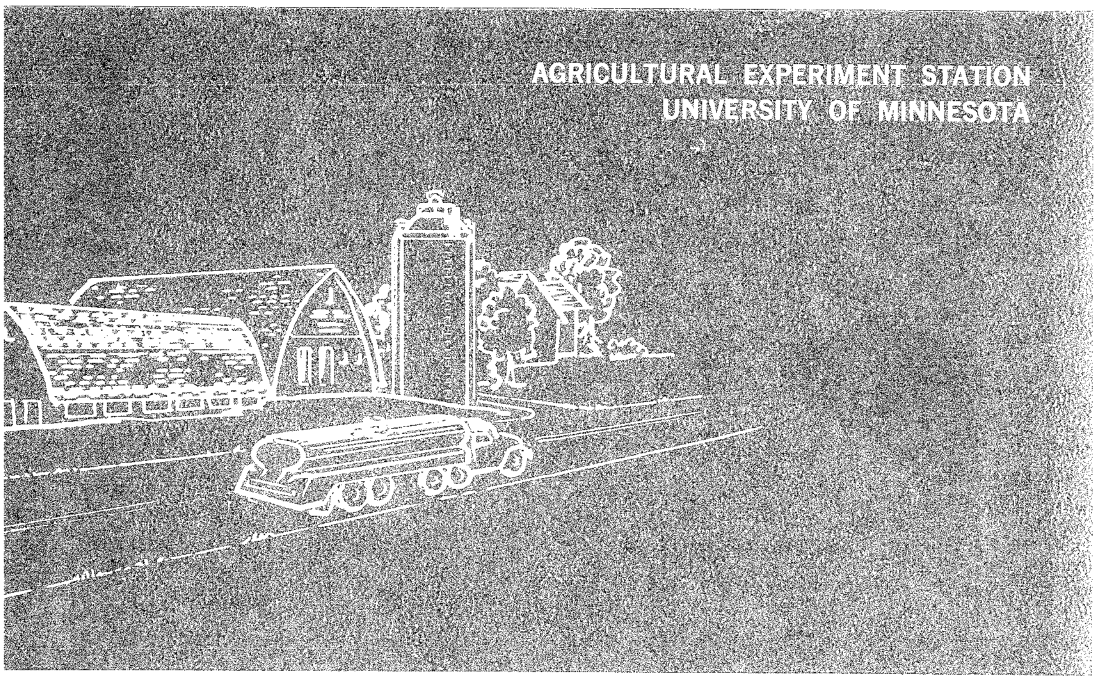
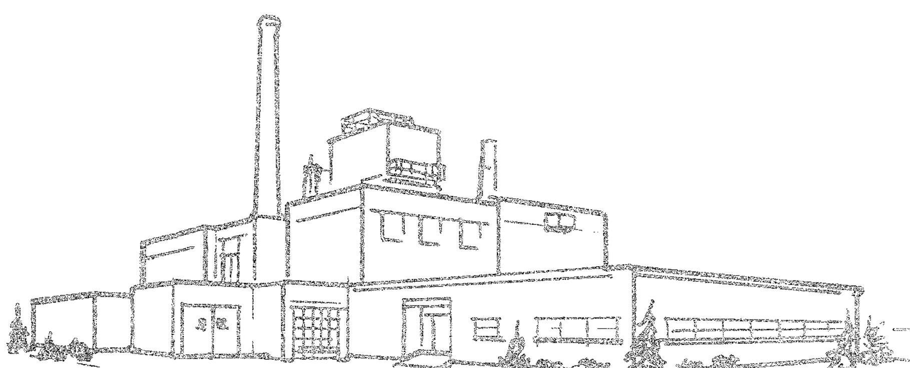
Station Bulletin 498
November 1969

Changing Market Structure of the Minnesota Dairy Manufacturing Industry





James W. Gruebele and E. Fred Koller

Table of Contents

The authors appreciate the generous cooperation of managers of dairy plants throughout Minnesota who supplied the basic data for this study.
J. W. Gruebele was a graduate research assistant in the Department of Agricultural Economics, University of Minnesota. E. Fred Koller is a professor in the Department of Agricultural Economics.

CHANGING MARKET STRUCTURE OF THE MINNESOTA DAIRY MANUFACTURING INDUSTRY

The Minnesota dairy manufacturing industry has undergone many major organizational and operational changes in the last 25 years. One major change has been the shift toward fewer and larger plants. The number of plants manufacturing dairy products in Minnesota declined from 938 plants in 1938 to 361 plants in 1963, a 62 percent decrease. There also was a trend toward larger plant size. In 1938, 43.2 percent of the specialized butter plants received less than 200,000 pounds of butterfat and in 1963 only 11.2 percent of the plants received less than that amount.

There were major technological changes in the Minnesota dairy manufacturing industry. These include clean-in-place systems, shift from can to bulk hauling, high-temperature-short-time pasteurization, and, recently, the continuous churn. Improved roads and trucks also are important developments. The development and adoption of new technology plays a major role in influencing the shift toward increased concentration in the state's dairy manufacturing industry.

Statement of Problem

Fewer and larger plants remain in the Minnesota dairy manufacturing industry as smaller plants have become receiving stations, merged with other plants, or gone out of business. Have the changes in the Minnesota dairy manufacturing industry improved the efficiency in the flow of milk and milk products from the producer to the consumer? Is nonprice competition important in the Minnesota industry? Have the performance dimensions of the industry improved as a result of the structural changes? Is the trend toward fewer and larger plants likely to continue?

Scope and Method of Study

This study is limited to the procurement and processing aspects of the market. It considers the milk-buying relationships between processing plants and producer. It also considers the efficiency and results of the plant operations. This study does not go into the butter selling and merchandising activities of these firms, however.

The framework for this study of market structure, conduct, and performance of the dairy manufacturing industry is similar to that developed by the widely known economist Bain.[1]

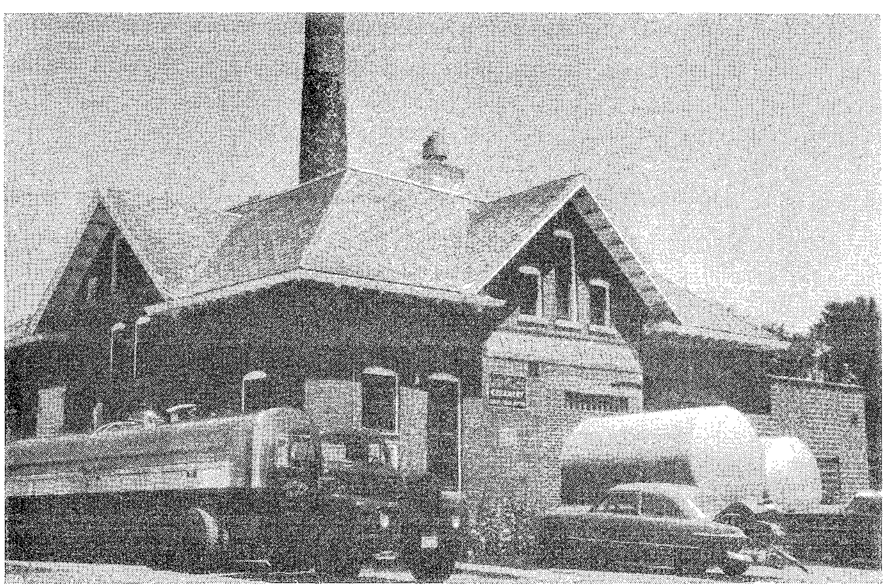
Market structure refers to characteristics which appear to influence strategically the nature of market competition. Some structural characteristics in this study are size and number of firms; ease with which firms enter or leave the market; type of ownership, that is, whether cooperatively owned or not; and the type of plant operation, butter, powder, or combined butter-powder operation.

Firm conduct refers to the behaviorial patterns that firms follow in adapting to competitive market conditions. This includes price and nonprice competitive practices.

Market performance refers to the economic results achieved by the firms in the industry. Some important performance aspects considered in this study are the industry's efficiency in terms of existing scales of plants and firms, technological efficiency and progressiveness, net margin ratios, and the amount of overlapping of milk procurement area.

Market structure study provides an analytical framework to study the effects of changes in an industry's structure on competition as well as on the overall performance of a particular industry. For the Minnesota dairy manufacturing industry, it can provide some important evidence about whether its changing structure is improving performance.

[1] Bain, J. S., *Industrial Organization*, John Wiley and Sons, 1959.



Loading milk at a creamery milk receiving station.

The analytical model, as used by Bain, emphasizes the relationships among changing market structure, conduct, and performance. Structural changes affect the competitive behavior of plants and the performance of individual plants as well as the performance of the whole industry. Clodius and Mueller indicate that the direction of causation is assumed to run from structure through conduct to performance.[2] For example, the structural change to fewer and larger plants may improve the performance by increased efficiency of operation. However, the direction of causation may flow also from performance back to market structure. For example, the degree of progressiveness may affect the size and number of firms. When firms adopt new technology, it may be necessary for them to increase the size of the plant operation to make full use of the new equipment.

Information on market structure was obtained for all firms in the state which manufacture butter, powder, or both. The information on structure and structural changes and the Markov chain method was used to project the future size and number of dairy manufacturing firms in the state. Implications for conduct and performance are expressed on the basis of tested interrelationships and the industry's projected structure.

Although the study is statewide, the market conduct and behavior study is limited to dairy plants in three areas in the state.

The years 1938, 1955, and 1963, selected because they were the only years for which complete information was available, were used to show changes in number and size of dairy plants in the state. Information on conduct and performance was collected for only 1 year.

Objectives of the Study

The objectives of the study are (1) to describe, in terms of the structural variables mentioned previously, the market structure of the Minnesota dairy manufacturing industry, (2) to analyze the relationship between structure and the conduct variables, price competition and nonprice competition, (3) to study the relationship between market structure and the several dimensions of performance mentioned earlier, and (4) to project the future structure of the Minnesota dairy manufacturing industry and specify effects of projected changes on conduct and performance.

Sources of Data

Many sources and types of data were used. The volume of butterfat received, volumes of manufactured products, prices, and other information were obtained from the annual reports of dairy plants and reports from the

[2] Clodius, Robert L. and Willard F. Mueller. *Market Structure Analysis as an Orientation for Research in Agricultural Economics*. Reprint from Journal of Farm Econ., Vol. XIIII, No. 3. August 1961.

Minnesota Department of Agriculture. Plant numbers, ownership, and type of operation were taken from the Minnesota Processors Directory published by the Minnesota Department of Agriculture.

In order to study market conduct, all of the dairy manufacturing plants located in three areas outlined following county lines in the state were selected for intensive analysis. For these studies, only plants which processed manufacturing milk and received milk directly from farmers were included in the analysis. Market conduct information was obtained by interviewing plant managers.

Market performance data were obtained from a random sample of 86 plants in the state. The sample was stratified on the basis of size to determine the optimal scale of plant. This was done to fulfill partially the study's third objective. Of the 86 plants, 48 are butter plants and 38 are butter-powder plants. A questionnaire, supplemented by balance sheets and income and expense statements from each plant, was used to get most of the information to test relationships between structure and performance of the Minnesota dairy manufacturing industry.

MARKET STRUCTURE OF THE INDUSTRY

Number and Size of Plants

Change in the number and size of plants is an important structural variable because it affects market competition and the performance of the industry. This is discussed in more detail below.

One important trend in the Minnesota dairy manufacturing industry has been toward fewer and larger plants. Table 1 shows that the number of plants has declined, except for butter-powder plants. Specialized milk drying and cheese plants make up a relatively small portion of the industry.

In 1963, about one-third of the dairy manufacturing plants in Minnesota processed nearly two-thirds of the butterfat.

Table 1. Number of plants in the Minnesota dairy manufacturing industry classified by plant operation, 1938, 1955, and 1963

	1938		1955		1963	
Plant operation	Number of plants	Percent	Number of plants	Percent	Number of plants	Percent
Specialized butter	867	92.4	504	85.6	278	77.0
Butter-powder	7	.8	46	7.8	55	15.3
Specialized milk drying	0	. . .	22	3.7	12	3.3
Cheese	64	6.8	17	2.9	16	4.4
Total	938	100.0	589	100.0	361	100.0

Table 2 shows that only 15 plants handled less than 100,000 pounds of butterfat in 1963. Only 0.3 percent of the butter was manufactured by these plants. On the other hand, 47 plants handled over 1,500,000 pounds of butterfat in 1963 and manufactured 48.5 percent of the butter.

The size of plants receiving over 1,500,000 pounds of butterfat in 1963 varied widely — 16 plants received more than 3 million pounds.

