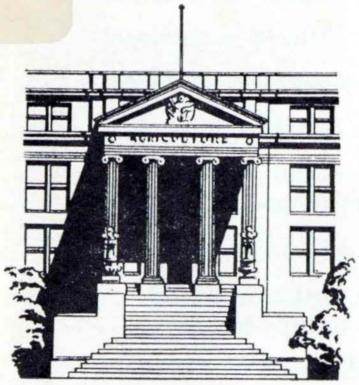

Analysis of Ranking

of

Dairy Bargaining Cooperative Objectives

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Research Bulletin 550 . . . January 1967 . . . Ames, Iowa

CONTENTS

SUMMARY

The objective of this study was to develop hypotheses concerning the determinants of the relative importance of various objectives to grade A milk producers' bargaining cooperatives.

A list of possible objectives of the cooperatives was developed from discussions with cooperative managers and people who have worked with these managers. Managers of nine cooperatives then ranked these objectives. Each ranked the objectives in order of importance to his own cooperative. Variations in the ranks assigned the objectives were analyzed in a search for statistically significant relations between characteristics of cooperatives and their markets and rankings of objectives. Regression analysis and discriminant analysis were used. After statistically significant results were obtained, their logical plausibility was examined.

Usually in econometric research we have prior hypotheses available at the beginning of a study. A statistically significant result confirms or rejects a prior hypothesis. At the beginning of this study there were no prior hypotheses available on determinants of relative importance of various objectives. The data were analyzed in a search for statistically significant results. A summary of these significant results follows. These results are hypotheses that can be tested in future research; they are not statistical confirmation of prior hypotheses.

The number following each objective shows the pooled (or average) rank assigned that objective. Following each objective is a list of variables affecting the rank assigned that objective. A "pos." in parentheses following a variable means that the variable was positively related to the importance of the objective in this study; the objective tends to be more important for cooperatives with a high value of this variable than for cooperatives with a low value of this variable. A "neg." in parentheses means that the variable was negatively related to the importance of the objective.

I. Objective 1, negotiating a high price—2
   - A. Cooperative's distance from Eau Claire, Wisconsin (pos.) Eau Claire is the center of a region of surplus grade A milk production. The availability of this milk to bottlers near Eau Claire may affect the ability of cooperatives serving these bottlers to negotiate for high prices.
   - B. Bottler's buying price for class I milk purchased from cooperative (pos.)
   - C. Percentage of cooperative's milk that could be handled in its own processing plant (pos.)
   - D. Rank assigned objective 2 (neg.)
   - E. Rank assigned objective 6 (pos.)

II. Objective 2, maintaining a market for members' milk—1
   - A. Average volume of bottlers supplied by cooperative (neg.)
   - B. Percentage of cooperative's milk sold to class I outlets (pos.)

III. Objective 3, maintaining past highest percentage of class I sales—3
   - A. Percentage of cooperative's volume sold to class I outlets (pos.)
   - B. Number of dairy cows per crop acre (neg.)

IV. Objective 4, controlling all milk produced in cooperative's procurement area—5
   - A. Average volume of bottlers supplied by cooperative (pos.)
   - B. Percentage of cooperative's milk replaceable from alternative sources (neg.)
   - C. Percentage of cooperative's volume sold to class I outlets (neg.)
   - D. Rank assigned objective 5 (pos.)

V. Objective 5, increasing size of procurement area—7
   - A. Bottler's buying price for class I milk (neg.)

VI. Objective 6, negotiating for value of services provided handlers—6
   - A. Percentage of bottlers who bargained with cooperative (neg.)
   - B. Rank of objective 1 (pos.)

VII. Objective 7, maintaining good relations with handlers—4
   - A. Percentage of cooperative's milk replaceable from alternative sources (pos.)
   - B. Negotiated premium on class I milk (neg.)
   - C. Number of bottlers who bargained with cooperative (neg.)
   - D. Percentage of cooperative's milk that could be handled in its own processing plant (neg.)
   - E. Rank assigned objective 1 (pos.)

It was possible to find reasonable explanations for most of the relationships found in the statistical analyses.

The use of principal components also was studied.

Analysis of Ranking of Dairy Bargaining Cooperative Objectives[1]

by George W. Ladd

Economists are interested in the objectives of economic agents because information on objectives can be used to understand and predict behavior. In theoretical analyses, assumptions on objectives are combined with other assumptions, and the logical consequences of these assumptions are derived. The assumptions may be indirectly tested by comparing the predictions of the theory with reality. In empirical work, hypotheses on objectives are used in the collection and analysis of data and the interpretation of the results.

Economists have devoted little attention to the determination of objectives or to the relative importance of various objectives. Where our ideas on objectives originate, it is difficult to say. Perhaps these ideas originate from many places: tradition, introspection and observation, among others. Rarely does our information on objectives come directly from the economic agents themselves.

The ability to predict a firm's objectives or ranking of objectives can be useful in predicting firm behavior and bargaining outcomes. The finding of stable relationships, if they exist, between objectives or ranking of objectives and characteristics of the firm, its management or its markets could improve our understanding of firm conduct. We might study economic and physical characteristics of the firm and its markets and psychological or sociological characteristics of management to see how they are related to a firm's objectives.

PURPOSE OF STUDY

The purpose of this study was to develop hypotheses on determinants of the relative importance of various objectives to grade A milk bargaining cooperatives. The procedure followed in this study is almost completely the reverse of the normal procedure in econometric work. Usually in econometric research we have prior hypotheses drawn from economic theory, knowledge of institutions or from previous econometric work. The plausibility of the hypotheses has been established before initiation of a study. During a study, data are collected and used to test the prior hypotheses, which are accepted or rejected on the basis of tests of significance.

There is no prior work on determinants of objectives; hence, there were no prior hypotheses available for testing in this study.

