14,000,000 2= 9,000,000 3= 2,000,000	491,590	31	24,901,890	1=14,000,000 2= 9,000,000 3= 2,000,000	491,590	31	24,901,890	29,882,270	434,789

TABLE XXIV (CONTINUED)

Demand Area	MODEL III Processing Center	MODEL III Quantity	MODEL III Size of Plant	MODEL III Cost	MODEL IV Processing Center	MODEL IV Quantity	MODEL IV Size of Plant	MODEL IV Cost	MODEL V Processing Center	MODEL V Quantity	MODEL V Size of Plant	MODEL V Cost	MODEL VI Processing Center	MODEL VI Quantity	MODEL VI Total Quantity Processing	MODEL VI Cost
			4=12,000,000				4=12,000,000				4=12,000,000					
32	31	12,098,110	---	---	31	12,098,110	---	---	27	3,821,060	---	---	32	23,127,920	23,127,920	343,450
32	75	8,012,750	---	---	75	4,206,510	---	---	31	12,098,110	---	---	31	4,980,370	---	---
32	74	7,997,440	---	---	74	10,802,500	---	---	73	12,189,130	---	---				
32						1,001,180	---	---								
33	33	18,000,000	1=12,000,000 2= 6,000,000	242,370	33	18,000,000	1=12,000,000 2= 6,000,000	242,370	33	18,000,000	1=12,000,000 2= 6,000,000	242,370	33	19,450,000	19,450,000	317,424
33	77	2,461,340	---	---	75	4,411,990	---	---	75	4,411,990	---	---	75	2,961,990	---	---
33	75	1,950,650	---	---												
34	34	26,615,800	1=15,000,000 2= 9,000,000 3= 2,615,800	354,060	34	25,938,570	1=15,000,000 2= 9,000,000 3= 1,938,570	344,350	34	24,000,000	1=15,000,000 2= 9,000,000	313,480	34	13,604,430	13,604,430	218,351
34					27	677,230	---	---	27	2,615,800	---	---	27	13,011,370	---	---
35	35	58,768,310	1=32,000,000 2=21,000,000 3= 5,768,310	714,420	35	58,768,310	1=32,000,000 2=21,000,000 3= 5,768,310	714,420	35	58,768,310	1=32,000,000 2=21,000,000 3= 5,768,310	714,420	35	58,768,310	58,768,310	956,748
36	77	9,532,750	---	---	77	9,532,750	---	---	39	9,532,750	---	---	77	9,532,750	---	---
37	37	35,000,000	1=21,000,000 2=14,000,000	438,200	37	35,000,000	1=21,000,000 2=14,000,000	438,200	37	35,000,000	1=21,000,000 2=14,000,000	438,200	37	38,765,920	38,765,920	607,074
37	80	3,765,920	---	---	80	3,765,920	---	---	80	3,765,920	---	---				
38	38	33,000,000	1=20,000,000 2=13,000,000	415,810	38	33,000,000	1=20,000,000 2=13,000,000	415,810	38	33,000,000	1=20,000,000 2=13,000,000	415,810	38	36,055,890	36,055,890	537,593
38	77	3,055,890	---	---	77	3,055,890	---	---	39	3,055,890	---	---				
39	39	29,174,320	1=16,000,000 2=10,000,000 3= 3,174,320	384,660	39	29,174,320	1=16,000,000 2=10,000,000 3= 3,174,320	384,660	39	29,174,320	1=16,000,000 2=10,000,000 3= 4,000,000 4=15,000,000	587,390	39	29,174,320	29,174,320	458,329
40	40	42,705,970	1=23,000,000 2=15,000,000 3= 4,705,970	539,690	40	42,705,970	1=23,000,000 2=15,000,000 3= 4,705,970	539,690	40	42,705,970	1=23,000,000 2=15,000,000 3= 4,705,970	539,690	40	42,705,970	42,705,970	658,099
41	41	27,786,640	1=15,000,000 2=10,000,000 3= 2,786,640	368,390	41	27,786,640	1=15,000,000 2=10,000,000 3= 2,786,640	368,390	41	27,786,640	1=15,000,000 2=10,000,000 3= 2,786,640	368,390	41	27,786,640	27.786,640	462,925
42	42	43,662,670	1=24,000,000 2=15,000,000 3= 4,662,670	549,840	42	43,662,670	1=24,000,000 2=15,000,000 3= 4,662,670	549,840	42	43,662,670	1=24,000,000 2=15,000,000 3= 5,000,000	554,240	42	43,662,670	43,662,670	689,870

TABLE XXIV (CONTINUED)

Demand Area	MODEL III Processing Center	MODEL III Quantity	MODEL III Size of Plant	MODEL III Cost	MODEL IV Processing Center	MODEL IV Quantity	MODEL IV Size of Plant	MODEL IV Cost	MODEL V Processing Center	MODEL V Quantity	MODEL V Size of Plant	MODEL V Cost	MODEL VI Processing Center	MODEL VI Quantity	MODEL VI Total Quantity Processing	MODEL VI 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	372,340	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	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	243,140	44	19,335,230	19,335,230	33,726
44	87	2,743,130	---	---	87	2,743,130	---	---	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=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	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	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	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	89	17,934,360	---	---	89	17,934,360	---	---	97	5,934,360	---	---				
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	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	37	5,676,350	---	---	46	5,676,350	---	---								
48	94	12,578,020	---	---	94	12,578,020	---	---	48	7,000,000	1= 7,000,000	97,580	46	12,578,020	---	---
48									97	5,578,020	---	---				
49	87	9,223,030	---	---	87	8,247,390	---	---	45	11,716,290	---	---	49	32,446,920	32,446,920	506,172
49	44	7,251,650	---	---	45	7,251,650	---	---	49	18,000,000	1=18,000,000	225,130				
49	49	1,335,230	1= 1,335,230	18,950	49	2,310,870	1= 2,310,870	32,790	94	2,730,630	---	---				
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	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	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	31,926,010	1=18,000,000 2=11,000,000 3= 2,926,010	415,760	51	31,926,010	31,926,010	482,721
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	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	31,879,100	1=18,000,000	415,110	53	31,879,100	1=18,000,000	415,110	53	29,000,000	1=18,000,000	370,690	53	31,879,100	31,879,100	504,965