Table 2. Number of plants by size and proportion of butter manufactured by each size group in Minnesota, 1963

Annual butterfat volume (thousand lb.)	Number of creameries	Lb. of butter manufactured (million lb.)	Percent of butter manufactured
Less than 100	15	1.1	.3
100-199	16	1.7	.5
200-299	26	6.1	1.8
300-399	33	10.8	3.2
400-499	34	14.8	4.4
500-749	70	43.4	12.8
750-999	47	42.2	12.5
1,000-1,499	45	54.0	16.0
1,500 and over	47	163.9	48.5
Total	333	338.0	100.0

Concentration ratios showing the proportion of butter produced by a certain number of firms illustrate that the structure of the dairy manufacturing industry has changed. The largest four firms in 1938 manufactured 14.5 million pounds or 4.8 percent of the butter (table 3). The largest four plants in 1963 manufactured 38.0 million pounds or 11.2 percent.

Table 3. Proportion of total butter manufactured by 4, 8, and 20 largest plants in Minnesota, 1938 and 1963

	1938		1963	
Number of plants	Million lb.	Percent	Million lb.	Percent
Largest 4	14.5	4.8	38.0	11.2
Largest 8	23.5	7.8	63.5	18.8
Largest 20	40.5	13.4	108.3	32.0

According to Bain's definitions of concentration levels,[3] the Minnesota dairy manufacturing industry is not highly or even moderately concentrated. It is becoming more concentrated, however.

[3] Bain, J. S., *op. cit.*, p. 129.

Table 4 compares the concentration for the Minnesota industry, the North Central Region and the United States. The data indicate that in the

Table 4. Proportion of total butter manufactured by 4, 8, and 20 largest plants in Minnesota in 1963, the North Central Region and the United States in 1958

Number of plants	1958	1963	
	North Central Region*	United States*	Minnesota
Largest 4	11	11	11
Largest 8	18	19	19
Largest 20	29	31	32

* Source: North Central Committee on Dairy Marketing Research, *Organization and Competition in the Midwestern Dairy Industries*, unpublished manuscript, p. 249, April 1967.

North Central Region, the United States, and Minnesota, the largest four plants manufacture 11 percent of the product. The largest 20 plants in Minnesota manufactured 32 percent of the state's butter. The concentration ratios in the Minnesota industry are similar to those in the North Central Region[4] and the United States.

What caused these changes? Bain says that a multiplicity of considerations determines the degree of concentration to be attained in various industries. He mentions the following factors: (1) the firms' drive to attain efficient size to exploit the existing economies of size and distribution, (2) the firms' drive in some industries to develop the most effective or profitable size for sales promotion, and (3) a desire to reduce competition.[5]

Technology — important in influencing the trend to fewer and larger firms in Minnesota — includes larger churns, high-temperature, short-time pasteurization, clean-in-place systems, and other changes. The larger, improved equipment, when fully utilized, helps to reduce per unit cost of output. Lower costs increase the advantage of larger creameries. Better trucks, improved roads, and bulk milk handling equipment reduce the cost of milk pickup and transportation for longer distances to processing plants.[6] These factors help to make larger volume plants possible.

The big change from farm-separated cream to milk receipts in creameries in the 1940's and 1950's required more equipment and larger investments by dairy plants. Many plants closed because they could not afford the additional investment.

Farmers in some areas of Minnesota shifted from dairying to other types of agriculture. With decreased butterfat receipts, some plants found that successful operation was no longer possible.

[4] The North Central Region includes Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

[5] Bain, J. S., *op. cit.*, pp. 182-183.

[6] Amann, Victor F. and E. Fred Koller. "Creamery Adjustment Problems," Minnesota Farm Business Notes, No. 412, December 1959.

One can see from the above information that the Minnesota dairy manufacturing industry is oligopsonistic with a competitive fringe of small- and medium-size plants. In an oligopsonistic market, there are relatively few buyers (creameries) and a large number of sellers (producers). Minnesota's larger plants comprise the oligopsonistic sector. The competitive fringe consists of plants not strongly influencing the prices paid or other competitive practices. Minnesota's small- and medium-size plants make up the competitive fringe.

Ownership

An important structural change in the Minnesota dairy manufacturing industry is the continuing trend toward cooperative ownership (table 5). In 1938, of 874 plants, 634, or 72.5 percent, were cooperatives. In 1963, of the 333 plants in the state, 297, or 89 percent, were cooperatives.

Table 5. Number of cooperative and noncooperative plants manufacturing butter in Minnesota, 1938 and 1963

	1938		1963	
Ownership	Number of plants	Percent	Number of plants	Percent
Cooperative	634	72.5	297	89.0
Noncooperative	240	27.5	36	11.0
Total	874	100.0	333	100.0

Another way to illustrate the increasing importance of cooperative ownership is by showing the proportion of butter manufactured by cooperative and noncooperative plants. In 1963, cooperatives manufactured 90.9 percent of the butter, while in 1938, cooperatives manufactured only about 72 percent (table 6). The trend in Minnesota continues to move toward even more cooperative plants.

Table 6. Butter manufactured classified by plant ownership in Minnesota, 1938 and 1963

	1938		1963	
Ownership	Butter (1000 lb.)	Percent	Butter (1000 lb.)	Percent
Cooperative	215,924	71.8	307,233	90.9
Noncooperative	84,688	28.2	30,655	9.1
Total	300,612	100.0	337,888	100.0

Cooperative plants, in general, were larger in size than noncooperatives in 1963 (table 7).

Table 7. Number and percent of cooperative plants and noncooperative plants classified by size in Minnesota, 1963

Butterfat received annually (1000 lb.)	Noncooperatives		Cooperatives	
	Number	Percent	Number	Percent
Less than 100	6	16.7	9	3.0
100-199	7	19.4	9	3.0
200-299	3	8.3	23	7.7
300-399	2	5.6	31	10.4
400-499	3	8.3	31	10.4
500-749	5	13.9	65	21.9
750-999	2	5.6	45	15.3
1000 and over	8	22.2	84	28.3
Total	36	100.0	297	100.0

Type of Plant Operation

Classified by type of operation, the major types of dairy manufacturing plants in the state are butter-powder and specialized butter plants. In a butter-powder plant, whole milk is received and butter and nonfat dried milk are manufactured in the same building. In specialized butter plants, milk is received and processed into butter but the skim milk is transferred to another plant specializing in drying the product. In the combined operation, milk is received only once avoiding (with obvious savings) interplant hauling of skim milk. Other important savings accrue in heating and cooling milk, when milk is transferred within the same plant rather than to another plant.

Because of these advantages, the trend has been toward the butter-powder operation. The number of specialized butter plants declined 67.9 percent from 867 plants in 1938 to 278 plants in 1963 (table 8). The number of butter-powder plants increased 685.7 percent from 7 plants in 1938 to 55

Table 8. Number of specialized butter, powder, and butter-powder plants in the Minnesota dairy manufacturing industry, 1938, 1955, and 1963

Type of operation	Number of plants			Change from 1938 to 1963 (percent)	Change from 1955 to 1963 (percent)
	1938	1955	1963		
Specialized butter	867	504	278	−67.9	−44.8
Butter-powder	7	46	55	+685.7	+19.6
Specialized powder	0	22	12	....	−45.5

plants in 1963. The number of specialized powder plants has declined since 1955.

The rising proportion of butter manufactured in the state by butter-powder plants shows their increasing importance. The proportion of butter manufactured by butter-powder plants increased from 1 percent in 1938 to 51 percent in 1963 (table 9).

Table 9. Butter manufactured by butter and butter-powder plants in in Minnesota, 1938, 1955, and 1963

Type of plant operation	1938		1955		1963	
	1000 lbs.	Percent	1000 lbs.	Percent	1000 lbs.	Percent
Butter	296,938	98.9	203,909	72.1	165,504	49.0
Butter-powder	3,674	1.2	78,925	27.9	172,384	51.0
Total . .	300,612	100.0	282,834	100.0	337,888	100.0

The butter-powder plants have gained also in total powder manufactured. Table 10 shows that the percentage of powder manufactured by butter-powder plants has been increasing. There were no specialized drying plants in 1938. Specialized powder plants manufactured 40 percent of the powder in 1955, and butter-powder plants manufactured about 60 percent. By 1963 butter-powder plants had increased production to 78.0 percent of the powder, and production by specialized powder plants had declined to 22.0 percent.

Table 10. Dry milk manufactured by butter-powder and powder plants Minnesota, 1938, 1955, and 1963

Type of operation	1938		1955		1963	
	1000 lbs.	Percent	1000 lbs.	Percent	1000 lbs.	Percent
Butter-powder	4,894	100.0	229,174	59.8	421,399	78.0
Specialized powder .	. . . .	. . . .	154,192	40.2	118,766	22.0
Total	4,894	100.0	383,366	100.0	540,165	100.0

The importance of butter-powder operations has increased substantially in both numbers and products manufactured.

Butter-powder plants generally are larger than butter plants (table 11). Actually this table de-emphasizes the size of butter-powder plants, many of which receive skim milk as well as whole milk.

In 1963, 20.5 percent of the plants received less than 300,000 pounds of butterfat, and no butter-powder plants received less than this amount. On the other hand, 31.7 percent of the butter plants and 92.7 percent of the butter-powder plants received more than 750,000 pounds of butterfat in 1963. The large butter and butter-powder plants have manufactured an increasing proportion of the total butter.

Table 11. **Number and percent of butter and butter-powder plants classified by volume of butterfat received in 1938, 1955, and 1963**

Size of plant (1000 lb.)	1938				1955				1963			
	Butter		Butter-powder		Butter		Butter-powder		Butter		Butter-powder	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Less than 100	105	12.1	. .	. . . .	38	7.5	. .	. . . .	15	5.4	. .	. . .
100-199	270	31.1	. .	. . . .	103	20.4	. .	. . . .	16	5.8	. .	. . .
200-299	185	21.3	. .	. . . .	89	17.7	2	4.4	26	9.3	. .	. . .
300-399	141	16.3	1	14.3	85	16.9	. .	. . . .	32	11.5	1	1.8
400-499	63	7.3	1	14.3	63	12.5	2	4.4	34	12.2	. .	. . .
500-749	63	7.3	3	42.8	70	13.9	7	15.1	67	24.1	3	5.5
750-999	12	1.4	2	28.6	31	6.1	2	4.4	45	16.2	2	3.6
1,000-1,499	14	1.6	. .	. . . .	15	3.0	11	23.9	33	11.9	12	21.8
1,500 and over	14	1.6	. .	. . . .	10	2.0	22	47.8	10	3.6	37	67.3
Total	867	100.0	7	100.0	504	100.0	46	100.0	278	100.0	55	100.0

As indicated earlier, the type of operation is expected to affect the market conduct and behavior of Minnesota dairy plants. It is expected also that the market performance including net return to producers will be affected by the type of operation.

Barriers to Entry and Exit

Barriers to enter an industry reflect the relative advantages established firms have over potential entrants.[7] One major entry barrier is product differentiation, the buyers' preference for the products of established firms over those of new firms. In some industries new entrants need to invest a considerable amount of money to gain acceptance for their products. Other major barriers are the cost advantages in production and distribution old firms have over new firms and the industry's economies of large scale production and distribution which are a significant proportion of industry output.[8]

One important entry barrier in the Minnesota dairy manufacturing industry is the capital requirement necessary to build a plant of optimal size. Due to technological changes, the optimal size and, therefore, the barriers to entry have increased.

The level of barriers to entry was not determined in this study and is suggested for future research. Only 11 plants entered the industry from 1955 to 1963 (table 12).[9] Nine of these plants received over one million pounds of butterfat in 1963. It appears that entrants must be rather large to compete effectively in the industry.

Table 12. The number, size, and type of ownership of firms entering the Minnesota dairy manufacturing industry from 1955 to 1963

Butterfat received (1000 lb.)	Number of noncooperatives	Number of cooperatives	Total butterfat (1000 lb.)	Percent
Less than 500	1	..	69	0.2
500-749	..	1	506	1.5
750-999	..	..	.....	....
1,000-1,499	..	2	2,594	7.4
1,500 and over	2	5	31,681	90.9
Total	3	8	34,850	100.0

In 1963, the 11 new plants received 34.8 million pounds of butterfat, 10.3 percent of that received by all plants manufacturing butter in the state. Eight plants entering the industry were owned cooperatively.

[7] Bain, J.S., *op. cit.*, pp. 237-241.

[8] *Ibid.*

[9] Entry refers to new plants including some which had manufactured only powder and now also manufacture butter. It does not include mergers or consolidations.

The condition of exit from the industry also is an important structural variable. Exit includes plants changing from butter plants or entirely ceasing operations. The lack of alternative uses for the creamery building and equipment is a major barrier to exit from the Minnesota dairy industry. Firms incurring losses but having a large amount of "sunk costs"[10] probably would continue to operate as long as they are able to cover variable costs such as labor, fuel, and supplies.

The height of the exit barriers was not determined in this study. However, the number of firms leaving the industry was determined. Most of the plants exiting were small plants receiving less than 400,000 pounds of butterfat annually (table 13). This supports the contention that the greatest economic pressure is on the small plants because of their high per unit costs.

Between 1955 and 1963, 227 dairy manufacturing plants left the industry in Minnesota.