We tried to learn from managers of some grade A milk producers' bargaining cooperatives what they perceived as their firm's objectives. We asked each manager to rank these objectives. Then we searched for statistically significant relationships between each manager's ranking of each objective and various economic and physical characteristics of the firm. After significant relationships were found, we attempted to explain the relationships.[2]

This report summarizes the significant results and presents some economic evaluation of these results. The statistically significant results presented here are not confirmation or rejection of prior hypotheses. They are statements of hypotheses that can be investigated in future work.

INSTITUTIONAL FRAMEWORK

Virtually all milk consumed as fluid milk in this country is grade A milk.[3] To qualify as a grade A milk producer, a farmer must meet certain standards of sanitation on his farm. In return, grade A milk producers receive a higher price for their milk than other milk producers. This study deals with marketing cooperatives whose members are grade A milk producers. These cooperatives perform various services for their members. Some of these services are: (a) market members' milk, (b) bargain over prices, (c) conduct quality improvement and quality testing and control programs, (d) sell inputs used in milk production, (e) provide credit and insurance policies and (f) distribute market information. Some cooperatives also possess facilities for producing manufactured dairy products. The cooperatives also provide services to bottlers; they perform functions that bottlers would have to perform if the cooperative did not. Among these are: (a) write checks to pay individual producers, (b) maintain high-quality milk and (c) full-supply bottlers. Bottlers' needs undergo large daily and seasonal variation. Under a full-supply contract, a cooperative furnishes a bottler exactly the quantity of milk he needs daily. The cooperative obtains milk from

[1] Project 1458 of the Iowa Agriculture and Home Economics Experiment Station.

[2] Data used in this study were collected as part of a broader study of the bargaining activities of grade A milk producers' marketing cooperatives. Some results of the broader study have been published (5).

[3] Fluid milk includes such products as bottled or cartoned milk or cream, flavored milk drinks, half and half, etc. A firm producing such products is referred to as a bottler or handler. Butter, nonfat dry milk, ice cream, cheese, etc., are referred to as processed or manufactured dairy products.

alternative sources if regular producers do not have enough milk. If they have too much, the cooperative disposes of the excess.

The cooperatives in this study operate in markets covered by federal milk-marketing orders. The Agricultural Marketing Agreement Act of 1937, as amended, authorizes federal milk-marketing orders. The declared purpose of this act is to "establish and maintain such orderly marketing conditions . . . as will establish [prices which] are reasonable in view of the price of feeds, the available supplies of feeds and other economic conditions [and which will] insure a sufficient quantity of pure and wholesome milk, and be in the public interest." Each order regulates part of the operations of bottlers who sell all or a substantial part of their milk in an area defined by the order. The defined areas vary from a single city to two-thirds of the state of Nebraska. The main purposes of an order are to provide a formula by which the order administrator computes the minimum prices a bottler must pay for milk used in various products, to provide auditing procedures to determine each bottler's use of milk and to provide a formula by which the minimum price to each producer is determined. Most orders contain two class prices. Class I milk is milk used in fluid milk and cream products. Class II milk is all other milk. The formulas provide that dealers pay a higher price for class I milk than for class II milk. Demand for fluid milk products is less price elastic (or more inelastic) than demand for processed dairy products. Hence, the class pricing plan of federal orders is a price-discrimination scheme.

There are now 76 federal milk-marketing orders. During 1962, 187,000 grade A milk producers delivered 52 billion pounds of milk (26 billion quarts) to handlers regulated by these orders. The 1960 population of these market-order areas amounted to 60 percent of the nonfarm population of the continental United States. The operation of federal milk-marketing orders is discussed in detail in United States Department of Agriculture Marketing Bulletin 27 (13).

COOPERATIVE STUDY

In the over-all study, of which this report covers one part, information was collected on a variety of topics in personal interviews with managers of grade A milk producers' cooperatives. From these managers, information for the year 1963 was collected on:

1. size and location of market's milkshed and importance of cooperative in the milkshed and in the wholesale and retail milk market;
2. mergers, consolidations or federations the cooperative had recently participated in;
3. services provided members;
4. information on market conditions collected by the cooperative;
5. recent changes in the structure of retail and wholesale markets served by the cooperative;
6. principal and alternative markets for members' milk, prices in and transportation costs to each market;
7. milk handlers' alternative sources of milk and price differentials;
8. services offered handlers;
9. participation in legal or administrative proceedings;
10. attitudes toward a milk strike; and
11. objectives of the cooperative.

The cooperatives studied were not selected by random sampling. They were selected purposely to assure coverage of a wide range of operating conditions and bargaining results at reasonable total travel costs. The cooperatives studied are all located in the Midwest; they are listed in Ladd and Hallberg (5). Although the sample was not random, inferences will be drawn from the statistical estimates.

COOPERATIVE OBJECTIVES

A list of seven objectives of grade A milk producers' cooperatives was developed after thorough discussions with the cooperative managers and with people who have worked closely with cooperatives in advisory capacities. Each cooperative manager interviewed was then asked to rank each objective in accordance with the importance of that objective to his cooperative. Of the ten managers interviewed, nine answered this question. We tried to include every perceived objective of every cooperative manager interviewed, and no manager suggested we had left off an important objective. The seven objectives are:

1. negotiating a price that will give members the highest possible net return for their milk,
2. maintaining a market for members' milk (i.e., assuring members they will always be able to sell their milk),
3. maintaining past highest percentage of class I sales,
4. securing 100-percent control of milk produced in cooperative's procurement area,
5. increasing the size of procurement area,
6. negotiating for the estimated value of services provided handlers and
7. maintaining good relations with handlers.