TABLE XXIV (CONTINUED)

	MODEL III				MODEL IV				MODEL V				MODEL VI			
Demand Area	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Total Quantity Processing	Cost
			2=11,000,000 3= 2,879,100				2=11,000,000 3= 2,879,000				2=11,000,000					
53									52	669,520	---	---				
53									39	1,842,250	---	---				
53									42	337,330	---	---				
54	54	26,000,000	1=16,000,000 2=10,000,000	336,550	54	26,000,000	1=16,000,000 2=10,000,000	336,550	54	28,747,950	1=16,000,000 2=10,000,000 3= 2,747,950	379,160	54	28,747,950	28,747,950	458,817
54	55	2,747,950	---	---	55	2,747,950	---	---								
55	55	19,728,000	1=11,000,000 2= 7,000,000 3= 2,000,000 4= 2,475,950	313,420	55	19,728,000	1=11,000,000 2= 7,000,000 3= 2,000,000 4= 2,475,950	313,420	55	19,728,000	1=11,000,000 2= 7,000,000 3= 1,728,000	271,340	55	19,728,000	23,673,600	375,937
56	56	39,146,440	1=22,000,000 2=14,000,000 3= 3,146,440	495,050	56	39,146,440	1=22,000,000 2=14,000,000 3= 3,146,440	495,050	56	39,146,440	1=22,000,000 2=14,000,000 3= 3,146,440	495,050	56	35,200,840	35,200,840	575,182
56													55	3,945,600	---	---
57	57	31,645,190	1=17,000,000 2=11,000,000 3= 3,645,190	414,220	57	31,645,190	1=17,000,000 2=11,000,000 3= 3,645,000	414,220	57	31,645,190	1=17,000,000 2=11,000,000 3= 3,645,000	414,220	57	31,645,190	31,645,190	484,804
58	58	40,166,140	1=22,000,000 2=14,000,000 3= 4,166,140	510,660	58	40,166,140	1=22,000,000 2=14,000,000 3= 4,166,140	510,660	58	40,166,140	1=22,000,000 2=14,000,000 3= 4,166,140	510,660	58	40,166,140	40,166,140	589,237
59	59	6,048,000	1= 3,000,000 2= 2,000,000 3= 1,048,000	106,050	59	6,048,000	1= 3,000,000 2= 2,000,000 3= 1,369,250	101,260	59	6,048,000	1= 3,000,000 2= 2,000,000 1= 1,906,430	109,230	59	6,048,000	6,048,000	109,166
60	60	8,000,000	1= 5,000,000 2= 3,000,000	118,590	60	8,000,000	1= 5,000,000 2= 3,000,000	118,590	60	8,000,000	1= 5,000,000 2= 3,000,000	118,590	60	6,713980	6,713,980	124,007
60	66	731,750	---	---	66	731,750	---	---	66	731,750	---	---	65	2,017,770	---	---
61	61	8,000,000	1= 5,000,000 2= 3,000,000	118,590	61	8,000,000	1= 5,000,000 2= 3,000,000	118,590	61	8,000,000	1= 5,000,000 2= 3,000,000	118,590	61	8,443,540	8,443,540	152,321
61	66	443,540	---	---	66	443,540	---	---	66	443,540	---	---				
62	62	8,000,000	1= 5,000,000 2= 3,000,000	118,590	62	8,000,000	1= 5,000,000 2= 3,000,000	118,590	62	8,000,000	1= 5,000,000 2= 3,000,000	118,590	62	8,619,470	8,619,470	163,511
62	66	619,470	---	---	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	63	6,000,000	1= 4,000,000	91,670	63	6,858,430	6,858,430	112,341

TABLE XXIV (CONTINUED)

	MODEL III				MODEL IV				MODEL V				MODEL VI			
Demand Area	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Total Quantity Processing	Cost
			2= 2,000,000				2= 2,000,000				2= 2,000,000					
63	66	535,260	---	---	66	858,430	---	---	59	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	97,580	64	7,000,000	1= 7,000,000	97,580	64	12,211,320	12,211,320	201,609
			2= 4,000,000													
			3= 1,211,320													
64					66	5,211,320	---	---	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	6,000,000	1= 6,000,000	85,150	65	10,088,850	12,106,620	200,122
65	66	4,088,850	---	---	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	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				2=26,000,000				2=26,000,000					
			3= 8,000,000				3= 8,000,000				3= 8,000,000					
			4=36,000,000				4=37,000,000				4=33,671,680					
67	67	11,000,000	1=11,000,000	145,560	67	18,000,000	1=11,000,000	243,140	67	18,000,000	1=11,000,000	243,140	67	20,491,110	20,491,110	346,095
							2= 7,000,000				2= 7,000,000					
67	66	9,491,110	---	---	66	2,491,110	---	---	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	68	16,389,840	1=11,000,000	222,670	68	20,506,470	24,607,760	369,855
			2= 7,000,000				2= 7,000,000				2= 5,389,840					
68	66	2,506,470	---	---	66	2,506,470	---	---	66	4,116,630	---	---				
69	69	29,000,000	1=18,000,000	370,690	69	29,000,000	1=18,000,000	370,690	69	29,000,000	1=18,000,000	370,690	69	29,329,990	29,329,990	482,185
			2=11,000,000				2=11,000,000				2=11,000,000					
69	80	3,272,030	---	---	80	3,272,030	---	---	80	3,272,030	---	---	68	2,942,040		
70	70	12,498,850	1= 7,000,000	181,180	70	12,498,850	1= 7,000,000	181,180	70	12,498,850	1= 7,000,000	181,180	70	12,498,850	12,498,850	206,856
			2= 4,000,000				2= 4,000,000				2= 4,000,000					
			3= 1,498,850				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	71	18,000,000	1=18,000,000	225,130	71	31,899,400	31,899,400	503,692
			2=11,000,000				2=11,000,000									
71	66	2,899,400	---	---	66	2,899,400	---	---	66	284,850	---	---				
71									74	13,614,550	---	---				
72	74	6,812,050	---	---	72	4,000,000	1= 4,000,000	59,440	72	6,000,000	1= 4,000,000	91,670	72	6,812,050	6,812,050	107,767
											2= 2,000,000					
72					74	2,812,050	---	---	73	812,050	---	---				
73	73	13,000,000	1=13,000,000	168,750	73	23,998,820	1=13,000,000	338,000	73	23,998,820	1=13,000,000	495,220	73	23,998,820	23,998,820	380,381
							2= 8,000,000				2= 8,000,000					
							3= 4,000,000				3= 4,000,000					
											4=12,000,000					