Table 13. Number of butter and butter-powder plants leaving the Minnesota dairy manufacturing industry, 1955 to 1963

Butterfat received annually (1000 lb.)	Plant exits		
	Number of cooperatives	Number of noncooperatives	Total number
Less than 100	19	14	33
100-199	53	11	64
200-299	30	11	41
300-399	32	3	35
400-499	14	4	18
500-749	10	4	14
750-999	6	2	8
1,000 and over	4	10	14
Total	168	59	227

Many creameries have ceased manufacturing butter and shifted to a milk-receiving operation. Under this arrangement, the local plant receives milk from producers and transfers it for processing to a butter-powder plant or another creamery. This procedure increases its volume and lowers its per unit cost. There were 46 milk receiving stations in Minnesota in 1955, 97 in 1963. In many cases, larger plants negotiated with smaller ones to close down processing operations of the smaller ones which become receiving stations for the larger plants. Many receiving stations operate in this way for a short time, then cease operations. This suggests that often greater gains are achieved by closing receiving stations at an early stage and hauling the milk directly to the larger creamery. Thus, in most cases, the milk receiving station represents only an intermediate step between a small creamery and a closed one.

[10] Sunk costs are cost items which cannot be recovered if production is discontinued.

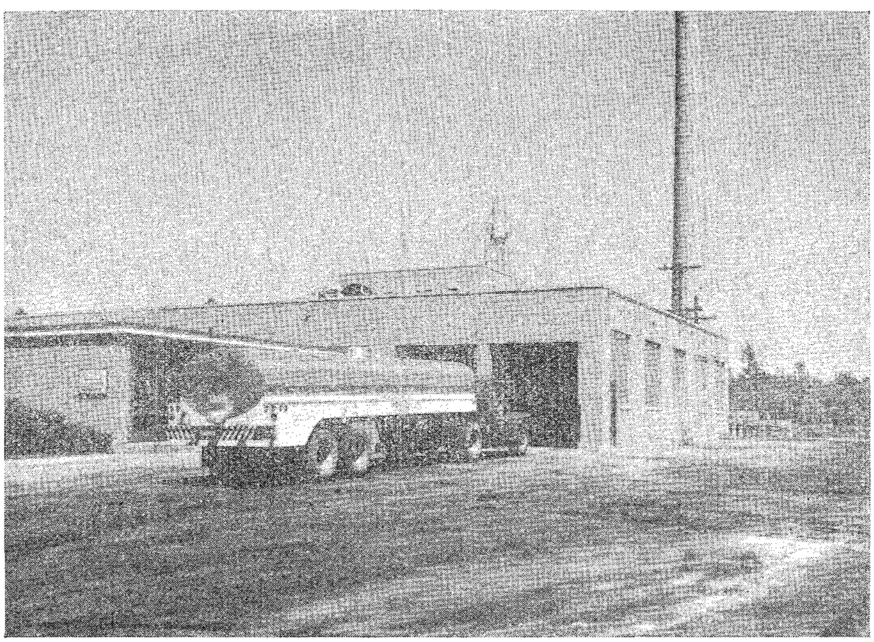
The large plants increased their volume not only by receiving more milk from receiving stations. Some also increased the volume of skim and whole milk received from other processing plants.

The gradual increase in milk production by the creamery's regular suppliers is another method of growth. However, this is often too slow in providing plants with the increased volumes necessary for efficient operation. Other growth methods must be used for a plant to have sufficient volume to warrant the adoption of cost-reducing technology.

Another growth method is merger or consolidation. In this case, two or more plants legally combine to become a larger, more efficient unit. Actually few creameries have merged in Minnesota because few could agree on the merger terms. Also, commercial clubs and local businesses often oppose mergers if it means closing the local creamery, which could mean less business for the community.

MARKET CONDUCT

This study's second objective is to analyze the relationship between structure and conduct in the Minnesota dairy manufacturing industry. Market conduct refers to the behavior patterns which firms follow in adapting themselves to competitive market conditions. The variables usually included in



Interplant tank truck movement of milk is increasing.

market conduct are price competition, sales promotion efforts, predatory practices (such as price cutting) aimed at eliminating established competitors, and nonprice competition.[11] The conduct variables appropriate for this study are price and nonprice competition. Other variables, such as sales promotion, are not applicable in the Minnesota dairy manufacturing industry.

Sample of Plants

To obtain information on the conduct or behavior of firms, a sample of dairy plants was selected within the state. To determine competitive behavior and the overlapping of milk procurement areas, information was obtained from all dairy plants in three defined county areas. All three areas are in the state's principal dairy belt, extending in a diagonal band from the southeastern to the northwestern part of the state (figure 1). The three areas are Freeborn and Steele Counties in the southeast, Wright County in central Minnesota, and Otter Tail and Todd Counties in the northwest. All the dairy plants in these three areas were surveyed in detail to observe the relation of market structure and market conduct. In almost all cases the data for the three areas were combined and treated as one group.

It was believed that these three areas would be representative of the competitive nature of the dairy manufacturing industry in the whole state. To determine how closely the behavior in these areas represents the state's market behavior, it is necessary to describe briefly the market organization of the three areas.

Market Structure of the Sample Area

From 1955 to 1963 in the three areas, the changes in size and number of plants were nearly proportionate to those in the entire state. For example, the number of plants declined 27 percent in the three areas and 39.5 percent in the entire state. The average butterfat volume in the three areas increased 102.5 percent as compared to 85.9 percent in the entire state.

The state trend toward fewer and larger plants applied to the three areas also. Concentration ratios in the three areas also are quite similar to those in the entire state. The plants in the entire state appear to be slightly more concentrated than those in the three areas. These differences, however, are not expected to affect market behavior.

The proportion of butter-powder plants in the three areas and in the entire state did not differ significantly. The small difference in the market structure of the sample area is not expected to affect materially the anticipated conduct for the industry in the whole state.

---

[11] Bain, J. S., *op. cit.*, page 325.

Structure-Conduct Relationships

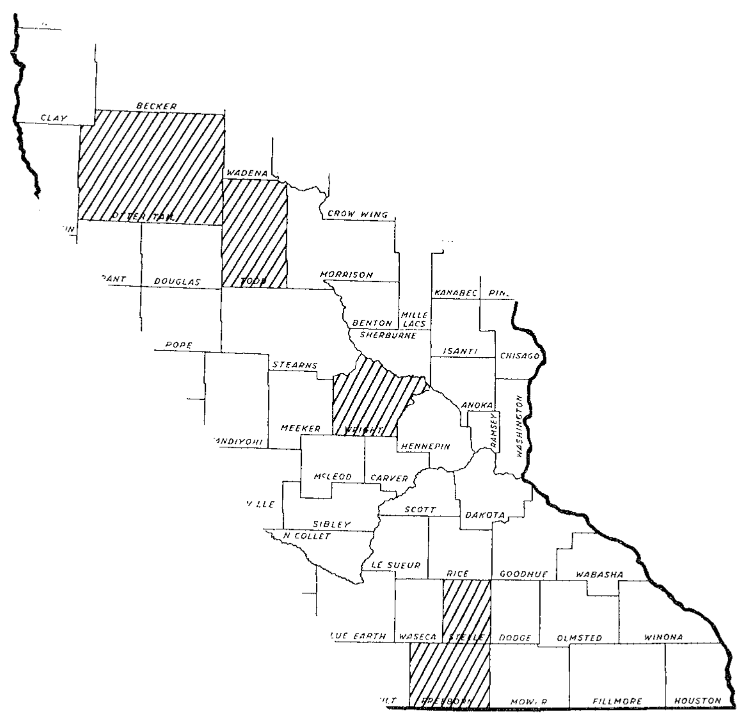
PRICE COMPETITION

One way creameries compete for suppliers' milk is through the prices they pay for milk. Creameries seek a larger volume and a high quality product through their milk and cream prices.

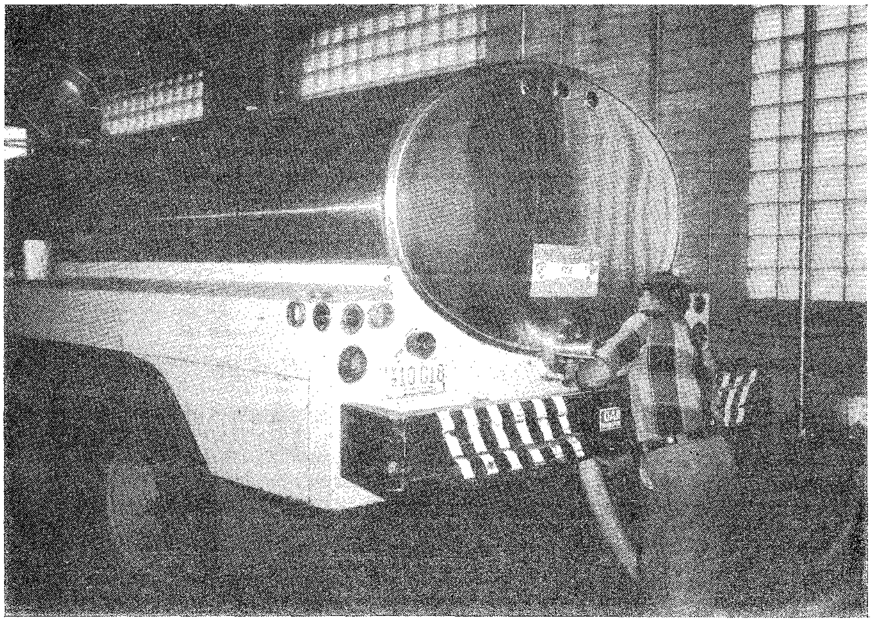
Price Determination

Increasing concentration in the Minnesota dairy manufacturing industry is expected to affect the conduct or market behavior of plants. Price leadership often exists in an oligopoly, where firms are few in number. Walsh and Evans[12] found that price leadership exists in the bakery industry, also an oligopoly. It was hypothesized that price determination in the Minnesota dairy manufacturing industry also is characterized by price leadership.

Figure 1. Principal dairy belt in Minnesota and location of three survey areas.



[12] Walsh, Richard G. and Bert M. Evans, *Economics of Change in Market Structure, Conduct and Performance, The Baking Industry 1947-1958*. University of Nebraska, New Series No. 28, December 1963, pp. 82-86.



Unloading milk at a modern butter-powder plant.

Managers in the three sample areas were asked how milk prices paid to producers were determined. Forty-seven of 57 plant managers said that they used the "gross receipts less cost" method to determine the price they paid for No. 1 manufacturing milk. A knowledge of costs and receipts is available to the manager because the farmer-patron is paid for the milk 13 to 28 days after the close of the monthly delivery period. Some creameries tried to hold back a small amount of receipts each month to be paid as patronage refunds at the close of the year.

The price paid by competing plants also was very important in determining the price paid to producers. Forty-five of 57 plant managers said that they were influenced by the price paid by competitors. Thirty-nine of the 45 managers tried to stay "in line" with competitors, three tried to pay more, and three less.

Nelson indicated similar results: "Of the 49 plant managers who watched competitors' prices, 39 reported a policy of paying the average of the competitors. Six plants had policies of paying above the average."[13]

To determine the price leadership pattern, managers were asked which plant or plants they watched the closest when setting prices. The small- and medium-size plants usually watched the prices paid by a nearby large creamery.

[13] Nelson, Ralph, *The Nature of Competition Among South Dakota Dairy Manufacturing Plants*, unpublished Ph.D. thesis, University of Minnesota, St. Paul, Minnesota, December 1960, p. 139.

In their baking industry study, Walsh and Evans found that the large plants were the price leaders. The reason cited was that the large plants were equipped to determine net margins needed to frame a satisfactory price policy for the entire market group. Because of their superior capacity and financial strength the large plants were able also to force their policies on others.[14]

The ability to pay was another important factor affecting milk price leadership. In December 1959, cheese prices rose and stayed at relatively high levels through 1961; consequently, cheese plants were able to pay high prices to farmers and were price leaders in some areas.

In a purely competitive market, the pay price for manufacturing milk is determined by independent market forces rather than being set by a price leader. In an oligopsony market (few large buyers) it is essential that the price be satisfactory to all members of the group or open price competition may result. In the Minnesota industry, the price must be satisfactory to the large plants but not necessarily to the fringe of small- and medium-size plants. In general, the smaller plants are not in a position to begin open price competition.

Only one manager said that plant managers got together and agreed on a price. Since this practice is illegal, even if it existed more widely, one would not expect managers to admit to using it.

There is some evidence that price determination in the Minnesota dairy manufacturing industry is characterized by price leadership.

Milk price determination and market power relations also are expected to be affected by the type of plant operation (butter or butter-powder). The cost savings in transportation, processing, and administrative costs realized by butter-powder plants are expected to give them superior market power advantages. Therefore, it was hypothesized that the butter-powder plants are price leaders in the Minnesota dairy manufacturing industry.

To test the hypothesis, plant managers in the three sample areas were asked which plant or plants influenced their pay price.