In theories of cooperative behavior, the first objective occupies the same status that the profit-maximization objective occupies in theories of proprietary firms. Objective 3 is included because farmers receive a higher price for class I milk than for other milk. Federal orders provide minimum, but not maximum prices. Cooperatives must be reimbursed for the services they provide dealers. Adequate reimbursement may require an above-order price. Therefore, objective 6 is included. The proximity of a large number of grade A producers who are not members of the cooperative may result in members deciding membership is not worth what it costs and withdrawing from the cooperative. Nonmembers are also a competitive source of supply. If numerous, they reduce the bargaining power of the cooperative. Therefore, objective 4 is included. Objective 5 is included for a similar reason: Producers who are outside the area covered by the cooperative's membership are competitive sources of supply.

In the United States as a whole, and in most fluid milk markets, production of grade A milk substantially exceeds consumption of class I products (made from grade A milk). Class II products can be made from milk other than grade A milk. Some bottlers could obtain all the milk they need from sources other than the cooperative regularly supplying them simply by paying a class I price to distant cooperatives for milk that the cooperatives are otherwise selling at class II prices for manufactured dairy products. This is a main reason for including objectives 2 and 7. Also, milk production undergoes sizable seasonal variation. The number of producers required to meet a bottler's needs in the months of short production exceeds the number required in months of flush production. If a cooperative did not perform the function in objective 2, some members might have no outlet for their milk during part of each year.

Table 1 presents the ranks assigned by the cooperative managers. In the first column, the objectives are numbered as they were in the preceding text. Each other column (except the last) indicates how a cooperative ranked the objectives. The smaller the assigned number, the more important this objective is to the manager. A commonly used measure of the degree of agreement between two rankings is the Spearman rank-correlation coefficient

$$\rho_s = 1 - \frac{6 \sum_i d_i^2}{N (N^2-1)}$$

where d_i is the difference between the two rankings of the i-th item, and N is the number of items ranked. ρ_s may vary from -1, indicating perfect negative correlation, to $+1$, indicating perfect positive correlation. When the number of rankings exceeds two, Kendall's coefficient of concordance, W, may be used (4, p. 95) to test the null hypothesis that the rankings are independent of each other. W may vary from 0 to $+1$. The data in table 1 yield a value of $W = 0.615$, significant at the 1-percent level. The null hypothesis, therefore, is rejected. There is reason to believe that the nine managers were applying basically the same standards in ranking these objectives. One estimate of this standard suggested by Kendall (4) is the pooled ranking. This is obtained by ranking each objective according to the sum of the ranks assigned to it, the one with the smallest sum being ranked first. If the sums are equal for two or more objectives, these objectives are ranked according to the sums of squares of the individual ranks assigned these objectives. The last column of table 1 shows the pooled ranks. Of the nine rankings by the managers, five are significantly correlated with the pooled rank at the 5-percent level.

These results tell us that there is some, but not perfect, agreement among the ranks assigned by the various cooperative managers. The rest of this study is an investigation of variations among rankings.

REGRESSION ANALYSIS OF RANKINGS

Single-Equation Models

Linear regressions of the form

$$Y_{kj} = \alpha_k + \sum_i \beta_i X_{ij} + \varepsilon_{kj}$$

Table 1. Ranks assigned to various objectives by managers of each of nine dairy bargaining cooperatives.

	Ranks assigned by manager of cooperative[a]									Pooled
Objective	1	2	3	4	5	6	7	8	9	ranking
1	1	3	5	4	2.5	2.5	1	5	1	2
2	2	1	1.5	1	2.5	1	2	3	2	1
3	5	2	3	3	2.5	4	3	4	4	3
4	4	4	4	6	5	7	6	1	6.5	5
5	7	7	7	7	7	6	7	7	6.5	7
6	3	6	6	5	6	5	5	6	3	6
7	6	5	1.5	2	2.5	2.5	4	2	5	4
	Rank correlation between cooperative rankings and pooled ranking[b]									
	0.643	0.929	0.704	0.821	0.889	0.830	0.929	0.393	0.722	

[a] Tied rankings are each assigned the average of the ranks they would have been assigned if no ties had occurred.

[b] Spearman rank-correlation coefficient corrected for tied rankings. To be significant at the 5-percent level this coefficient must equal or exceed 0.750 and, at the 10-percent level, 0.626.

were fitted, where Y_{kj} is the rank assigned objective k ($k = 1, 2, \ldots, 7$, numbered as in table 1) by cooperative manager j ($j = 1, 2, \ldots, 9$), X_{ij} is the value of variable X_i for cooperative j; and ε_{kj} is a normally and independently distributed random error with mean zero and variance σ^2. The X_{ij}'s considered for inclusion in regressions are:

X_{1j} = percentage of the local handlers with which cooperative j attempted to bargain in 1963 who would bargain;

X_{2j} = average volume per handler with which cooperative j bargained in 1963 (in millions of pounds);

X_{3j} = estimated 1963 average annual value to cooperative j's handlers of obtaining milk from cooperative j rather than from more distant alternative sources;

X_{4j} = 1 if X_3 less the negotiated premium on class I milk is at least as large as the value of services provided handlers —
= 0 otherwise;

X_{5j} = cooperative j's estimate of the value of services provided handlers in cents per hundredweight;

X_{6j} = cooperative j's distance from Eau Claire, Wisconsin;

X_{7j} = percentage of cooperative j's volume replaceable from alternative sources;

X_{8j} = handlers' buying price for 3.5-percent producer milk used for fluid purposes in 1963 in cents per hundredweight;

X_{9j} = percentage of cooperative j's volume sold to class I outlets;

X_{10j} = annual average 1963 negotiated premium on class I milk in cents per hundredweight;

X_{11j} = number of class I handlers who would bargain with cooperative j in 1963;

X_{12j} = cooperative j's volume as a percentage of the total volume in the cooperative's procurement area (estimated by the cooperative);

X_{13j} = percentage of cooperative j's volume that could have been handled in the cooperative's own processing plant;

X_{14j} = cooperative j's total membership (grade A producers only);

X_{15j} = per capita income in the major metropolitan area served by cooperative j;

X_{16j} = approximate number of dairy cows per thousand crop acres in cooperative j's procurement area in 1962;

X_{17j} = 1 for cooperatives located in an area where labor union activity was assumed relatively high —
= 0 otherwise;

$X_{26j} = X_{9j}^2$; and

$X_{27j} = X_{2j}^2$.