TABLE XXIV (CONTINUED)

	MODEL III				MODEL IV				MODEL V				MODEL VI			
Demand Area	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Total Quantity Processing	Cost
73	74	10,998,820	---	---												
74	74	55,172,550	1=30,000,000	987,700	74	55,172,550	1=30,000,000	987,700	74	55,172,550	1=30,000,000	987,700	74	55,172,550	66,207,060	1,003,699
			2=19,000,000				2=19,000,000				2=19,000,000					
			3= 7,000,000				3= 7,000,000				3= 7,000,000					
			4=24,980,900				4=24,980,900				4=24,980,000					
75	75	18,036,600	1=10,000,000	386,910	75	18,036,600	1=10,000,000	370,440	75	18,036,600	1=10,000,000	316,960	75	18,036,600	20,998,590	322,538
			2= 6,000,000				2= 6,000,000				2= 6,000,000					
			3= 3,000,000				3= 3,000,000				3= 3,000,000					
			4= 9,000,000				4= 7,655,100				4= 3,448,590					
76	77	12,193,760	---	---	74	12,193,760	---	---	74	12,193,760	---	---	74	11,034,510	---	---
76													68	1,159,260	---	---
77	77	65,002,120	1=36,000,000	1,177,580	77	65,002,120	1=36,000,000	994,980	77	65,002,120	1=36,000,000	780,110	77	65,002,120	74,534,880	1,097,153
			2=23,000,000				2=23,000,000				2=23,000,000					
			3= 7,000,000				3= 7,000,000				3= 6,002,130					
			4=33,000,000				4=11,590,770									
78	77	6,754,130	---	---	80	17,056,650	---	---	78	9,000,000	1= 9,000,000	121,900	78	17,056,650	17,056,650	265,231
78	80	10,302,520	---	---					80	8,056,650	---	---				
79	79	25,000,000	1=25,000,000	301,050	79	25,000,000	1=25,000,000	301,050	79	25,000,000	1=25,000,000	301,050	79	30,276,210	30,276,210	507,732
79	80	19,654,780	---	---	80	19,654,770	---	---	80	19,654,770	---	---	81	14,378,560	---	---
80	80	237,478,800	1=131,000,000	3,756,560	80	237,478,800	1=131,000,000	3,756,560	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				2=59,000,000				2=59,000,000					
			3=24,000,000				3=24,000,000				3=24,000,000					
			4=17,000,000				4=17,000,000				4=17,000,000					
			5= 7,000,000				5= 7,000,000				5= 7,000,000					
			6=119,000,000				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	81	40,000,000	1=40,000,000	456,200	81	71,892,790	86,271,350	1,237,131
			2=25,000,000				2=25,000,000									
81	80	6,892,790	---	---	80	6,892,790	---	---	80	31,892,790	---	---				
82	82	18,762,220	1=10,000,000	259,750	82	17,432,980	1=10,000,000	238,330	82	10,000,000	1=10,000,000	133,770	82	18,762,220	18,762,220	311,640
			2= 7,000,000				2= 7,000,000									
			3= 1,762,220				3= 432,980									
82					66	1,329,240	---	---	80	8,762,220	---	---				
83	66	16,591,650	---	---	66	16,591,650	---	---	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	1= 5,000,000	121,670	84	8,176,990	1= 5,000,000	121,670	84	8,176,990	8,176,990	140,880
			2= 3,000,000				2= 3,000,000				2= 3,000,000					

TABLE XXIV (CONTINUED)