Table 14. Number and percent of butter and butter-powder plants that were price leaders in the three sample areas in the Minnesota dairy manufacturing industry, 1963

	Type of operation*			
	Butter		Butter-powder	
	Number	Percent	Number	Percent
Price leaders	17	42.5	9	81.8
Price followers	23	57.5	2	18.2
Total	40	100.0	11	100.0

* Computed F value = 4.87 $F(.05, 1, 49) = 4.035$

[14] Walsh, R.G. and B. M. Evans, *op. cit.*, pp. 84 and 85.

Almost 82 percent of the butter-powder plants were price leaders (table 14). Only 43 percent of the butter plants were considered price leaders. The percentage of butter plants considered to be price leaders is expected to decrease as the butter-powder firms in the area become established. The largest plants were the price leaders.

Level of Prices Paid

The relative level of milk prices is expected to be related to the size and number of plants. It was hypothesized that larger plants, because of their greater efficiency, pay higher prices than smaller plants. These plants can afford to pay higher prices and still allocate patronage refunds to patrons at the close of the year. It is thought that the higher price attracts patrons enabling larger plants to operate closer to full capacity and adding to their overall efficiency.

Price information was obtained from plants in the three sample areas. Large plants paid a slightly higher price than smaller plants (table 15). Plants receiving more than 750,000 pounds of butterfat annually paid an average of 3 cents more per hundredweight than did plants receiving less than 400,000 pounds of butterfat. This difference is not statistically significant, however.

Table 15. Milk prices paid by plants in the three sample areas, classified by size of plant, 1963

Size of plant (1000 lbs. butterfat received annually)	Number of plants		Price paid* for No. 1 milk† (dollars per cwt.)
Less than 400	17		3.07
400-749	17		3.08
750 and over	20		3.10
Total	54	Average	3.08

* Milk price does not include the patronage refunds paid by some cooperatives.
† Computed F value = .68 $F(.05, 2, 51) = 3.182$

Although the difference between the prices large and small plants paid for milk was insignificant, the total price (or total returns) paid was expected to be greater for large plants than for the small plants. Total price (total returns) is the average pay price per hundredweight plus the patronage refund per hundredweight.

The patronage refund, the excess of returns over cost, usually is based on the milk volume shipped by the producer. For 80 plants in Minnesota, the patronage refund declared in 1963 ranged from 0 to 49 cents per hundredweight.

Because cooperatives operate in the producer's interest, it was hypothesized that the cooperatives pay higher prices for milk than noncooperatives pay.

To test this, milk price information was obtained from the sample of 80 plants in the entire state. The noncooperative plants paid higher prices for milk than did cooperative plants (table 16). However, the difference is not statistically significant. Also, the price paid by the cooperative plants did not include the patronage refund. The reason for the unexpected result is that noncooperatives must be very competitive price-wise because of the patronage refund which cooperatives pay.

When total returns (including yearend patronage refunds) are considered, the cooperative plants paid slightly more per hundredweight than did the noncooperative plants (see table 25). This difference is not significant statistically either.

Because of the advantages of the butter-powder plants, it was hypothesized that the butter-powder plants paid higher average prices for milk than did the butter plants.

Table 16. Prices paid for milk by 80 plants by type of ownership, 1963

Type of ownership	Number of plants	Average price paid for No. 1 milk* (dollars)
Cooperative	74	3.13
Noncooperative	6	3.19
Total	80	3.14

* Computed F value 1.83 $F(.05, 1, 78) = 3.964$

Price information on the sample of 80 plants was analyzed. The 33 butter-powder plants paid an average of $3.17 per hundredweight and the 47 butter plants, $3.10 per hundredweight. This price difference paid is statistically significant.

Table 17. Prices paid by butter and butter-powder plants for 80 plants in Minnesota, 1963

Type of plant	Number of plants	Average price paid for No. 1 milk* (dollars cwt.)
Butter-powder	33	3.17
Butter	47	3.10
Total	80	3.13

* Computed F value = 8.26 $F(.01, 1, 78) = 6.974$

Price Wars

Price wars are another aspect of market conduct or behavior. The increasing concentration of creamery plants implies that price wars are possible.

However, as plants become fewer and larger, there may be more price agreement and fewer price wars. Fellner indicates that price wars often occur when economic conditions change significantly.[15] Conditions in the Minnesota industry changed because of rising cheese prices from December 1959 through 1961.

Whether price wars exist in the Minnesota dairy manufacturing industry was determined by questioning managers in the sample areas. Twenty of the 57 plant managers said that there had been either a period of extreme price competition or a price war. Eight of nine plant managers in Wright County complained of price war activity. Only five of 29 plant managers in Otter Tail and Todd Counties complained of such activity.

All of the managers complaining of price wars in Freeborn-Steele and Wright Counties indicated that cheese plants were responsible. This was due in part to higher cheese prices which enabled cheese plants to pay producers a higher price for milk. These managers agreed that the price wars often resulted because many plants had excess capacity and needed additional patronage.

Table 18 shows the average price paid by plants complaining of price war activity and those not complaining of price wars. The price war plants

Table 18. Average price paid for milk by plants in the sample areas classified by whether they complained of price wars, 1963

Type of plant	Number of plants	Price paid for No. 1 milk* (dollars)
Price war plants	19	3.12
Nonprice-war plants	35	3.06

* Computed F value = 6.66   F(.05, 1, 52) = 4.026

paid higher average prices than did the nonprice-war plants. This difference was statistically significant.

The above data appear to support the contention that at times and under certain conditions price wars exist in the Minnesota dairy manufacturing industry.

Price Discrimination

Walsh and Evans say that in oligopolistic markets, the sellers try to avoid the full impact of open price competition. They indicate, however, that additional market shares are sought through price discrimination.[16] For

[15] Fellner, William, *Competition Among the Few*, New York, New York: Albert Knopf, 1949, p. 178.
[16] Walsh, R. G. and B. M. Evans, *op. cit.*, p. 98.

example, one medium-size baking company with three plants cut its bread price in half in one location without reducing it in either other town.

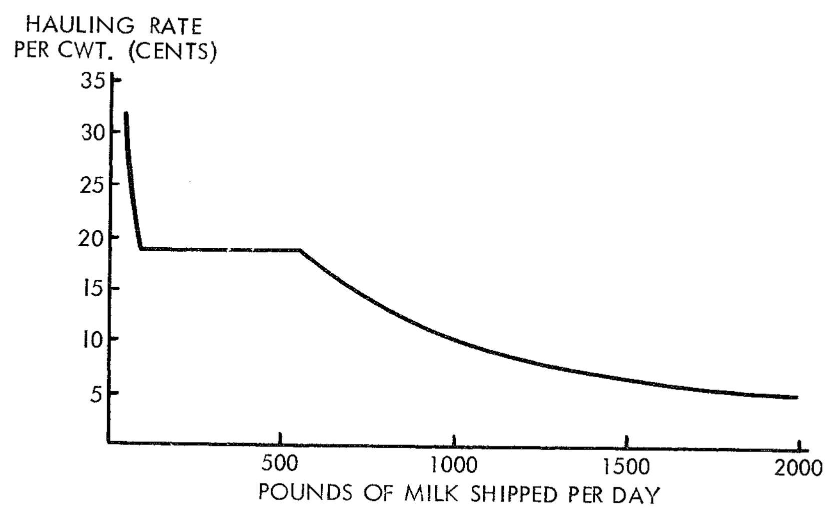
It is possible that Minnesota dairy manufacturing firms practice price discrimination. A more apt description of the situation in the Minnesota industry is discrimination in milk hauling charges rather than in direct prices paid.

Milk hauling rates are important because they are a factor in determining the net price producers receive. Milk hauling rates on contract routes are set by the hauler, creamery manager, or board of directors.

The hauling rates in the three sample areas varied from 15 to 25 cents per hundredweight and averaged 19 cents per hundredweight. However, 23 of the 57 plants in the three sample areas had maximum monthly charges ranging from $30 to $45. Also, 28 of the 57 plants had minimum monthly charges ranging from $4 to $10. Over half of the plants in Freeborn-Steele and Wright Counties, but only five of the 29 plants in Otter Tail and Todd Counties had maximum monthly charges.

Figure 2 shows the differences in the hauling charges producers pay with a $5 minimum and a $30 maximum charge per month. With a $5 minimum charge per month, the cost for a 60-pound-a-day shipper is about 28 cents per hundredweight. With a $30 maximum charge per month, the cost to a 1,000-pound-a-day shipper is 10 cents per hundredweight and 5 cents per hundredweight for a 2,000-pound-a-day shipper.

Figure 2. Average rates producers pay for hauling various quantities of milk.



Are these differential rates justified by actual cost differences? If the difference in rate barely compensates for hauling cost differences, the rates are justified. If not, there is price discrimination.

NONPRICE COMPETITION

According to Markham, rational oligopolists channel their competitive effort to where it is least vulnerable to defeat, namely to nonprice competitive practices.[17] Nelson found that nonprice practices were important to competition in the South Dakota market structure study of the dairy manufacturing industry.[18] Plant managers often use nonprice competitive tactics because they fear if they try to compete on a price basis their rivals will retaliate. Nonprice competition denotes the many services and convenience functions provided by firms for farmers. It was hypothesized that plant managers in the Minnesota dairy manufacturing industry prefer nonprice competition to price competition.

Information on nonprice services was obtained from the plants in the three sample areas. Table 19 lists some of the services provided by the creameries in these areas. Some of the services are not listed but are of lesser importance. Most plants in the sample areas sold dairy farm supplies (usually at favorable prices), made group insurance available, advanced money on the next check, and withheld assignments out of milk checks. All 57 plants from which nonprice information was obtained said that they sold dairy farm supplies.

In a number of cases, managers were forced to provide a service because rival plants offered it. The producers, in these cases, asked for the nonprice service. Usually the managers did not object to providing the services.

Some services benefited both the producer and the plant. The sale of farm supplies, such as feed and dairy supplies, was convenient for the producer, but in many cases also brought additional profits to the plant.

Table 19. Nonprice competitive practices reported by 57 dairy manufacturing plants in the three sample areas, Minnesota

Nonprice practice	Number of plants using practice
Sell dairy farm supplies	57
Make group insurance available to patrons	54
Advance money on next check	54
Withhold assignments out of check	54
Sponsor community projects	41
Provide daily weight slips	41
Creamery ownership of milk cans	37

[17] Markham, Jesse W., "Changing Structure of the American Economy: Its Implications for the Performance of Industrial Markets," Journal of Farm Economics, May 1959, p. 390.
[18] Nelson, Ralph, *op. cit.*, p. 148.

The managers agreed that the services created good will and held old patrons. Usually the services did not attract new suppliers because other plants offered similar services.

The drawback in using the nonprice services too extensively is that they tend to be irreversible. A plant that begins a new service, such as free milk cans, for its patrons may enjoy a period of increased patronage. Before long, however, other creameries also begin furnishing milk cans to hold their producers. Soon almost every creamery in the area is providing the service, and the farmers come to expect it. If any creamery wants to discontinue the service, the danger of losing patrons and good will in the community will make it difficult to do so. New services are added easily but they cannot be discontinued easily.

Nevertheless, when asked which kind of competition they preferred, almost all plant managers said nonprice competition because it cannot be quoted in exact terms and competitors generally need more time to evaluate it. Most managers agreed that price must be somewhat in line and that nonprice services do not substitute for a better price.

Other nonprice competitive practices in the Minnesota industry are the services of the hauler and fieldman. As plants grow larger and the relationship between the manager and producer becomes less personal, the importance of the hauler and fieldman as goodwill ambassadors increases.

It is the milk hauler's responsibility to transport the milk from the producer to the plant and to serve as a liaison or connecting link between the suppliers and creamery. About 70 percent of the managers in the three sample areas said they thought that good hauling service would substitute to some degree for price.

The fieldman is important in the procurement process. His primary function is to check on milk quality and suggest solutions to quality problems. Another duty in some areas is soliciting suppliers. Only 16 of the 57 plants in the three sample area plants used the fieldman for the latter purpose, however.

There appears to be substantial support for the proposition that managers prefer nonprice services to price competition. Almost all the managers in the three sample areas said they preferred nonprice competition to price competition.

MARKET PERFORMANCE

The study's third objective is to analyze the relationship between market structure and performance in the Minnesota dairy manufacturing industry. The performance dimensions considered are (1) processing efficiency, (2) net margin ratios, (3) rate of progressiveness, and (4) overlapping of milk procurement areas. A sample of plants was studied to get information on the performance of the Minnesota dairy manufacturing industry. The sample included 86 plants — 48 butter plants and 38 butter-powder plants — in the state. Seven were owned noncooperatively, and 79 were owned cooperatively.

Table 20 shows the number of butter plants (classified by pounds of butterfat received) and the number of butter-powder plants (classified by total solids received) included in the stratified sample of plants in Minnesota. All butter plants in the state receiving over 1,500,000 pounds of butterfat and all butter-powder plants receiving over 20 million pounds of total solids were included in the sample. The larger plants were sampled more heavily because they represent a more significant part of the industry.