Selected regression results follow. Here and in later sections, results were selected for presentation according to the criterion: An equation should have a relatively large R^2 and a high proportion of significant coefficients. With the exception of the few cases discussed in the paragraph immediately after equation 7.B, economic criteria were not used in selecting equations. In a later discussion, equations 1.A, 2.A, . . . , 7.A are treated as one set; equations 1.B, 2.B, . . . , 7.B are treated as another set. The equation numbered 3.A and 3.B is common to both sets. For each equation, R^2 is the conventional coefficient of determination. In equations in which $\alpha_k \neq 0$, R^2 measures the proportion of variation in Y_k about the mean of Y_k that is accounted for by the regression. In equations in which $\alpha_k = 0$ (i.e., homogeneous regression, R^2 measures the proportion of variation in Y_k about zero that is accounted for by the regression. For every k and j, $1.0 \leqslant Y_{kj} \leqslant 7.0$, and Y_{kj} is integer or integer plus half. The Y_{kj} estimated from the regressions (denoted as est Y_{kj}) need not possess either of these properties. This limits the usefulness of R^2 as a measure of goodness of fit, since R^2 is a measure of an equation's ability to predict magnitude; but the relevant criterion here is how well an equation predicts ordering.

For each equation, ρ_0 is the rank correlation between the actual rankings of the objective by the nine managers and the estimated rankings from the equation. The transformations performed on the data to compute ρ_0 are illustrated in table 2 by using objective 1 as an example. The values of Y_{1j} are the values of the dependent variable in equation 1.A; est Y_{1j}'s are the estimates of Y_{1j} from equation 1.A. To compute ρ_0 the Y_{1j}'s were ranked, as in column 2; the est Y_{1j}'s were also ranked, as in column 4. ρ_0 is the rank correlation between columns 2 and 4.

In table 2, column RY_{1j} shows how each manager ranked objective 1 compared with the ranks assigned by other managers. For example, managers of cooperatives 5 and 6 assigned the same rank to objective 1; they assigned a lower rank than did managers of cooperatives 1, 7 and 9; they assigned a higher rank to this objective than did managers of cooperatives 2, 3, 4 and 8. Column R est Y_{1j} shows how equation 1.A estimated the rank assigned by each manager compared with the rank assigned by other managers. The equation estimated that cooperative 1 assigned a higher rank to objective 1 than did any other manager, that manager 9 ranked it lower than manager 1 but higher than any other manager, etc.

In this report, a triple asterisk, ***, denotes significance at the 1-percent level (referred to as highly significant); ** denotes significance at the 5-percent level (referred to as significant); * de-

Table 2. Example of computation of ρ_0 for equations in sets A and B.

Cooperative j	Y_{1j} cooperatives ranking of objective 1	RY_{1j} reordered rankings	est Y_{1j} from equation 1.A	R est Y_{1j} ranked est Y_{1j}	$d_j =$ RY_{1j} − R est Y_{1j}	d_j^2 $(RY_{1j}$ − R est $Y_{1j})^2$
1	1	2	0.548	1	1	1.00
2	3	6	2.298	4	2	4.00
3	5	8.5	3.318	6	2.5	6.25
4	4	7	3.951	7	0	0.00
5	2.5	4.5	3.275	5	−0.5	0.25
6	2.5	4.5	4.009	9	−4.5	20.25
7	1	2	2.094	3	−1	1.00
8	5	8.5	3.994	8	0.5	0.25
9	1	2.0	1.513	2	0	0.00
						33.00

$$\rho_0 = 1 - \frac{6\,\Sigma\, d_j^2}{N(N^2-1)} = 1 - \frac{33.00}{720} = 0.725$$

notes significance at the 10-percent level (referred to as barely significant). The term not significant means not significant at the 10-percent level.

Selected results are:

(1.A) $\text{est } Y_{1j} = -0.014\, X_{8j} - 0.021\, X_{13j} + 9.75$
$\qquad (0.018) \qquad (0.013) \qquad (7.66)$
$R^2 = 0.58^*,\ \rho_0 = 0.72^{**}$

(1.B) $\text{est } Y_{1j} = -0.035\, X_{13j} + 0.0044\, X_{15j}$
$\qquad (0.009)^{***} \qquad (0.0020)^{*}$
$- 6.45$
(4.68)
$R^2 = 0.74^{**},\ \rho_0 = 0.98^{***}$

(2.A) $\text{est } Y_{2j} = 0.047\, X_{2j} - 0.024\, X_{9j} + 2.63$
$\qquad (0.020)^{*} \qquad (0.007)^{**} \qquad (0.58)^{***}$
$R^2 = 0.73^{**},\ \rho_0 = 0.83^{***}$

(2.B) $\text{est } Y_{2j} = -0.29\, X_{2j} + 0.097\, X_{9j}$
$\qquad (0.11)^{*} \qquad (0.017)^{***}$
$- 0.00074\, X_{26j} + 0.011\, X_{27j},$
$(0.00016)^{***} \qquad (0.004)^{**}$
$R^2 = 0.98^{***},\ \rho_0 = 0.87^{***}$

(3.A) and (3.B) $\text{est } Y_{3j} = -0.016\, X_{9j} + 0.019\, X_{16j}$
$\qquad (0.012) \qquad (0.009)^{**}$
$+ 3.79,\ R^2 = 0.55^*,\ \rho_0 = 0.60^{**}$
$(0.93)^{***}$

(4.A) $\text{est } Y_{4j} = -0.084\, X_{2j} + 0.088\, X_{9j}$
$\qquad (0.070) \qquad (0.018)^{***}$
$R^2 = 0.91^{***},\ \rho_0 = 0.46^{*}$