	MODEL III				MODEL IV				MODEL V				MODEL VI			
Demand Area	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Size of Plant	Cost	Processing Center	Quantity	Total Quantity Processing	Cost
			3= 176,990				3= 176,990				3= 176,990					
85	87	14,545,030	---	---	87	14,454,030	---	---	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	332,750	86	28,000,000	1=28,000,000	332,750	86	2,633,560	2,633,560	42,822
86	80	22,129,320	---	---	80	22,129,320	---	---	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	1=91,000,000	2,693,560	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				2=41,000,000				2=41,000,000					
			3=16,000,000				3=16,000,000				3=16,000,000					
			4=12,000,000				4=12,000,000				4=12,000,000					
			5= 5,000,000				5= 5,000,000				5= 5,000,000					
			6=83,000,000				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	89	9,977,010	---	---	88	39,780,840	39,780,840	647,632
88	87	26,311,370	---	---	87	26,311,370	---	---	87	48,334,370	---	---	87	18,530,530	---	---
89	89	135,594,310	1=75,000,000	2,269,380	89	135,594,310	1=75,000,000	2,269,380	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				2=41,000,000				2=41,000,000					
			3=14,000,000				3=14,000,000				3=14,000,000					
			4= 7,000,000				4= 7,000,000				4= 7,000,000					
			5=68,000,000				5=68,000,000				5=36,642,610					
90	90	64,000,000	1=41,000,000	745,890	90	64,000,000	1=41,000,000	745,890	90	64,000,000	1=41,000,000	745,890	90	75,098,430	75,098,430	1,122,722
			2=23,000,000				2=23,000,000				2=23,000,000					
90	80	10,439,830	---	---	80	3,078,630	---	---	89	11,098,430	---	---				
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	40,885,570	1=26,000,000	508,040	91	47,317,980	48,725,870	782,050
											2=14,885,570					
91	87	21,317,980	---	---	87	21,317,980	---	---	89	6,432,400	---	---				
92	92	24,000,000	1=24,000,000	290,350	92	24,000,000	1=24,000,000	290,350	92	24,000,000	1=24,000,000	290,350	92	66,080,160	66,080,160	998,471
92	80	42,080,160	---	---	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	93	20,000,000	1=20,000,000	267,030	93	21,590,930	21,590,930	334,659
			2= 8,000,000													
93	80	1,590,930	---	---	80	1,590,930	---	---	80	196,150	---	---				
93									39	1.394,780						
94	94	58,784,970	1=56,000,000	968,810	94	58,784,970	1=56,000,000	968,160	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=30,000,000				2=30,000,000					
											3=10,000,000					
94	89	42,281,730	---	---	89	42,281,730	---	---	89	7,797,330	---	---				
95	95	12,000,000	1=12,000,000	157,220	95	12,000,000	1=12,000,000	157,220	95	12,000,000	1=12,000,000	157,220	89	21,189,600	---	---

TABLE XXIV (CONTINUED)

Demand Area	MODEL III Processing Center	Quantity	Size of Plant	Cost	MODEL IV Processing Center	Quantity	Size of Plant	Cost	MODEL V Processing Center	Quantity	Size of Plant	Cost	MODEL VI Processing Center	Quantity	Total Quantity Processing	Cost
95	89	9,189,600	---	---	89	9,189,600	---	---	99	9,189,600	---	---				
96	96	92,000,000	1=92,000,000	975,660	96	92,000,000	1=92,000,000	975,660	96	92,585,060	1=92,000,000	983,190	96	166,313,590	166,313,590	2,556,240
											2= 585,060					
96	97	74,313,590	---	---	97	74,313,590	---	---	97	73,728,520	---	---				
97	97	458,890,950	1=252,000,000	6,080,000	97	458,890,950	1=252,000,000	6,421,330	97	458,890,950	1=252,000,000	5,711,430	97	458,890,950	458,890,950	6,933,842
			2=115,000,000				2=115,000,000				2=115,000,000					
			3=46,000,000				3=46,000,000				3=46,000,000					
			4=32,000,000				4=32,000,000				4=32,000,000					
			5=14,000,000				5=14,000,000				5=14,000,000					
			6=155,174,080				6=196,000,000				6=114,816,210					
98	97	23,697,290	---	---	97	29,140,360	---	---	97	15,329,960	---	---	98	33,431,620	33,431,620	566,332
98	99	9,734,320	---	---	99	4,291,260	---	---	99	18,101,660	---	---				
99	99	79,626,300	1=44,000,000	1,378,770	99	79,626,300	1=44,000,000	1,378,770	99	79,626,300	1=44,000,000	1,378,770	99	73,697,040	73,697,040	1,238,841
			2=24,000,000				2=24,000,000				2=24,000,000					
			3= 8,000,000				3= 8,000,0008				3= 8,000,000					
			4= 3,000,000				4= 3,000,008				4= 3,000,000					
			5=40,000,000				5=40,000,000				5=40,000,000					
99													89	5,929,260	---	---
100	100	6,214,560	1=23,000,000	279,630	100	6,214,560	1=23,000,000	279,630	100	29,214,560	1=23,000,000	459,870	100	41,297,000	49,556,400	812,725
											2=14,000,000					
100	87	5,443,060	---	---	99	35,082,440	---	---	99	12,082,440	---	---				
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	65,000,000	1=40,000,000	757,250	101	72,677,080	72,677,080	1,148,298
											2=25,000,000					
101	97	32,677,070	---	---	97	36,677,070	---	---	97	7,677,070	---	---				
102	102	175,000,000	1=99,000,000	1,917,790	102	144,000,000	1=99,000,000	1,523,920	102	175,000,000	1=99,000,000		102	179,457,820	179,457,820	2,833,632
			2=45,000,000				2=45,000,000				2=45,000,000					
			3=18,000,000								3=18,000,000					
			4=13,000,000								4=13,000,000					
102	97	4,457,820	---	---	97	35,457,820	---	---	97	4,457,820	---	---				
103	100	16,785,440	---	---	100	16,785,440	---	---	100	7,785,440	---	---	100	8,259,400	---	---
103									103	9,000,000	1= 9,000,000	121,900	103	8,526,040	8,526,040	154,066
104									97	2,219,510	---	---	105	1,465,150	---	---
									104	15,000,000	1= 9,000,000	206,960	104	15,754,360	15,754,360	270,502
											2= 6,000,000					
105	105	7,000,000	1= 4,000,000	105,540	105	7,000,000	1= 4,000,000	105,540	105	7,325,760	1= 4,000,000	111,210	105	7,325,760	8,790,910	143,907

TABLE XXIV (CONTINUED)