Table 20. Number of specialized butter plants (classified by pounds of butterfat received) and number of butter-powder plants (classified by total milk solids received) in the sample of 86 plants, Minnesota, 1963

Size of plant (1000 lb. of butterfat received)	Number of butter plants	Size of plant (1000 lb. of total milk solids*)	Number of butter-powder plants
100-299	3	Less than 4,000	6
300-499	4	4,000-6,999	6
500-749	6	7,000-10,499	10
750-999	8	10,500-19,999	8
1,000-1,499	20	20,000 and over	8
1,500 and over	7		
Total	48	Total	38

* Includes both butterfat and nonfat solids.

Structure-Performance Relationships

Processing Efficiency

Bain says, "A dominant aspect of performance in any industry is its relative efficiency in producing and distributing goods, such efficiency being measured by how closely the firms in the industry approximate the lowest attainable costs for the outputs they produce and distribute."[19]

The Minnesota dairy manufacturing industry has become more concentrated in recent years. It is expected that the industry's overall processing efficiency has increased because plants have become fewer and larger. Because benchmark cost data could not be obtained for these dairy manufacturing plants, the relationship between increasing firm concentration and processing efficiency could not be tested. However, the per unit costs for different size plants can be compared. Therefore, it was hypothesized that large plants manufacture butter and powder at lower per unit costs than small plants do. Testing this relationship would permit some inferences about the relationship between increasing concentration and processing efficiency.

---

[19] Bain, J. S., *op. cit.*, pp. 342-343.

Average plant operating cost per unit of butterfat received was computed for each butter plant. Butter and butter-powder plants differ in their operations so cost comparison with the combined plants is not meaningful.

The specialized butter plant operating cost per pound of butterfat received declined as the plant size increased (table 21). For example, plants receiving from 100,000 to 299,000 pounds of butterfat had an average processing cost of about 10 cents per pound of butterfat. Plants receiving over 1,500,000 pounds of butterfat had an average per unit processing cost of 5.47 cents.

Table 21. Average plant operating cost for 41 Minnesota butter plants classified by size, 1963

Butterfat received (1000 lb.)	Number of plants	Cost per lb. of butterfat received (cents)
100-299	3	10.07
300-499	3	10.50
500-749	6	6.89
750-999	5	6.26
1,000-1,499	18	5.83
1,500 and over	6	5.47
Total	41	Average 6.06

A butter-powder plant's average operating cost per pound of total milk solids received decreased as the size of the plant increased (table 22).

Table 22. Average operating cost of 37 Minnesota butter-powder plants classified by size, 1963

Total milk solids received* (1000 lb.)	Number of plants	Cost per lb. of total milk solids received (cents)
Less than 4,000	6	6.06
4,000-6,999	6	4.61
7,000-10,499	8	3.85
10,500-19,999	10	3.08
20,000 and over	7	3.01
Total	37	Average 3.39

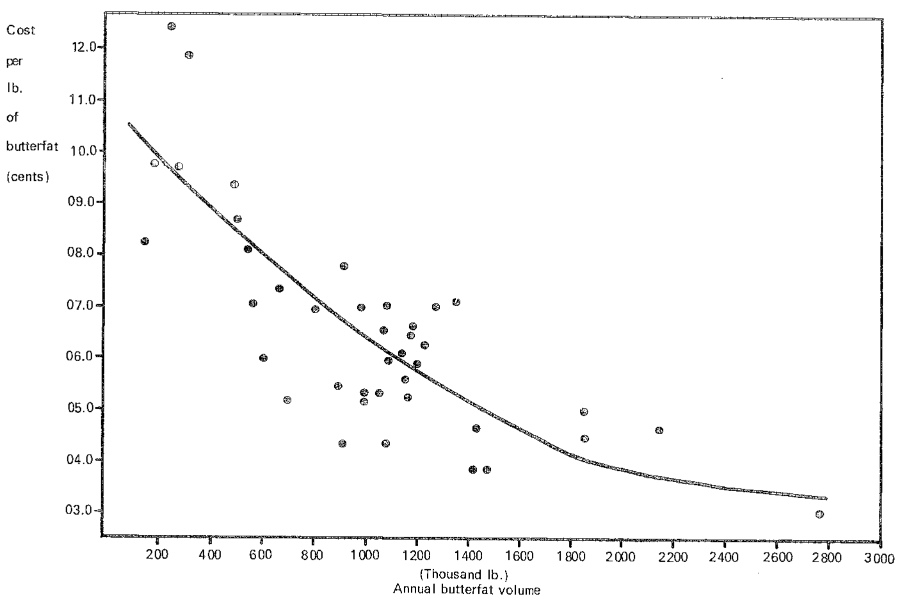
* Includes fat and nonfat solids combined.

Although dairy manufacturing plants have become fewer and larger, it was hypothesized that some plants would not have attained the size to exploit fully the economies of large size. Several points seem to support this hypothesis. First, technological developments adopted by the industry have increased the plant size required to attain the optimal scale of the plant.

Second, although the number has decreased, many small plants (those receiving less than 400,000 pounds of butterfat annually) still exist in the industry. The barriers to exit caused some plants, which might have exited, to remain in the industry. Cook found that barriers to exit were the primary reasons forcing many small firms to remain in the ice cream business.[20]

The average operating cost for each butter plant is plotted on figure 3. The butterfat volume a plant handles affects the per unit cost. Each dot represents the cost-volume position of a particular butter plant. The curved regression line is fitted statistically. Plant costs declined over the range of plant volumes, from 10.03 cents per pound at 149,000 pounds of butterfat annually to 4.19 cents at 2,769,000 pounds of butterfat annually. The regression line approximates a theoretical long-run cost, or economies of size, curve. However, the regression line differs from the theoretical economies of size curve in that the line does not represent the near-minimum costs of processing each volume. The curve, constructed from average plant costs, lies somewhat above the theoretical economies of size curve.[21]

Figure 3. Relationship between per unit cost and annual butterfat volume in 40 butter plants in Minnesota, 1963.



[20] Cook, Hugh L., *Consequences of Structural Changes in the Ice Cream Industry.* Bulletin No. 236, Agricultural Experiment Station, University of Wisconsin, Madison, Wisconsin, June 1962, pp. 54-55.

[21] Knudtson, Arvid C., and E. Fred Koller, *Manufacturing Costs in Minnesota Creameries,* Bulletin No. 442, Agricultural Experiment Station, University of Minnesota, St. Paul, Minnesota, June 1957, p. 24.

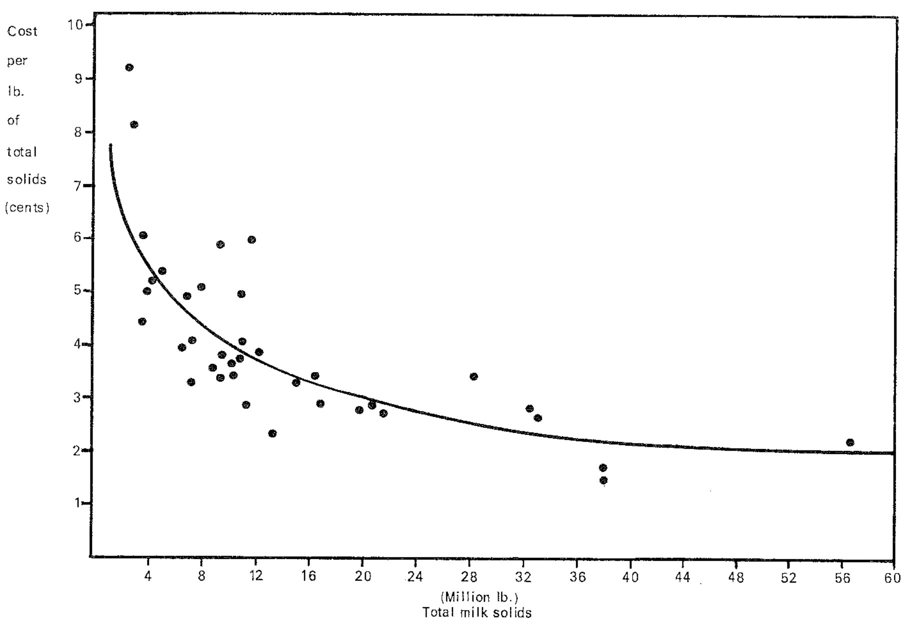
The curve does show the average economies of size achieved by butter plants in Minnesota. The potential savings may be even greater than indicated in the average planning curve.

Economies of size have not been attained fully. This is consistent with the results of other studies. In the baking industry study Walsh and Evans found that optimal performance was not achieved with respect to efficiency.[22]

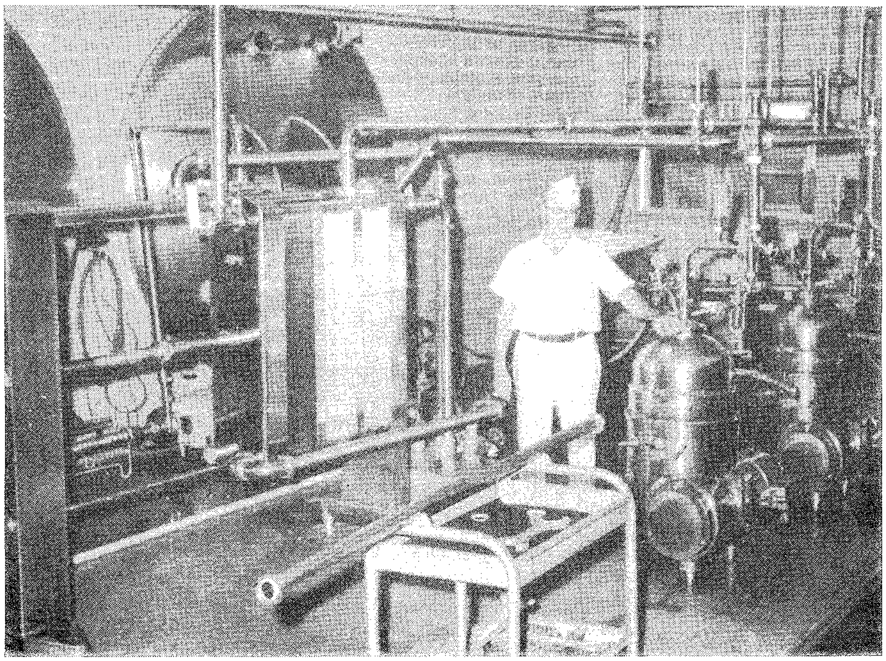
Figure 4 shows the relationship of volume of total milk solids and total per unit costs in butter-powder plants. The regression line was fitted statistically, and shows that butter-powder plants do not exploit fully economies of size. However, some large butter-powder plants are close to optimal size. The average cost decreases from 8.3 cents per pound at 1.2 million pounds of total milk solids annually to 1.99 cents per pound at 56 million pounds.

Many changes would be required before almost every firm in the Minnesota industry could operate at or near optimal size. Such changes would have strong implications for further concentration. Not only would the butter and butter-powder plants be larger, but there would be even fewer plants. The Minnesota dairy manufacturing industry would become substantially more concentrated.

Figure 4. Relationship between per unit costs and annual total solids volume in 35 butter-powder plants in Minnesota, 1963.



[22] Walsh, R. G. and B. M. Evans, *op. cit.*, p. 130.



Plant worker checking cream separators and pasteurizer.

The dairy manufacturing industry operates at less than optimal performance. The trend in this industry has been toward concentration. The data indicate that this trend should continue if performance is to improve.

Net Margins

Excess profits in an industry generally are viewed as evidence that the industry is not performing well. For example, firms in an industry may be able to maintain excess profits because of barriers to entry or pricing practices, such as price discrimination, to drive out competitors. Excess profits may be earned by firms in the Minnesota industry, but not because of monopoly power. Nor do excess profits necessarily indicate bad performance. Because ownership is predominantly cooperative, net margins are distributed or allocated as patronage refunds. Thus, other things being equal, the greater the excess profits of cooperative firms, the larger the return to producers.

What are excess profits? According to Bain, they are returns to capital in excess of a "normal return."[23] Bain said that for the period 1949 to 1953 the normal return was 4 percent on owner equity.[24] Because of the risks, 5

[23] Bain, J. S., *op. cit.*, p. 383.
[24] *Ibid.*, p. 383.

percent was chosen for investment in the dairy manufacturing industry. It was assumed that this rate would attract capital to this industry.

It is expected that the net margins of these plants are related to the size and number of firms. Because of their expected greater efficiency, it was hypothesized that net margins are greater for large firms than for smaller ones.

Information on the annual net margins was obtained from the stratified sample of 86 plants. The adjusted net margins, or excess net margins, were calculated by subtracting an amount equal to 5 percent of the net worth of each plant from the annual net margins.

Table 23. Adjusted net margins and net margin ratios for 48 butter plants, classified by size, in Minnesota, 1963

Butterfat received (1000 lb.)	Number of plants	Adjusted net margins* per plant (dollars)	Adjusted net margin ratios (percent)
100-299	3	1,660	3.3
300-499	4	1,778	1.7
500-749	6	6,974	4.7
750-999	8	9,753	4.8
1,000-1,499	20	17,916	6.6
1,500 and over	7	21,675	6.0
Total	48	Average 13,376	5.8

* The adjusted net margins and net margin ratios are computed by subtracting 5 percent of the net worth from net margins.