(4.B) $\text{est } Y_{4j} = -0.62\, X_{2j} + 0.25\, X_{9j}$
$\qquad (0.44) \qquad (0.06)^{***}$
$- 0.0014\, X_{26j} + 0.015\, X_{27j}$
$(0.0006)^{*} \qquad (0.015)$
$R^2 = 0.96^{***},\ \rho_0 = 0.77^{***}$

(4.C) $\text{est } Y_{4j} = -0.19\, X_{2j} + 0.23\, X_{9j}$
$\qquad (0.07)^{**} \qquad (0.06)^{***}$
$- 0.0015\, X_{26j}$
$(0.0006)^{*}$
$R^2 = 0.95^{***},\ \rho_0 = 0.39$

(5.A) $\text{est } Y_{5j} = \bar{Y} = 6.83 =$ mean of ranks assigned objective five

(5.B) $\text{est } Y_{5j} = -0.0032\, X_{6j} + 0.018\, X_{8j}$
$\qquad (0.0011)^{**} \qquad (0.001)^{***}$
$R^2 = 0.99^{***},\ \rho_0 = 0.62^{**}$

(6.A) $\text{est } Y_{6j} = 0.054\, X_{1j},\ R^2 = 0.96^{***},$
$\qquad (0.004)^{***}$
$\rho_0 = 0.59^{**}$

(6.B) $\text{est } Y_{6j} = 0.035\, X_{1j} + 1.81,$
$\qquad (0.016)^{**} \qquad (1.54)$
$R^2 = 0.39^*,\ \rho_0 = 0.59^{**}$

(6.C) $\text{est } Y_{6j} = 0.055\, X_{1j} - 0.0053\, X_{2j},$
$\qquad (0.014)^{***} \qquad (0.074)$
$R^2 = 0.96^{***},\ \rho_0 = 0.39$

(7.A) $\text{est } Y_{7j} = 0.061\, X_{13j},$
$\qquad (0.011)^{***}$
$R^2 = 0.81^{***},\ \rho_0 = 0.79^{***}$

(7.B) $\text{est } Y_{7j} = 0.0072\, X_{11j} + 0.029\, X_{13j}$
$\qquad (0.0034)^{*} \qquad (0.005)^{***}$
$+ 2.01$
$(0.23)^{***}$
$R^2 = 0.93^{***},\ \rho_0 = 0.78^{***}$

Deleting α_k from equation 1.A (i.e., estimating a homogeneous regression) made the coefficient of X_{8j} positive and significant and made the coefficient of X_{13j} significant. Deletion of α_k from equation 2.A made the coefficient of X_9 positive and nonsignificant. Deletion of α_k from equation 3.A made the coefficient of X_9 positive and significant. In a later section, Economic Interpretation of Results, the economic implications of the statistical results will be considered. I will argue there that the signs of the coefficients of X_{8j} and X_{9j} obtained in equations 1.A, 2.A and 3.A are easier to explain than the signs obtained when α_k was deleted.

Setting $\alpha_k = 0$ implies $Y_{kj} = 0$ if all X's in the regression are set at zero. $Y_{kj} = 0$ does not make sense in the present context since $Y_{kj} \geqslant 1.0$ by specification. And it is also difficult to see what it means to say that the X's in these equations are zero.

Variables X_{6j}, X_{7j}, X_{8j}, X_{10j}, X_{11j}, X_{13j} and X_{14j} are all significantly correlated with Y_{7j}. X_{7j} is negatively correlated with Y_{7j}; the others are posi-

Table 3. Example of computation of ρ_c for intracooperative rankings.

Equation	Objective k	Y_{k1} ranking of objective k by cooperative 1	est Y_{k1}	r(est Y_{k1}) ranked (est Y_{k1})	d_k Y_{k1} — r(est Y_{k1})	d_k^2
1.A	1	1.0	0.55	1	0	0
2.A	2	2.0	2.17	2	0	0
3.A	3	5.0	4.86	4	1	1
4.A	4	4.0	3.46	3	1	1
5.A	5	7.0	6.83	7	0	0
6.A	6	3.0	5.25	5	−2	4
7.A	7	6.0	6.11	6	0	0

$$\rho_c = 1 - \frac{6(6)}{7\,(48)} = 0.89$$

tively correlated. Several of these X_j's are also highly correlated with each other.

Each of these equations shows how each cooperative ranks a given objective in comparison with the rank assigned that objective by other cooperatives. This may be useful information, but it would also be useful to be able to predict how each cooperative would rank a given objective in relation to other objectives. There seems no way to directly get at this. In the regression model in matrix notation $Y = X\beta + \mu$, Y is an n by one vector of observations on the dependent variable, X is an n x p matrix of observations. If we define Y as the 7 by one vector of rankings assigned the objectives by one cooperative, then X is a vector, not a matrix, of observations. We can get at the issue indirectly by determining how well equation set A or equation set B predicts the rankings for each cooperative. For cooperative j we can use the equations to compute est Y_{kj}'s ($k = 1, 2, \ldots, 7$), rank these and compute ρ_c, their correlation with the actual rankings by cooperative j. The procedure is illustrated in table 3 by using equation set A and cooperative 1.

Table 4 presents the results for equation sets A and B. All rank correlation coefficients in table 4 are significant. Comparison of the values of ρ_c with values of ρ_0 indicates that the equations do better at predicting intracooperative rankings (table 4) than at predicting intercooperative rankings, although they were estimated by using intercooperative data. The results do suggest that information on the characteristics of a cooperative and its market area can be used to determine how that cooperative will rank its objectives.

Table 4. Rank correlations between ranking of objectives by each cooperative and predicted rankings from equation sets A and B.