Demand Area	MODEL III Processing Center	MODEL III Quantity	MODEL III Size of Plant	MODEL III Cost	MODEL IV Processing Center	MODEL IV Quantity	MODEL IV Size of Plant	MODEL IV Cost	MODEL V Processing Center	MODEL V Quantity	MODEL V Size of Plant	MODEL V Cost	MODEL VI Processing Center	MODEL VI Quantity	MODEL VI Total Quantity Processing	MODEL VI Cost
			2= 3,000,000				2= 3,000,000				2= 3,000,000 3= 325,760					
105	97	325,760	---	---	97	325,760	---	---								

APPENDIX IV

SELECTED STATISTICS IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

TABLE XXV

NUMBER OF PRODUCTION AREAS IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Potential Number of Production Areas	MODEL I	II	III	IV	V	VI
Western Region	20	15	13	15	19	18	16
Pacific	7	6	6	4	6	6	7
Mountain	13	9	7	11	13	12	9
West South Central Region	15	14	9	11	12	15	10
Southern Region	20	19	9	13	19	20	9
South Atlantic	14	13	5	7	13	14	5
East South Central	6	6	4	6	6	6	4
North Central Region	27	19	26	27	26	26	26
West North Central	16	10	15	16	15	15	15
East North Central	11	9	11	11	11	11	11
Northeast Region	10	9	7	5	10	10	8
Mid-Atlantic	6	5	4	5	6	6	4
New England	4	4	3	0	4	4	4
Total	92	76	64	71	86	89	69

TABLE XXVI

UNUSED PRODUCTION IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Unused Production					
	Model					
	I	II	III	IV	V	VI
Western Region	251,915,250	304,581,820	633,754,480	296,482,330	257,136,430	320,614,750
Pacific	210,894,060	230,662,080	602,793,990	275,896,620	215,736,800	222,272,630
Mountain	41,021,190	73,919,740	30,960,490	20,585,710	41,399,630	98,342,120
West South Central Region	24,185,210	147,684,150	57,697,620	52,671,340	41,145,250	156,044,760
Southern Region	56,535,070	365,396,190	327,524,560	122,091,500	14,083,930	365,396,190
South Atlantic	56,535,070	302,271,700	273,464,710	83,578,890	13,005,650	302,271,700
East South Central	0	63,124,490	54,059,850	38,512,610	1,078,280	63,124,490
North Central Region	889,424,500	1,637,250	6,726,480	578,757,220	859,092,350	1,637,250
West North Central	406,161,750	1,637,250	0	290,613,900	341,365,120	1,637,250
East North Central	483,262,750	0	6,726,480	288,143,320	517,727,230	0
North East Region	608,362,910	1,011,123,520	804,719,780	780,420,560	658,964,970	986,729,950
Mid-Atlantic	563,320,290	769,583,090	434,566,050	597,266,830	560,137,000	748,209,230
New England	45,042,620	241,540,430	370,153,730	183,153,730	98,827,970	238,520,720
Total	1,830,422,940	1,830,422,930	1,830,422,920	1,830,422,950	1,830,422,930	1,830,422,900

TABLE XXVII

TOTAL ASSEMBLY COSTS IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	388,257	660,433	7,070,618	933,524	414,377	842,193
Pacific	361,564	408,745	6,502,210	795,889	371,164	427,415
Mountain	26,693	251,688	568,408	137,635	43,213	414,778
West South Central Region	157,619	1,067,440	428,128	212,154	109,295	1,246,350
Southern Region	803,157	2,092,443	2,908,199	1,112,445	863,038	4,232,356
South Atlantic	620,767	1,558,350	2,578,239	831,137	679,201	3,122,876
East South Central	182,390	534,093	329,960	281,308	183,837	1,109,480
North Central Region	123,910	1,915,548	1,065,718	898,722	455,501	1,285,594
West North Central	73,050	387,814	502,409	207,592	155,579	406,296
East North Central	50,860	1,527,734	563,309	691,130	299,922	879,298
Northeast Region	1,743,116	3,387,532	3,595,441	2,351,482	1,786,993	4,041,560
Mid-Atlantic	1,339,888	2,731,210	2,132,637	2,193,958	1,493,290	3,292,987
New England	403,228	656,322	1,462,804	157,524	293,703	748,573
Total	3,216,059	9,123,396	15,068,104	5,508,327	3,629,204	11,648,053

TABLE XXVIII

INTERMARKET MOVEMENTS OF RAW MILK, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	I	II	III	IV	V	VI
Western Region	72,086,010	112,039,030	472,914,240	86,052,250	69,589,800	134,381,650
Pacific	65,445,940	65,445,930	397,150,840	65,445,930	11,443,860	69,948,840
Mountain	6,640,070	46,593,100	75,763,400	20,606,320	68,445,940	64,433,210
West South Central Region	46,127,350	120,550,330	54,023,540	40,606,490	336,081,250	181,671,690
Southern Region	327,636,980	428,590,080	460,350,320	308,448,890	262,834,310	618,490,220
South Atlantic	254,668,560	352,585,010	387,440,710	235,539,280	73,246,940	475,634,310
East South Central	72,968,420	76,005,070	72,909,610	72,909,610	35,072,300	142,855,910
North Central Region	53,603,670	471,242,660	325,303,217	301,957,760	189,968,590	345,788,700
West North Central	32,587,030	99,915,080	114,658,317	93,249,180	68,050,380	101,683,650
East North Central	21,016,640	371,327,580	210,644,900	208,708,580	121,918,210	244,105,050
Northeast Region	634,461,790	683,315,260	691,652,670	568,714,550	548,017,250	626,364,440
Mid-Atlantic	427,488,570	518,462,970	469,652,670	487,095,730	405,304,790	471,236,700
New England	206,973,220	164,852,290	222,000,000	81,618,820	142,712,460	155,127,740
Total	1,137,915,800	1,819,103,990	2,004,243,987	1,305,779,940	1,178,729,190	1,906,696,700