The large butter plants earned higher adjusted, or excess, margins than did smaller plants. For example, plants receiving more than 1,500,000 pounds of butterfat annually had an average adjusted net margin ratio, or excess profit, of 6.0 percent. For plants receiving 300,000-499,000 pounds of butterfat annually, it was only 1.7 percent. One reason that larger plants appear to earn larger excess net margins than small plants earn is the greater efficiency in their operations.

Table 24 shows the average adjusted net margins and adjusted net margin ratios for butter-powder plants. Plants receiving more total milk solids an-

Table 24. Adjusted net margins (excess net margins) ratios for 38 butter-powder plants, classified by size, in Minnesota, 1963

Total solids received (1000 lb.)	Number of plants	Adjusted net margins* per plant (dollars)	Adjusted net margin ratios (percent)
Less than 4,000	6	9,034	3.1
4,000-6,999	6	10,855	3.3
7,000-10,499	8	23,711	3.1
10,500-19,999	10	62,967	7.6
20,000 and over	8	161,535	8.0
Total	38	Average 58,723	6.5

* The adjusted net margins and net margin ratios are computed by subtracting 5 percent of the net worth from net margins.

nually had higher adjusted, or excess net margins and net margin ratios than smaller plants. The average adjusted net margin ratio for plants receiving over 20 million pounds of solids annually was 8.0 percent. For plants receiving less than 4 million pounds of solids, it was only 3.1 percent.

Table 24 supports the hypothesis that large plants have higher net margins and net margin ratios than smaller plants.

Net margins earned are expected to be related to the structural variable, type of ownership. Because they have different economic goals, the cooperatives and noncooperatives will earn different net margins.

The predominance of cooperative plants has an important effect on the Minnesota dairy manufacturing industry. Because of the influence of cooperatives it is expected that the returns to producers are higher than if all firms were organized on a noncooperative basis. Generally, the policy of cooperatives is to allocate all net margins to producers in patronage refunds. With the increasing concentration in the Minnesota industry, one would expect producers to be exploited because of increased monopsonistic or monopoly power. Excess profits are not the result of the restriction of milk supplies because most firms are plagued with excess capacity. Plants are striving for additional patronage and are not restricting resources so that profits can be increased. Firms often increase excess profits through increased efficiency of operation. This means that the suppliers will benefit because patronage refunds will increase. Therefore, excess net margins do not indicate bad performance in the Minnesota industry.

Total Returns to Producers

Since cooperatives can vary prices and patronage refunds, a more precise measure of returns to suppliers is the total of the producer pay price and patronage refund.

It was hypothesized that cooperatives pay higher total returns to producers (the No. 1 milk pay price plus patronage refunds) than do noncooperatives.

Table 25 shows that cooperatives pay a higher total return to producers than do noncooperative plants. Noncooperatives paid higher average prices than did the local cooperatives. However, when the patronage refund is considered, the total payment by cooperatives is $3.23 per hundredweight, while it was $3.19 for noncooperatives in 1963. The difference is not statistically significant, however.

Another structural variable, type of plant operation, is expected to be related to the net margins. Because butter-powder plants have cost advantages, it was hypothesized that the total return to producers (the average milk pay price plus the patronage refund) is higher in butter-powder plants than in butter plants.

The stratified random sample of 86 plants provided the information to test this relationship. The butter-powder plants pay not only a higher average price for milk, they also allocate larger patronage refunds (table 26). The

Table 25. Average price paid for milk and total return by cooperative and noncooperative plants in Minnesota, 1963

Ownership	Average price paid for milk (dollars per cwt.)	Average patronage refund paid	Total return*
Cooperatives	3.13	.10	3.23
Noncooperatives	3.19	. .	3.19

* Computed F value = .48   F(.05, 1, 78) = 3.964

Table 26. Milk prices, patronage refund, and total returns per hundredweight of No. 1 manufacturing milk in butter and butter-powder plants, Minnesota, 1963

Operation	Number of plants	Average milk price	Average patronage refund (dollars per cwt.)	Total returns
Butter-powder	28	3.16	0.13	3.29
Butter	46	3.11	0.08	3.19

* Computed F value = 11.18   F(.01, 1, 72) = 7.00

total returns to producers were $3.29 per pound from butter-powder plants and $3.19 from butter plants.

The trend toward butter-powder operations suggests that the producer returns will be higher than they would be without the trend.

Rate of Progressiveness

Rate of progressiveness is an important performance dimension because new technology is one way to increase marketing efficiency in the Minnesota industry.

The size and progressiveness of firms was compared. Some inferences were made about the relationship between concentration and progressiveness.

It was hypothesized that large plants are more progressive than small plants. This is because, as indicated by Padberg and Clarke,[25] being progressive is expensive and may be feasible only for large plants; and most new technology requires a large volume to justify its adoption.

The criterion used for rate of progressiveness was the extent that plants have adopted recent innovations. The year in which the new technology was adopted was also considered. The specific dairy plant innovations used to measure progressiveness include: high-temperature-short-time (HTST) pasteurization, clean-in-place (CIP) systems, and the percentage of producer milk received in bulk form.

[25] Padberg, David I., and D. A. Clarke, Jr., *Structural Changes in the California Fluid Milk Industry — Their Effects on Competition and Performance.* Bulletin No. 802, Agricultural Experiment Station, University of California, Berkeley, California, June 1964. pp. 44-45.

To test the relationship between size and progressiveness of firms, information was taken from mail questionnaires sent to the sample of 86 plants in Minnesota. Fifty-nine plants responded to the questionnaire. Table 27 shows the percentage of plants (classified by size) which adopted the innovations. A greater percentage of the large plants than small plants adopted the innovations. For example, 88 percent of the plants receiving more than 1,500,000 pounds of butterfat annually used high-temperature-short-time pasteurization. However, only 6 percent of plants handling less than 1,000,000 pounds of milk annually adopted HTST.

Table 28 shows the percentage of milk received in bulk and the percentage received in cans by the 59 plants, classified by size. The larger plants received a large proportion of their milk supply in bulk. Plants receiving more than 1,500,000 pounds of butterfat annually received 55 percent of their milk in bulk. Plants receiving less than 1,000,000 pounds of butterfat annually received only 34 percent of their milk in bulk.

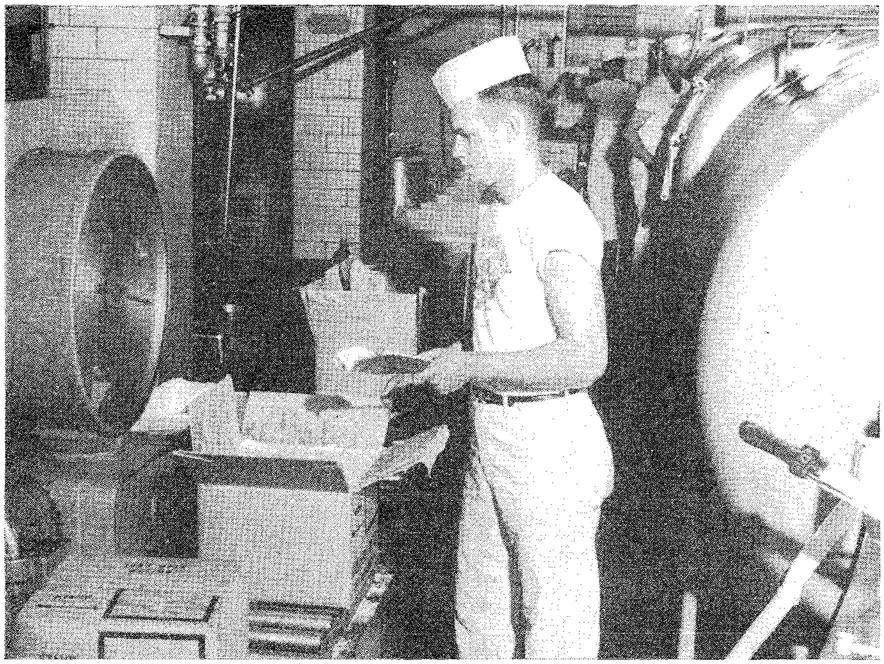
Table 27. Percent of 59 butter and butter-powder plants adopting high-temperature-short-time pasteurization, clean-in-place systems, and receiving bulk milk, Minnesota, 1965

Size of plant (1000 lb. of butterfat received)	Number of plants	Percent of total plants in each size category		
		HTST	CIP	Bulk milk
Less than 1000	17	6	41	88
1,000-1,499	16	38	81	94
1,500 and over	26	88	100	100

Table 28. Percent of milk received in bulk and cans by 59 dairy plants classified by size, Minnesota, 1965

Size of plant (1000 lb. of butterfat received)	Average percent of milk received in	
	Bulk	Cans
Less than 1,000	34	66
1,000-1,499	36	64
1,500 and over	55	45

The year in which the plant adopts a technique is important in determining the rate of progressiveness. Table 29 shows the number of plants classified by the year in which they adopted the new technology. Large plants adopted the techniques earlier. By 1958, 13 of the 26 plants receiving over 1,500,000 pounds of butterfat annually had adopted the clean-in-place system. However, only 3 of the 17 plants receiving less than 1,000,000 pounds of butterfat annually had adopted the clean-in-place system by 1958.



Plant workers packaging and weighing butter into bulk containers.

Table 29. Number of plants by size adopting HTST, CIP, and bulk milk (classified by year of adoption)

	HTST (1000 lb.)			CIP (1000 lb.)			Bulk milk (1000 lb.)		
Years	Less than 1000	1,000-1,499	1,500 and over	Less than 1000	1,000-1,499	1,500 and over	Less than 1000	1,000-1,499	1,500 and over
	Number of plants								
1948-1954 . .	—	1	4	—	1	1	—	—	2
1955-1956 . .	1	—	4	2	2	2	2	4	8
1957-1958 . .	—	1	6	1	—	10	2	2	4
1959-1960 . .	—	2	4	1	5	6	5	4	7
1961-1962 . .	—	1	3	2	2	4	3	1	3
1963-1965 . .	—	1	1	1	2	1	2	3	2
Unknown . .	—	—	1	—	1	2	1	1	—
Total . .	1	6	23	7	13	26	15	15	26
Number in size group . .	17	16	26	17	16	26	17	16	26

The above data support the hypothesis that large plants are more progressive than small plants. It is quite probable that increased concentration means increased progressiveness. Plants in Minnesota are becoming larger, and it appears that larger plants are more progressive.

It also was hypothesized that butter-powder plants are more progressive than are butter plants. Butter-powder plants are expected to be more progressive because of the cost advantages they enjoy. Table 30 shows that, in all cases, a larger percentage of the butter-powder plants had adopted each innovation than had the butter plants.

Table 31 shows the number of butter and butter-powder plants, classified by the year of adoption, adopting each new technology. A greater proportion of the butter-powder plants adopted the technologies earlier than did the butter plants. By 1958, 15 of the 29 butter-powder plants and only 2 of 30 butter plants had adopted high-temperature-short-time pasteurization. Not only was the proportion of butter-powder plants adopting this technology greater, but they were also adopting it earlier than were butter plants.

Table 30. Percent of butter and butter-powder plants adopting HTST, CIP, and bulk milk in Minnesota, 1965

Type of operation	Number of plants	Percent of plants		
		HTST	CIP	Bulk milk
Butter	30	20.0	63.3	90.0
Butter-powder	29	82.8	89.7	100.0

Table 31. The number of butter and butter-powder plants adopting HTST, CIP, and bulk milk (classified by year of adoption)

	HTST		CIP		Bulk milk	
Year	Butter	Butter-powder	Butter	Butter-powder	Butter	Butter-powder
1948-1954	1	4	1	1	0	2
1955-1956	–	5	2	4	6	8
1957-1958	1	6	2	9	4	4
1959-1960	3	3	7	5	10	7
1961-1962	1	3	4	3	2	4
1963-1965	–	2	2	2	4	3
Unknown	–	1	1	2	1	1
Total	6	24	19	26	27	29
Number in sample	30	29	30	29	30	29

Table 32. Percent of milk received in can and bulk in butter and butter-powder plants in Minnesota, 1965

Operation	Number of plants	Percent of milk received in	
		Bulk	Can
Butter	30	34.8	65.2
Butter-powder	29	47.0	53.0

Table 32 shows the percentages of milk which butter and butter-powder plants receive in bulk and cans. Butter-powder plants receive 47 percent of their milk in bulk, compared to 34.8 percent for butter plants.

The above data support the hypothesis that butter-powder plants are more progressive than butter plants.

Overlapping of Milk Procurement Areas

Overlapping of procurement areas, the amount of cross-hauling and route duplication, is measured by the number of creameries procuring milk in a defined area. Excessive overlapping is inefficient and wasteful and indicates that the industry's performance could be improved. It was reasoned that the increased concentration in the Minnesota dairy manufacturing industry has decreased the amount of overlapping of procurement areas. This relationship cannot be tested directly because benchmark data on overlapping in the three sample areas is not available.