Cooperative number	ρ_c from equation set A[a]	ρ_c from equation set B[b]
1	0.89	0.90
2	0.93	1.00
3	0.88	0.96
4	0.93	0.96
5	0.91	0.91
6	0.85	0.83
7	0.96	0.96
8	0.96	1.00
9	0.91	0.99

[a] All significant at the 1-percent level.

[b] All significant at the 1-percent level, except ρ_c for cooperative 6, which is significant at the 5-percent level.

Multiple-Equation Model[4]

The preceding least-squares regressions take no account of the relation between ranks assigned various objectives by a given manager. The rank a manager assigns objective k may be affected by, or determined simultaneously with, the rank he assigns objective t.

The equations considered in this section are of the form

$$Y_{kj} = \sum_r \beta_{kr} Y_{rj} + \sum_i \gamma_{ki} X_{ij} + \gamma_{k0} + \varepsilon_{kj}$$

They differ from those used in the previous section in the inclusion of the rankings of more than one objective in each equation. The Y_{kj} and Y_{rj} are endogenous variables. In the analysis here, all X_{ij} will be treated as exogenous variables although it is recognized that some of the X_{ij} may be influenced by the Y_{kj} and should, therefore, properly be treated as endogenous. If the X_{ij} and Y_{rj} are known and the β's and γ's have been estimated, this equation can be used to estimate ranks assigned objective k.

Having a system of such equations, consisting of one equation for each objective, one could also compute ρ_0 (as in table 2) for each objective and ρ_c (as in table 3) for each cooperative. This, however, was not done in this study. The reduced form equations could be used to study all objectives simultaneously.

For estimating equations that have more than one endogenous variable, least-squares coefficients are biased, but possess relatively small variance; simultaneous equation estimates of coefficients are consistent, but possess larger variance. The mere fact that one's estimates are consistent, which is a large sample property, does not offer much comfort when the sample has only nine

[4] Multiple equation models and simultaneous equations methods of estimation are discussed in Johnston (3), Tintner (12) and other econometrics texts.

observations. The smaller variance of least-squares estimates seems more important. When the R^2 is as large as it is in many of the equations in this study, the bias in the least-squares estimates may be expected to be fairly small. The equations that follow were all estimated by least squares.

$$\text{(4.D)} \quad \text{est } Y_{4j} = -\underset{(0.07)^{**}}{0.23}\, X_{2j} + \underset{(0.012)^{***}}{0.086}\, X_{9j} + \underset{(0.55)^{**}}{1.62}\, Y_{2j}$$

$$R^2 = 0.96^{***}, \ \rho_0 = 0.70^{**}$$

$$\text{(4.E)} \quad \text{est } Y_{4j} = -\underset{(0.07)^{**}}{0.16}\, X_{2j} + \underset{(0.023)^{*}}{0.048}\, X_{9j} + \underset{(0.28)^{*}}{0.62}\, Y_{5j}$$

$$R^2 = 0.95^{***}, \ \rho_0 = 0.42$$

$$\text{(5.D)} \quad \text{est } Y_{5j} = -\underset{(0.0009)^{***}}{0.0038}\, X_{6j} + \underset{(0.001)^{***}}{0.020}\, X_{8j} - \underset{(0.05)^{*}}{0.13}\, Y_{4j}$$

$$R^2 = 0.99^{***}, \ \rho_0 = 0.77^{***}$$

$$\text{(6.D)} \quad \text{est } Y_{6j} = \underset{(0.008)^{***}}{0.041}\, X_{1j} + \underset{(0.22)^{*}}{0.41}\, Y_{1j}$$

$$R^2 = 0.98^{***}, \ \rho_0 = 0.75^{***}$$

The use of least-squares regression in studying variations in rankings, as was done here, encounters three difficulties: (a) One difficulty that arises is the selection of a measure of goodness of fit. This has two aspects: 1) R^2 is not a good measure of goodness of fit to ranked data. There were several cases in which two equations for the same objective had nearly equal values of R^2, but one had a much larger value of ρ_0 than did the other. Equations 4.B and 4.C, 6.A and 6.C and 4.D and 4.E are examples. 2) An additional variable cannot reduce R^2, but it may reduce ρ_0. Equations 4.A and 4.E and 6.A and 6.C are examples. (b) The second difficulty—the validity of the t ratio as a test of significance of a coefficient—is related to the first. A variable whose coefficient is nonsignificant by the t test may substantially increase ρ_0. Equations 4.A and 4.B are examples. On the other hand, a variable that is significant by the t test may have little effect on ρ_0; see equations 7.A and 7.B. (c) The final difficulty is that the values of R^2 and ρ_0 have weaknesses as measures of intracooperative accuracy of estimation. This happened in more than one instance. Set E_1 of the equations consisted of one equation for every objective; set E_2 also consisted of one equation for every objective. All of the equations in E_2 were different from the equations in E_1. In set E_1 every R^2 and ρ_0 equalled or exceeded the R^2 and ρ_0 for the same objective for the equations in E_2. When the two sets were used as in table 4 to compute intracooperative rankings and ρ_c, most ρ_c's computed from set E_2 exceeded the ρ_c's computed from set E_1. The use of discriminant analysis would avoid some of these problems.

DISCRIMINANT ANALYSIS

Suppose we were studying annual family automobile purchases; we know that families can be classified into one of four classes:

(a) bought no automobile during year,
(b) bought a used automobile only,
(c) bought a new automobile only and
(d) bought more than one automobile.

Then we might be interested in the question: Having information on family size, income, composition and place of residence, and number and age of automobiles owned at the first of the year, can we predict to which class this family will belong? Discriminant analysis is a procedure for attacking this type of question.

Assume there are no ties in the cooperative's rankings of objective k. Then one could set up seven classes: 1) cooperatives ranking k number 1, 2) cooperatives ranking k number 2, . . ., 7) cooperatives ranking k number 7. This could be done for each objective and discriminant analysis carried out for each objective. Less than seven classes would usually be enough. The presence of ties requires redefinition of classes or addition of other classes.