TABLE XXIX

EXPORTS OF RAW FLUID MILK, UNITED STATES AND REGIONS,
MODELS I THROUGH VI

	I	II	III	IV	V	VI
Western Region						
Mountain→Pacific	8,798,690	20,183,770	93,220,040	46,597,440	11,798,690	20,177,260
→West South Central	852,290	2,406,500	0	0	2,406,500	2,406,500
West South Central Region						
West South Central→East South Central	6,301,060	18,501,060	6,301,060	6,301,060	7,751,060	6,301,060
Southern Region						
South Atlantic→East South Central	17,196,300	0	0	0	17,196,300	0
→Mid-Atlantic	0	113,177,140	0	30,236,760	0	0
East South Central→West South Central	6,975,310	1,292,440	0	8,784,220	8,784,220	21,716,910
→South Atlantic	20,719,450	24,682,480	0	0	15,072,070	24,682,480
North Central Region						
West North Central→Pacific	0	0	249,331,010	18,848,490	0	0
→Mountain	0	46,593,100	75,763,400	16,781,100	0	62,626,030
→West South Central	0	119,239,260	26,784,210	5,837,270	0	115,008,260
→East North Central	0	51,716,610	4,220,150	698,050	13,974,330	49,106,010
→East South Central	0	20,755,420	4,068,670	0	0	72,243,840
East North Central→Pacific	0	0	35,700,210	0	0	0
→West North Central	687,630	0	29,000,000	0	687,630	0
→South Atlantic	0	150,808,070	249,577,100	56,145,970	0	238,088,760
→East South Central	39,401,422	48,948,590	71,324,100	27,639,370	35,000,000	56,650,560
→Mid-Atlantic	0	222,197,410	56,053,480	64,098,950	0	265,964,460
→New England	0	0	57,138,390	0	0	13,726,480
Northeast Region						
Mid-Atlantic→New England	0	164,852,290	164,861,610	0	0	139,373,390
Total	100,932,152	980,671,660	1,067,019,330	281,968,680	112,670,800	

TABLE XXX

THE NUMBER OF PROCESSING FACILITIES ESTABLISHED IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	14	13	55	55	54	645
Pacific	6	6	22	22	24	432
Mountain	8	7	33	33	30	213
West South Central Region	12	9	30	30	30	231
South Region	17	14	55	54	60	587
South Atlantic	11	9	36	35	40	397
East South Central	6	5	19	19	20	190
North Central Region	16	16	76	77	75	1524
West North Central	10	10	42	44	44	587
East North Central	6	6	34	33	31	937
North East Central Region	5	7	21	21	31	1608
Mid-Atlantic	3	3	16	16	20	1046
New England	2	4	5	5	11	562
Total	64	59	237	237	250	4595

TABLE XXXI

PLANT CAPACITIES IN THE OPTIMUM MARKET ORGANIZATION, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	758,536,710	753,315,540	753,011,890	752,858,010	754,167,820	753,315,540
Pacific	584,373,290	575,990,370	576,017,990	576,017,990	582,530,550	584,373,300
Mountain	174,163,420	177,325,170	176,993,900	176,840,020	171,637,270	168,942,240
West South Central Region	397,662,770	386,867,910	377,240,580	377,240,580	380,209,350	394,700,760
Southern Region	793,293,510	669,966,470	770,363,050	772,281,200	830,983,990	839,400,610
South Atlantic	537,524,420	462,496,050	530,948,530	532,866,680	575,406,460	593,164,280
East South Central	255,769,090	207,470,420	239,414,520	239,414,520	255,577,530	246,236,330
North Central Region	1,476,869,660	1,795,520,370	1,608,322,670	1,601,704,800	1,511,603,540	1,523,112,320
West North Central	413,076,080	578,612,140	487,383,460	482,094,830	463,898,370	461,290,870
East North Central	1,063,793,580	1,216,908,230	1,120,939,210	1,119,609,970	1,047,705,170	1,061,821,450
North East Region	1,252,329,120	1,073,025,060	1,169,164,090	1,174,607,160	1,201,727,030	1,168,162,510
Mid-Atlantic	975,648,960	779,559,460	947,164,090	987,607,160	930,401,270	882,956,300
New England	276,680,160	293,465,600	222,000,000	187,000,000	271,325,760	285,206,210
Total	4,678,691,770	4,678,695,350	4,678,102,280	4,678,691,750	4,678,691,730	4,678,691,740

TABLE XXXII

PROCESSING COSTS PER POUND IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH IV

	Model					
	I	II	III	IV	V	VI
	(Cents)					
Western Region	1.03	1.03	1.16	1.19	1.19	1.43
Pacific	0.98	0.98	1.13	1.13	1.13	1.38
Mountain	1.18	1.15	1.25	1.37	1.36	1.59
West South Central Region	1.14	1.11	1.27	1.26	1.27	1.53
Southern Region	1.09	1.09	1.26	1.26	1.26	1.54
South Atlantic	1.09	1.08	1.24	1.24	1.25	1.53
East South Central	1.09	1.09	1.28	1.28	1.28	1.57
North Central Region	0.95	0.93	1.16	1.14	1.17	1.53
West North Central	1.07	1.03	1.26	1.28	1.28	1.58
East North Central	0.90	0.89	1.11	1.09	1.12	1.51
North East Region	0.88	0.93	1.05	1.04	1.07	1.57
Mid-Atlantic	0.87	0.90	1.04	1.03	1.05	1.56
New England	0.93	1.01	1.12	1.08	1.15	1.60
TOTAL	0.98	0.98	1.16	1.15	1.17	1.53