Information on current overlapping of milk procurement areas was obtained from managers in the three sample areas. The information was obtained from all plants within each sample area and those outside which procured milk in the areas. Figures 5 and 6 show the overlapping of procure-

Figure 5. Overlapping of milk procurement areas in Freeborn County, 1962.

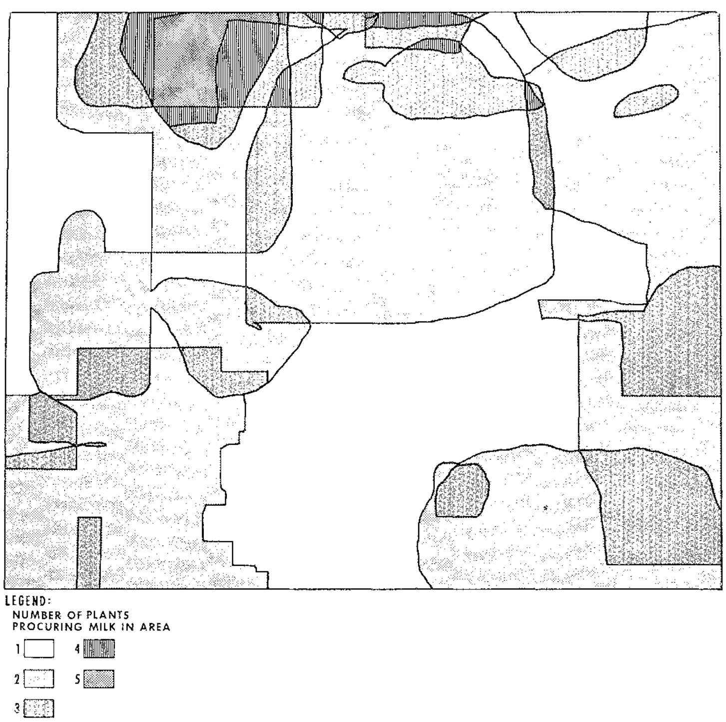
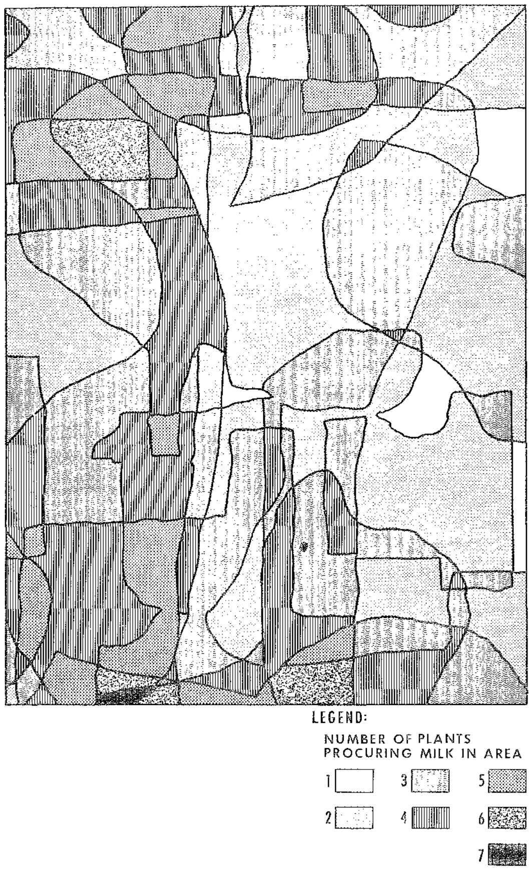


Figure 6. Overlapping of milk procurement areas in Steele County, 1962.



ment areas in Freeborn and Steele Counties in 1962. Freeborn County in figure 5 has as many as five plants procuring milk in a given area. The maps for Otter Tail, Todd, and Wright Counties are not included. These three counties also showed as many as five plants procuring milk in some areas. Only three or fewer plants procured milk in the major portion of each of these four counties.

The maximum number of plants overlapping in any part of Steele County was seven. However, four or fewer plants procured milk in most sections of the county. The greater overlapping of procurement areas in Steele County was caused by two large manufacturing plants outside the county which procured milk in most of the county.

Dankers and Koller studied overlapping of procurement areas about 30 years ago in another Minnesota county.[26] Overlapping of procurement

[26] Dankers, W. H. and E. Fred Koller, *A Survey of Cooperative Creameries in Houston County*, pamphlet No. 62. Agricultural Extension Service and Department of Agricultural Economics, University of Minnesota, St. Paul, Minnesota, November 1939, p. 10.

has not decreased. Plants are larger now than they were then, and better roads and trucks have enabled plants to increase the size of their procurement areas. As plants increased their capacities, they had to increase their procurement areas to operate near their capacities.

By comparing the average overlapping of areas of large and small plants, additional inferences can be made about whether increased concentration causes a decrease in the overlapping of procurement areas. It was hypothesized that the average overlapping of procurement areas by large plants is less than for small plants. The reason is that it is expected the large plants have a larger area where there are no competing plants procuring milk. In the case of a small creamery it is likely that a large creamery covers its entire procurement area. For example, in Freeborn County one plant procured milk in the entire county. According to figure 6, this plant has no competitiors in a substantial area. Because its procurement area covers the entire county, each small plant in the county has at least one competitor in its entire procurement area.

To test the proposition, weighted averages of the number of competing plants were obtained for every plant in the three sample areas.[27]

Table 33 shows the inconclusive results for each of the three areas. The reduction of plants has taken out some potential competitors. Improved trucks and roads and the need for larger amounts of milk to reduce excess capacity, however, have encouraged plants to increase the size of their procurement areas. This apparently has offset the effects of the reduction in plant numbers.

Table 33. Weighted average number of plants procuring milk for plants in the three sample areas, classified by size

Size of plant (1000 lb. of butterfat received annually)	Average number of competing plants		
	Freeborn-Steele	Wright	Otter Tail-Todd
Less than 750	3.0	2.3	3.0
750 and over	2.9	2.5	2.9

PROJECTED STRUCTURAL CHANGES

This study's fourth objective is to predict the future market structure of the Minnesota dairy manufacturing industry. Implications for conduct and performance will be stated on the basis of relationships analyzed earlier in this study.

[27] If in 50 percent of a plant's procurement area four plants were procuring milk and in the other half two plants were procuring milk, the average number of competing plants would be three.

Markov Chain Process[28]

The Markov chain method, useful in estimating some aspects of the industry's future market structure, can be used to predict the size distribution of dairy plants in the future. The Markov chain projects not only exits from the industry but also the number of firms in each size category and entries into the industry. With this method, transition probabilities (derived from changes in numbers of plants of specific sizes during a given period) are used to project the future number and size distribution of plants. The industry's future computed from transition probabilities is not a prediction but an indication of tendencies.

According to Farris and Padberg[29] a key assumption in employing Markov chain processes in market structure analysis is that firm growth is stochastic. "That is, growth by firms in a given size category takes place according to probabilities of movement assigned to that category. Such probabilities can be estimated from firm movements among selected categories in selected periods."[30] It is also necessary to assume that the change will continue in the same direction in the future and that the conditions (e.g., new technology) causing those changes will continue in the future.

These assumptions are quite restrictive. For example, evidence has indicated that firm exits from the industry are dependent on size. Smaller firms have been exiting from the industry at a much more rapid rate than large firms. The stochastic assumption apparently is not met with regard to plant exits.[31] However, for purposes of this study, the number of firms will be projected into the future. The most restrictive assumption is that the conditions which have influenced concentration in the industry will continue to exist.[32]

Table 34 shows the changes in size, entries to, and exits from the Minnesota dairy manufacturing industry between 1955 and 1963. There were 333 dairy manufacturing plants in 1963. There were 229 exits from the industry during the study period 1955 to 1963. One of the 12 entries to the industry was in the 500,000-749,000-pound class, one in the less-than-100,000-pound class, and 10 in the over-1,000,000-pound class. This supports the contention that small plants (especially new ones) have difficulty competing. In general, the plants either exited from the industry or grew larger.

To project the future size distribution, a transition matrix was necessary (see appendix). Table 35 shows the 1963 size distribution and the projected 1971 and 1979 size distribution for the Minnesota dairy manufacturing in-

[28] The Markov chain process is used to predict mechanically the size distribution of an industry in equilibrium. The predictions are based on changes occurring during defined periods.

[29] Farris, Paul L. and Daniel I. Padberg, "Measures of Market Structure Changes in the Florida Fresh Citrus Packaging Industry," Agricultural Economics Research, Vol. XVI, No. 4, U.S. Department of Agriculture, ERS, October 1964.

[30] *Ibid*, p. 95.

[31] The definition of exit includes plants that changed their operation from a butter plant, ceased operations entirely, or merged with other plants.

[32] See above for a summary of these conditions.

Table 34. Changes in size, entries to, and exits from the Minnesota dairy manufacturing industry, 1955 to 1963

Size of plant (1000 lb. of butterfat annually)	Number of plants in category in 1955	1963 size category of plants remaining in operation								Number of exits 1955 to 1963
		Less than 100	100-199	200-299	300-399	400-499	500-749	750-1,000	Over 1,000	
Less than 100	38	3	1	..	..	..	1	..	..	33
100-199	103	9	10	11	1	5	1	1	1	64
200-299	91	2	5	9	13	9	11	1	..	41
300-399	85	..	..	5	13	8	12	8	4	35
400-499	65	..	..	..	6	8	19	7	6	19
500-749	77	..	..	1	..	4	19	24	15	14
750-999	33	..	..	..	..	..	5	3	16	9
1,000 and over	58	..	..	..	..	..	1	3	40	14
New entries	..	1	..	..	..	..	1	..	10	..
Total	550	15	16	26	33	34	70	47	92	229

dustry. According to the projected structure, in 1979 only one plant in the state will receive less than 100,000 pounds of butterfat annually. Eight entrants and 103 exits are projected between 1963 and 1971 resulting in a projected total of 238 plants in 1971. According to the projections, in 1971 only 40 plants would be handling less than 500,000 pounds of butterfat annually.

The 1979 projections show only 13 plants handling less than 500,000 pounds of butterfat annually. According to the projections, 14 plants will enter and 161 plants will exit from the industry between 1963 and 1979. The number of plants projected for 1979 is 186. In 1963, 27.7 percent of the plants received more than 1,000,000 pounds of butterfat; by 1979, 64.5 percent of the plants are projected to be handling more than 1,000,000 pounds of butterfat.

These projections using the Markov chain analysis indicate the tendencies based upon prevailing conditions from 1955 to 1963. New technology such as the continuous churn could result in even fewer butter plants by 1971 and 1979 than are indicated in Table 34.

Some Predicted Structural Changes

The changes projected by the Markov chain process significantly influence the market structure variables. For example, the Minnesota industry will continue to become more concentrated. By 1979, the Minnesota industry will be much closer to an oligopsony than it is today. There will be fewer small plants. In 1963, 196 plants handled less than 750,000 pounds of butterfat annually; based on projections, 87 plants will handle less than 750,000 pounds of butterfat annually in 1971 and only 32 plants in 1979.

Type of Ownership

The Markov chain was used to project changes in the type of ownership to 1971 and 1979. Table 36 compares the proportion of cooperatively owned plants in 1955 and 1963 and the projected proportions for 1971 and 1979. In 1963 almost 90 percent of plants were cooperatives. According to the projections, by 1979 there will be 178 (95.7 percent) cooperatively owned plants.

Type of Plant Operation

There has been a consistent trend from a simple butter operation where only a part of the milk, namely butterfat, is manufactured to a butter-powder operation where both skim milk and butterfat are manufactured.