Because of the limited number of observations, only two classes were used in each discriminant analysis in this study. Because of the limited variability in rankings assigned objective 5, it was not analyzed. In the analysis of objective 6, cooperatives ranking that objective above its pooled rank were assigned to class one; all others were assigned to class two. In the analyses of each of the other objectives, class one consisted of those cooperatives assigning the objective a rank equal to or higher than its pooled rank; others were in class two.

Single-Equation Models

For objective k define the variables:

X_{ijt} = t-th observation in class j on i-th X variable;

$i = 1, 2, \ldots, p;\ j = 1, 2,;\ t = 1, 2, \ldots, N_j$

$$X_{ij.} = \frac{\sum_t X_{ijt}}{N_j} = \text{mean of } X_i \text{ in class j}$$

Y_{kjt} = t-th observation in class j on variable Y_k

$$Y_{k1t} = \frac{N_2}{N_1 + N_2}$$

$$Y_{k2t} = -\frac{N_1}{N_1 + N_2}$$

Table 5. Est Y_{kjt} for objectives 1, 2, 3, 4 and 7.

Class j	Observation t	Objective 1 eq. 1.H	Objective 2 eq. 2.H	Objective 3 eq. 3.H	Objective 4 eq. 4.J	Objective 7 eq. 7.H
1	1	0.6228	0.3451	0.4445[a]	−0.1535[a]	0.3333
	2	0.1894[b]	0.3660	0.4445[b]	0.5077	0.3128[a]
	3	0.6228	0.0252[c]	0.4445	0.1466	0.3333
	4	—	—	0.4445	0.3183[c]	0.0780[b]
	5	—	—	−0.3555[c]	0.5667	0.2940
	6	—	—	—	—	0.3987
	Mean	0.4783	0.2454	0.2845	0.2717	0.2917
2	1	−0.3623	−0.4683	−0.3555	−0.6071	−0.4358
	2	−0.2145[a]	0.1673[a]	−0.3555	−0.1247	−0.4075[c]
	3	−0.3623	−0.4206	−0.3555	−0.1499[b]	−0.9071
	4	−0.3623	0.1673[b]	−0.3555	−0.5037	—
	5	−0.3623	−0.0080	—	—	—
	6	0.2288[c]	−0.1738	—	—	—
	Mean	−0.2392	−0.1227	−0.3555	−0.3464	−0.5835
	Average of two means	0.1196	0.0614	−0.0355	−0.0374	−0.1459

[a] Cooperative number 3: misclassified in functions 2.H and 4.J.
[b] Cooperative number 5: misclassified in equation 2.H.
[c] Cooperative number 8: misclassified in functions 1.H, 2.H and 3.H.

If we estimate the coefficients in the regression equation with a dummy dependent variable

$$Y_{kjt} = \beta_0 + \sum_i \beta_i X_{ijt} + \varepsilon_{jt}$$

the expression

$$\text{est } Y_{kjt} = b_0 + \Sigma\, b_i X_{ijt}$$

is a discriminant function; b_0 and b_i are estimates of β_0 and β_i. Any observation for which

$$\text{est } Y_{kjt} \geqslant b_0 + \tfrac{1}{2} \sum_i b_i\,(X_{i1\cdot} + X_{i2\cdot})$$

is classified into group one; any observation for which

$$\text{est } Y_{kjt} < b_0 + \tfrac{1}{2} \sum_i b_i\,(X_{i1\cdot} + X_{i2\cdot})$$

is classified into group two.[5]

An R^2 can be computed for a discriminant function, just as for a conventional regression. The significance of a discriminant function can be tested by using the same variance (F) ratio as is used to test a conventional regression.

Selected results follow.

(1.H) $\text{est } Y_{1jt} = 0.00985\, X_{13jt} - 0.362,$ $R^2 = 0.72^{***}$

This equation indicates that cooperatives with large values of X_{13} tended to rank objective 1 relatively high; i.e., in class one.

(1.J) $\text{est } Y_{1jt} = 0.00287\, X_{6jt} - 0.935,$ $R^2 = 0.55^{**}$

When used alone, both X_6 and X_{13} are significant discriminators, but the addition of X_6 to equation 1.H did not significantly improve the discriminating ability of that equation. This may be because of the correlation of 0.73 between X_6 and X_{13}.

(2.H) $\text{est } Y_{2jt} = 0.000117\, X_{26jt} - 0.581,$ $R^2 = 0.37^{*}$

X_9, with a positive coefficient, yielded a discriminant function for objective 2 that was significant at the 11-percent level.

(3.H) $\text{est } Y_{3jt} = 0.800\, X_{4jt} - 0.356,$ $R^2 = 0.64^{***}$

(3.J) $\text{est } Y_{3jt} = 0.0149\, X_{9jt} - 1.006,$ $R^2 = 0.36^{*}$

(4.H) $\text{est } Y_{4jt} = 0.0451\, X_{2jt} - 0.743,$ $R^2 = 0.43^{*}$

(4.J) $\text{est } Y_{4jt} = -0.00862\, X_{7jt} + 0.00152\, X_{27jt} + 0.253,$ $R^2 = 0.62^{*}$

(7.H) $\text{est } Y_{7jt} = -0.00873\, X_{10jt} - 0.00573\, X_{13jt} + 0.399,$ $R^2 = 0.88^{***}$

(7.J) $\text{est } Y_{7jt} = 0.0138\, X_{7jt} - 1.192,$ $R^2 = 0.57^{**}$

(7.K) $\text{est } Y_{7jt} = -0.00552\, X_{11jt} + 0.227,$ $R^2 = 0.51^{**}$

Variables X_7, X_{10}, X_{11} and X_{13} are all significant discriminators of rankings of objective 7, but are highly correlated with each other. None of the variables used was a significant discriminator of rankings assigned objective 6.