TABLE XXXIII

TOTAL PROCESSING COSTS IN THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	7,811,900	7,723,240	8,736,390	8,948,650	8,948,060	10,746,224
Pacific	5,752,110	5,679,760	6.521,140	6,521,510	6,611,540	8,067,524
Mountain	2,059,790	2,043,480	2,215,250	2,427,140	2,336,520	2,678,700
West South Central Region	4,524,850	4,287,220	4,783,250	4,739,110	4,826,570	6,054,639
Southern Region	8,656,320	7,270,380	9,671,670	9,700,700	10,469,640	12,922,054
South Atlantic	5,857,550	5,012,890	6,602,740	6,631,770	7,193,580	9,062,737
East South Central	2,798,770	2,257,490	3,068,930	3,068,930	3,276,060	3,859,317
North Central Region	14,018,080	16,764,300	18,642,160	18,302,560	17,620,880	23,368,052
West North Central	4,416,470	5,946,290	6,160,830	6,154,280	5,932,380	7,288,981
East North Central	9,601,610	10,818,010	12,481,330	12,148,280	11,688,500	16,079,071
Northeast Region	11,073,340	9,938,290	12,318,970	12,195,940	12,907,520	18,290,625
Mid-Atlantic	8,505,480	6,987,650	9,839,440	10,180,770	9,792,410	13,740,213
New England	2,567,860	2,950,640	2,479,530	2,015,170	3,115,110	4,550,412
Total	**46,084,490**	**45,983,430**	**54,152,440**	**53,886,960**	**54,772,670**	**71,381,594**

TABLE XXXIV

INTERMARKET MOVEMENTS OF PACKAGED MILK BY MODEL, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	39,384,740	44,320,810	19,744,090	16,168,080	23,212,060	12,979,750
Pacific	8,382,920	0	0	27,620	3,540,170	3,880,420
Mountain	31,001,820	44,320,810	19,744,090	16,140,460	19,671,890	9,099,330
West South Central Region	46,824,910	89,340,610	42,281,500	40,281,500	40,644,460	17,991,740
Southern Region	105,014,320	95,870,550	15,675,950	15,675,950	28,548,810	16,523,620
South Atlantic	67,396,650	67,785,630	9,999,600	15,675,950	12,385,810	16,523,620
East South Central	37,617,670	28,084,920	5,676,350	0	16,163,000	0
North Central Region	534,918,250	926,738,860	380,932,680	358,249,460	316,612,660	167,852,450
West North Central	76,904,170	258,151,900	108,321,510	86,245,370	78,709,080	44,466,820
East North Central	458,014,080	668,586,960	272,611,170	272,004,090	237,903,580	123,385,630
Northeast Region	425,961,590	91,948,130	239,321,540	280,090,370	168,815,030	9,724,550
Mid-Atlantic	336,065,010	74,728,620	239,321,540	280,090,370	168,815,030	8,259,400
New England	39,896,580	17,219,620	0	0	0	1,465,150
Total	**1,152,103,810**	**1,248,218,960**	**697,955,760**	**710,465,360**	**577,833,020**	**225,072,110**

TABLE XXXV

EXPORTS OF PROCESSED MILK, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	I	II	III	IV	V	VI
Western Region						
Mountain→Pacific	0	3,880,420	4,502,500	4,474,880	0	0
→West South Central	0	0	0	0	852,290	0
→West North Central	5,211,110	0	0	0	0	0
Pacific →Mountain	3,880,420	0	0	0	2,037,670	3,880,420
West South Central Region	0	0	0	0	0	0
Southern Region						
South Atlantic→Mid-Atlantic	8,720,300	0	0	0	0	0
→East South Central	0	0	5,676,350	0	2,179,580	0
→East North Central	0	0	0	0	1,394,780	0
North Central Region						
West North Central→Mountain	0	0	321,250	457,510	0	0
→West South Central	0	10,794,860	20,422,180	20,422,180	16,601,120	0
→East North Central	16,591,650	124,303,310	23,345,780	17,920,890	16,591,650	14,818,500
→East South Central	0	9,532,750	12,588,640	12,588,640	0	9,532,750
East North Central→Pacific						
→West North Central	32,272,030	0	3,272,030	3,272,030	3,272,030	0
→South Atlantic	0	132,076,130	32,826,530	30,908,380	2,743,130	1,407,890
→East South Atlantic	0	38,765,920	3,765,920	3,765,920	3,765,920	0
→Mid-Atlantic	0	122,256,300	56,914,390	51,471,330	7,797,330	27,118,860
Northeast Region						
Mid-Atlantic→New England	16,785,440	0	71,465,600	106,465,600	22,139,840	8,259,400
→South Atlantic	65,768,070	0	30,797,120	30,797,120	14,243,010	0
Total	149,228,840	441,609,690	265,898,290	279,644,480	93,618,350	65,017,820

TABLE XXXVI

TOTAL DISTRIBUTION COST OF OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	192,419	232,301	131,494	109,938	111,021	51,322
Pacific	46,336	0	0	188	26,539	16,259
Mountain	146,083	232,301	131,494	109,750	84,482	35,063
West South Central Region	128,494	273,457	169,630	163,022	161,311	48,656
Southern Region	284,618	353,635	66,673	150,714	116,023	57,075
South Atlantic	150,596	248,878	66,673	150,714	54,173	57,075
East South Central	134,022	104,757	0	0	61,850	0
North Central Region	1,825,145	4,313,377	1,523,494	1,308,754	985,528	554,946
West North Central	368,980	1,060,977	443,260	347,966	261,362	121,948
East North Central	1,456,165	3,252,400	1,080,234	960,788	724,166	432,998
Northeast Region	1,362,673	310,500	703,459	949,884	501,784	33,379
Mid-Atlantic	1,154,916	269,122	703,459	949,884	501,784	29,321
New England	207,757	41,328	0	0	0	4,058
Total	**3,793,349**	**5,483,270**	**2,594,750**	**2,682,312**	**1,875,667**	**755,378**