The Markov chain method was used to project the number of butter and butter-powder plants to 1971 and 1979. Table 37 shows the number and

Table 35. Size distribution for 1963 and the projected size distribution for 1971 and 1979 based on transition probabilities derived from 1955 to 1963

Size of plant (1000 lb. of butterfat received annually)	Size distribution for 1963		Projected numbers			
			1971		1979	
	Number of plants	Percent	Plants	Percent	Plants	Percent
Less than 100	15	4.5	4	1.7	1	.5
100-199	16	4.8	3	1.2	0	..
200-299	26	7.8	7	2.9	3	1.6
300-399	33	9.9	12	5.0	3	1.6
400-499	34	10.2	14	5.9	6	3.1
500-749	70	21.0	45	18.9	27	13.9
750-999	47	14.1	36	15.1	26	14.0
1,000 and over	92	27.7	117	47.5	120	64.5
Total	333	100.0	238	100.0	186	100.0

Table 36. Number and percent of cooperatives and noncooperatives in 1955 and 1963 and the projected number and percent of cooperatives and noncooperatives in 1971 and 1979

	Distribution of plants				Projected number in 1971 and 1979 based on transition probabilities			
	1955		1963		1971		1979	
Ownership	Number	Percent	Number	Percent	Plants	Percent	Plants	Percent
Cooperative	458	83.3	297	89.2	224	94.1	178	95.7
Noncooperative	92	16.7	36	10.8	14	5.9	8	4.3
Total	550	100.0	333	100.0	238	100.0	186	100.0

Table 37. Number and percent of butter and butter-powder plants in 1955 and 1963 and the projected number and percent of butter and butter-powder plants in 1971 and 1979

	Distribution of plants				Projected number in 1971 and 1979 based on transition probabilities			
Plant	1955		1963		1971		1979	
operation	Number	Percent	Number	Percent	Plants	Percent	Plants	Percent
Butter	504	91.6	278	83.5	173	72.7	116	62.4
Butter-powder	46	8.4	55	16.5	65	27.3	70	37.6
Total	550	100.0	333	100.0	238	100.0	186	100.0

percentage of butter and butter-powder plants in 1955 and 1963 and the projected figures for 1971 and 1979. Only 8.4 percent of plants were butter-powder plants in 1955. According to the projections, by 1979, 37.6 percent will be butter-powder plants. Since over half of the butter was produced by butter-powder plants in 1963, an even larger proportion of the butter is expected to be manufactured by butter-powder plants.[33]

Implications for Conduct

Price Competition

On the basis of the projected future market structure estimates, the firm concentration in the Minnesota dairy industry will continue to increase. The increasing concentration implies an increasing interdependence among firms. Price leadership is expected to become more firmly established. Less variation among firms is expected in the pay price for No. 1 milk. In other words, the pay price established by price leaders in 1979 would be followed more generally.

Although overt price collusion may be more probable in 1979 than today, this form of price determination is not expected to be very prevalent because it is illegal.

Because of the increasing proportion of butter-powder plants, the majority of the price leaders are expected to be butter-powder plants.

The number of price wars (or aggressive price competition) is expected to decrease. Managers will realize soon that price wars are costly, and if too many competitors are driven out of the industry, legal antitrust action may be taken against them.[34] A live-and-let-live policy, where plants will be competing on the basis of services and general merits rather than with price and price wars is likely to be adopted.

Implications for Market Performance

The structural variable changes projected by the Markov chain analysis are expected to have significant effects on the performance of the industry. This study shows that significant relationships exist between structural and performance variables.

[33] These are merely statements of tendencies based on the assumption that no major changes in dairy manufacturing technology or demand will intervene. If continuous churns or large capacity churns are adopted widely, creameries and butter-powder plants would decrease further in number.

[34] It is not likely that legal action will be needed in the Minnesota dairy manufacturing industry, because it is composed primarily of cooperatives. Cooperatives are designed to operate in the interest of producers, not to exploit them.

Processing Efficiency

The results of this study show that larger plants operate at lower per unit costs than smaller plants. The projected size distribution indicates a future trend toward fewer and larger plants. As a result, the plant operating efficiency in the industry may be expected to improve. In addition, a larger proportion of plants may be expected to operate at or near optimal size.

Net Margins

It is expected that net margins, or at least total net returns, will be higher in 1979 than they are today.[35] Larger plants earn higher net margins than smaller plants.

The trend toward butter-powder operations also will tend to increase the total payment to producers. Net returns to producers are significantly larger from butter-powder plants than from butter plants.

Rate of Progressiveness

The trend toward fewer and larger plants indicates also that the Minnesota dairy manufacturing industry will become more progressive. Large plants adopt new technology earlier and a larger percentage adopt it than do small plants. Butter-powder plants are more progressive than are butter plants. Because the proportion of butter-powder plants is expected to increase by 1979, it follows that the industry will become more progressive.

SUMMARY AND CONCLUSIONS

This study of the industrial organization of the Minnesota dairy manufacturing industry deals with the interrelationships of market structure, market conduct, and performance in the industry.

The aspects of market structure that were considered important in the Minnesota industry were (1) size and number of firms, (2) type of ownership, (3) type of plant operation, and (4) conditions of entry and exit.

The trend has been toward fewer and larger plants which indicated the industry is moving even closer to an oligopsony. The industry is oligopsonistic with a fringe of medium and small plants.

Most Minnesota dairy manufacturing plants are owned cooperatively. The trend continues toward this form of ownership.

The trend toward butter-powder plants in the Minnesota industry has been consistent. In 1938, there were only seven butter-powder plants in Min-

[35] Cooperatives may pay higher prices and leave smaller net margins for patronage refunds, or vice versa.

nesota. In 1963, over one-half of the butter produced in the state was manufactured by the 55 butter-powder plants.

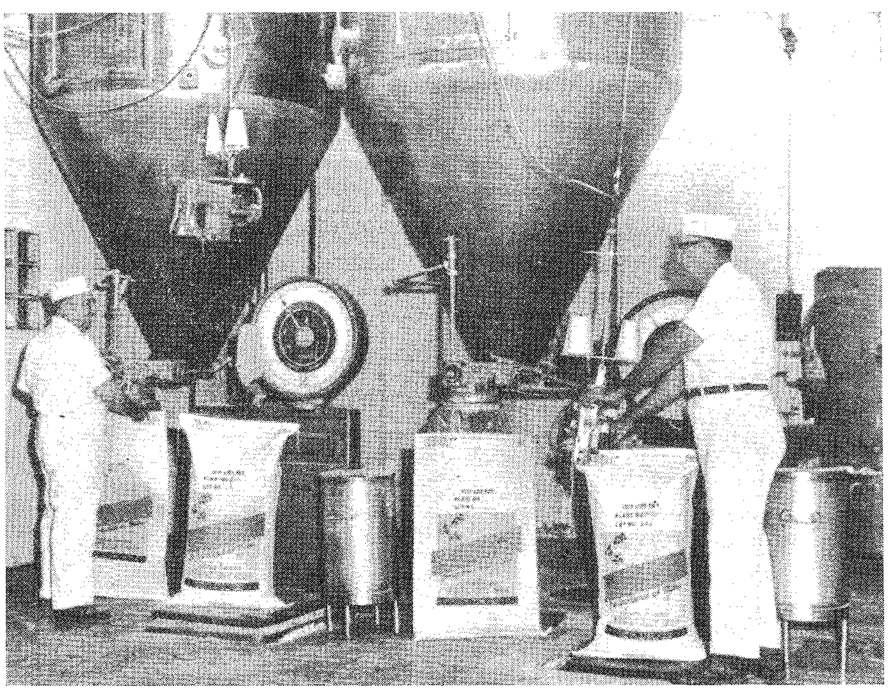
An important entry barrier in the Minnesota dairy manufacturing industry is the capital investment necessary to build a plant of optimal size. Technological changes have increased the optimal size and the barriers to entry.

The primary exit barrier is a lack of an alternative use for plant and equipment. Moreover, a sociological barrier may play an important role in keeping the local creamery operating.

The market conduct variables considered in this study are price and nonprice competition.

As expected, price leadership is the predominant form of price determination. The price leaders usually were the area's large plants and butter-powder plants. Because they affected the size distribution of plants, the conditions of entry or exit influenced the market power relationships.

Although large plants paid producers somewhat more for manufacturing milk than did small plants, the difference was not statistically significant.



Workers packaging and weighing dry milk in preparation for storage and sale.

The difference in the average price paid for milk (before patronage refunds) by cooperative and noncooperative plants was insignificant. Noncooperatives must be competitive with regard to milk prices because many cooperatives also pay a patronage refund at the end of the year.

The average pay price for milk was higher from butter-powder plants than from butter plants. Price wars occurred in some of the sample areas. Plants in price war areas paid significantly higher prices than did plants in nonprice-war areas. The price wars apparently stemmed from relatively high cheese prices during the analysis period.

The performance dimensions considered in this study are (1) processing efficiency, (2) net margins, (3) rate of progressiveness, and (4) overlapping of procurement areas.

Large firms, in general, were more efficient than small firms. In both butter and butter-powder plants, per unit plant operating costs declined as size increased. One can infer that increased concentration in the Minnesota industry has resulted in increased efficiency.

In general, the adjusted net margins (excess net margins) were greater for large plants than for small plants.

The type of ownership has an important welfare impact on the Minnesota dairy manufacturing industry. With cooperative ownership, excess profits do not mean exploitation of producers. They receive the excess of returns over costs either in the form of higher milk pay prices or patronage refunds.

The average total returns paid to producers (No. 1 milk pay price plus patronage refund) is higher for cooperatives than noncooperatives. However, the difference is not statistically significant.

The average total return paid by butter-powder plants is significantly higher than the price paid by butter plants.

The relationship between increasing concentration and the rate of progressiveness could not be tested because benchmark data were unavailable. However, the relationship between size of firms and progressiveness was tested. Large plants, in general, are more progressive than smaller plants. It was tested and found that butter-powder plants are more progerssive than butter plants.

The Markov chain analysis was used to project the future size distribution, type of ownership, and type of plant operation in the Minnesota dairy manufacturing industry. Between 1963 and 1979, 161 plants are expected to exit the industry. Most of the remaining plants are expected to become larger. By 1979, the projected, increased proportion of cooperatives is 95.7 percent. The projected proportion of butter-powder plants is 37.6 percent.

Price leadership is expected to become even more predominant in the Minnesota industry in the future. There will be less independent pricing because plants will be more interdependent. Because of this, they are expected to be more cognizant of their competitors' actions.

Based on the market structure changes projected for 1971 and 1979, the industry's performance is expected to improve. The change toward fewer and larger plants is expected to increase the processing efficiency of the industry. Net margins of dairy plants are expected to increase also as the industry structure changes in the future. Likewise, since it is projected that the proportion of butter-powder plants will increase, the producers' net returns for a hundredweight of milk are likely to improve.

Conclusions

Changes in the market structure of the dairy manufacturing industry in the direction of a smaller number and increase in the size of firms appear to result in an improvement in the overall performance of the industry. With increasing concentration, efficiency increases, net margins earned increase, and firms become more progressive because with improved financial position they are able to adopt new technology. In the Minnesota industry (primarily cooperatives) these results are desirable from the producers' point of view.

Firms in the dairy manufacturing industry need to improve further their operating efficiency. An important method to improve the efficiency of plant operation is by reducing excess capacity. Excess capacity increases per unit costs considerably.

This and several other studies of the dairy manufacturing industry show that there are economies of size over a wide range of plant outputs. Management in Minnesota should consider mergers or consolidations to increase plant size and attain further economies of size. The need for mergers and consolidations in the Minnesota industry is emphasized further by the amount of overlapping of milk procurement areas. Such overlapping is wasteful. With less overlapping, the overall marketing efficiency and returns would improve.

Butter-powder plants paid higher returns to producers than did butter plants. Management should consider changing to a butter-powder operation wherever possible. However, large additional supplies of milk are needed to warrant making this change. It is possible though that new technology, such as the continuous churn, may shift the advantage from the butter-powder operation to the large, specialized butter operations. Further research is needed to ascertain the continuous churn's effects on the structure of the Minnesota dairy manufacturing industry.

The Minnesota dairy manufacturing industry has adjusted its organizations and operations to important developments in recent years, but not as rapidly as it should have. If the industry adjusts more rapidly, its overall performance will improve.

APPENDIX

Computation of the Markov Chain Transitional Matrix

Transitional matrices are utilized in the Markov chain method to project the future size distribution of a given industry. For the Minnesota dairy manufacturing industry, a nine by nine matrix is used with rows and columns corresponding to each of eight size categories and an extra row and column for entries and exits. The computation of entry probability entailed selecting a specified number which reflects an arbitrary determination of potential entrants. According to Farris and Padberg, the arbitrary selection does not affect the relevant portion of the results.

To project the industry structure to 1971, the transition matrix is squared and multiplied by the 1955 size distribution. To project the industry structure to 1979, the matrix is raised to the third power. Table 38 shows the matrix used to project the size distribution. The projected number of plants in 1971 in the less-than-100,000-pound category is obtained by squaring the transitional value .07895 and multiplying it by the number of plants in that category in 1955. Table 35 shows the results of this computation.

Table 38. Transition probability matrix used to project dairy plant size distribution to 1971 and 1979

Size of plant (1000 lb. of butterfat received annually)	Size of plant (1000 lb. of butterfat received annually)								
	Less than 100	100-199	200-299	300-399	400-499	500-749	750-999	Over 1000	Exited
Less than 100	.07895	.02632	.....	......	.....	.02632	.....	.....	.86842
100-199	.08738	.09709	.10680	.000971	.04854	.00971	.00971	.00971	.62136
200-299	.02198	.05495	.09890	.14286	.09890	.12088	.01099	.....	.45054
300-399	.....	.....	.05882	.15294	.09412	.14118	.09412	.0475	.41176
400-499	.....	.....	.....	.09231	.12308	.29231	.10769	.09231	.29231
500-749	.....	.....	.01299	.....	.05195	.24675	.31169	.19481	.18182
750-999	.....	.....	.....	.....	.....	.15157	.09091	.48485	.27273
Over 1,000	.....	.....	.....	.....	.....	.01724	.05172	.68966	.24138
New entries	.00010	.....	.....	.....	.....	.00010	.....	.00010	.....