TABLE XXXVII

TOTAL COST OF ALL MARKET ACTIVITIES OF THE OPTIMUM MARKET ORGANIZATIONS, UNITED STATES AND REGIONS, MODELS I THROUGH VI

	Model					
	I	II	III	IV	V	VI
Western Region	8,392,576	8,615,974	15,938,502	9,992,112	9,473,458	11,639,739
Pacific	6,160,010	6,088,505	13,023,350	7,317,587	7,009,243	8,511,198
Mountain	2,232,566	2,527,469	2,915,152	2,674,525	2,464,215	3,128,541
West South Central Region	4,810,963	5,628,117	5,381,008	5,114,286	5,097,176	7,359,645
Southern Region	9,744,095	9,716,458	12,656,542	10,963,859	11,448,701	17,211,485
South Atlantic	6,628,913	6,820,118	9,247,652	7,612,621	7,926,954	12,242,688
East South Central	3,115,182	2,896,340	3,398,890	3,350,238	3,521,747	4,968,797
North Central Region	16,100,549	22,993,225	21,231,372	20,510,036	19,061,909	25,208,592
West North Central	4,860,384	7,395,081	7,106,499	6,709,838	6,349,321	7,817,225
East North Central	11,240,165	15,598,144	14,124,873	13,800,198	12,712,588	17,391,367
Northeast Region	14,155,142	13,636,322	16,617,870	15,497,306	15,196,297	22,365,564
Mid-Atlantic	11,000,284	9,987,982	12,675,536	13,324,612	11,787,484	17,062,521
New England	3,154,858	3,648,290	3,942,334	2,172,694	3,408,813	5,303,043
Total	53,203,325	60,590,096	71,815,294	62,077,599	60,277,541	83,785,025

APPENDIX V

MODEL IVa

In Chapter Six, several models were presented to test the sensitivity of optimum market organization under various assumptions pertaining to base point pricing schemes. To adequately test these affects, no changes were made regarding other assumptions which may influence the market organization; however, the equation used to estimate consumption in Chapter III contains a pricing variable. As prices paid to farmers vary, these additional costs and savings were assumed to be passed on to the consumer. The purpose of this brief analysis is to compare the results of Model IV (prices paid to farmers determined by a base price plus a 9 cent incremental adjustment per hundredweight per one hundred miles) with Model IVa (prices paid to farmers determined in same manner but price effects on consumption also included).

Consumption estimates used in Model IVa were basically determined in the same manner as those in Model IV. The only exception was that the price used in Model IVa was standardized to the base point price (which is the hypothetical farm price in the New York City area) plus the 9 cents differential. Deviations in the standardized price and the actual 1965 farm price were determined and multiplied by a factor of 1.22 to estimate the retail price for a given area.* The newly computed retail price was used in the computation of new consumption estimates. As a result of the new pricing affect on consumption, total consumption in the United States decreased by approximately 44 million pounds. Since processing capacity was determined on the basis of consumer demand

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*The factor 1.22 is a factor used to determine the adjustment in retail price from a $1.00 change in farm price. Source: Leo V. Blakley, "Nationwide Flat Class I Pricing of Milk: Opportunities and Limitations," Agricultural Economics Paper 676, Oklahoma State University, p. 10.

in a given market, the capacities were adjusted to reflect these changes and model organization as discussed in Chapter VI.

Since a model of this magnitude is very sensitive, there were many individual differences between the two models. Most of these were not significant deviations from Model IV, however there were some which deserve mentioning. As the result of the new price effect on consumption, the Western and North Central regions reflected general consumption decreases in demand for fluid milk, while consumption in the West South Central, Southern (particularly the "deep" South) and the Northeastern regions was generally higher.

The sources of supply were basically the same for the various regions as in Model IV, although at different levels. As a result of decreased consumption in the Western regions, imports from the North Central region declined approximately 15 million pounds. In the Southern region, consumers experienced an increase in consumption because of lower prices relative to the institutionally set higher 1965 prices. The additional supplies, 61 million pounds per month which were needed to fulfill consumer demands were imported from the North Central region. The Chicago production area is the major contributor of these supplies. The Northeastern region also experienced consumption increases and obtained an additional 8 million pounds from the North Central region. In addition, the West South Central region requires an additional 4 million pounds of resource imported from the North Central region.

Even though the Western and North Central regions experience declines in consumption and a net decline of 44 million pounds in the total economy, assembly costs increased approximately 122,000 dollars.

This increase was the result of additional consumer demand in regions of deficit production which required additional intermarket movements of the resource.

Another aspect of the reorganization involved processing costs. Since consumer demand decreased, one would expect a decrease in total processing costs. In the actual analysis, processing costs did decrease approximately 164,000 dollars and per unit costs increased 0.01 cents per unit. If per unit costs had been the same as in Model IV, savings from reduced quantities being processed would have been 504,000 dollars. The major reason for the increase in per unit cost centers around developments in the Western and North Central regions. In the West, consumption generally decreased in most markets. Being sparsely populated, the large facilities lost economies which allowed the competitive factor for transporting of the final product into new markets. As a result, three smaller less efficient facilities were established plus the general decrease in the size of most facilities led to an increase in per unit processing cost of 0.04 cents per unit. In the North Central region, an increase in per unit cost is attributed to the general decrease in processing capacity.

The distribution of the final product generally followed the pattern as that of Model IV. In comparing Model IVa with IV, distribution costs increased approximately 1,000 dollars. Net savings in total organizational costs of 41,000 dollars were experienced in Model IVa when changes in consumption due to price changes were taken into account.

VITA

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Candidate for the Degree of

Doctor of Philosophy

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