Table 5 presents values of the discriminant functions computed from equations 1.H to 7.K. Equations 1.H, 3.H and 4.J each classify one cooperative incorrectly; three cooperatives are misclassified by equation 2.H.

Multiple-Equation Model

The preceding discriminant-analysis results classify each cooperative with regard to only one objective at a time, independently of how it may rank other objectives. This is the way in which discriminant analysis is conventionally used: An item must be classified into one group or another; it is not classified into each of several groups.

We now turn to the question of whether knowledge of the group a cooperative falls in on one objective may be used to classify that cooperative into the proper group for another objective. The function now is

[5] Discriminant functions are discussed in: George W. Ladd. Linear probability functions and discriminant functions. Econometrica (in press). 1966.

$$Y_{kjt} = \sum_r \beta_{kr} Y_{rjt} + \sum_i \gamma_{ki} X_{ijt} + \gamma_{k0} + \varepsilon_{kjt}.$$

If we have data on the X_{ijt} and Y_{rjt} and have estimates of the β's and γ's, this function can be used. Compute

(8) $\text{est } Y_{kjt} = \sum b_{kr} Y_{rjt} + \sum c_{ki} X_{ijt} + c_{k0}$.

The cooperative is classified in group one with respect to objective k if

$$\text{est } Y_{kjt} \geqslant \tfrac{1}{2}[\sum b_{kr}(Y_{r1}. + Y_{r2}.) + \sum c_{ki}(X_{i1}. + X_{i2}.)] + c_{k0}$$

and is classified in group two otherwise. $Y_{rj}.$ is the mean of Y_{rjt} for all cooperatives classed in group r (= 1, 2) with respect to objective k.

If we have data only on the X_{ijt} or if we want to classify a cooperative with respect to all objectives simultaneously, a different procedure must be used. The system of discriminant functions for a given cooperative consists of the system of equations

$$\beta Y = \Gamma X + \varepsilon$$

where Y is the column vector $(Y_{1jt}, Y_{2jt}, \ldots, Y_{7jt})'$, X is the column vector $(X_{1jt}, X_{2jt}, \ldots, X_{kjt})'$ and β and Γ are coefficient matrices. The subscript pair, jt, must be interpreted as a unit to mean a given cooperative. Let B and C be the estimates of β and Γ in the discriminant function system. If B is nonsingular, we compute the reduced form equations

$$\text{est } Y = B^{-1}CX = PX$$

(9) $\text{est } Y_{kjt} = \sum_i P_{ki} X_{ijt} + P_0$

Compute

$$P_0 + \tfrac{1}{2} \sum P_{ki} (X_{i1}. + X_{i2}.) = Y_{k0}$$

The cooperative is classified into group one if

$$\text{est } Y_{kjt} \geqslant Y_{k0}$$

and is placed in group two if

$$\text{est } Y_{kjt} < Y_{k0}$$

Although not done in this study, the est Y_{kjt} from equations 8 or 9 could also be used to compute ρ_0 for each objective (as in table 2) and ρ_c for each cooperative (as in table 3).

Selected discriminant functions follow:

(1.L) $\text{est } Y_{1jt} = 0.00615 X_{13jt} - 0.423 Y_{2jt} + 0.464 Y_{6jt} - 0.226, \quad R^2 = 0.97^{***}$

(1.M) $\text{est } Y_{1jt} = 0.00162 X_{6jt} - 0.3699 Y_{2jt} + 0.5721 Y_{6jt} - 0.526, \quad R^2 = 0.88^{**}$

The addition of Y_{2jt} and Y_{6jt} to equations 1.H and 1.J to obtain equations 1.L and 1.M increased discrimination ability by significant amounts.

Y_{7jt}, the rank of objective 7, was added to functions for objective 2. Its addition did not significantly improve the equation. Y_{6jt} and Y_{7jt}, singly and in combination, were added to equations 3.H and 3.J. Neither way did their addition significantly improve the equations.

(4.L) $\text{est } Y_{4jt} = 0.0220 X_{2jt} - 0.63 Y_{6jt} - 0.362, \quad R^2 = 0.71^{**}$

Addition of Y_{6jt} increased R^2 by a significant amount.

(4.M) $\text{est } Y_{4jt} = -0.00833 X_{7jt} + 0.000700 X_{27jt} - 0.618 Y_{6jt} + 0.492, \quad R^2 = 0.89^{***}$

Addition of Y_{6jt} increased R^2 by a significant amount.

(6.L) $\text{est } Y_{6jt} = 0.444 Y_{1jt} - 0.667 Y_{4jt} + 0.00008, \quad R^2 = 0.80^{***}$

No discriminant function for objective 6 using only X's was significant; equation 6.L is highly significant.

(7.L) $\text{est } Y_{7jt} = -0.00330 X_{10jt} - 0.0153 X_{13jt} + 0.699 Y_{1jt} + 0.636, \quad R^2 = 0.97^{***}$

Addition of Y_{1jt} resulted in a significant increase in R^2. Addition of Y_{1jt} to X_{7jt} or X_{11jt} did not significantly increase R^2.

Functions 1.L to 7.L were used to classify each cooperative. Results are in table 6. None of the cooperatives is misclassified.

Table 6. Simultaneous discriminant functions $Y_{kjt} = \sum \beta_{kr} Y_{rjt} + \sum \gamma_{ki} X_{ijt} + \gamma_{k0} + \varepsilon_{kjt}$ evaluated for individual cooperatives and at group means.

Class j	Observation t	Objective 1 eq. 1.L	Objective 4 eq. 4.M	Objective 6 eq. 6.L	Objective 7 eq. 7.L
1	1	0.7359	0.2128	0.6667	0.3777
	2	0.4652	0.5178	0.2223	0.1722
	3	0.7359	0.3513	0.6667	0.3777
	4	—	0.6961	0.2223	0.2422
	5	—	0.2009	0.0001	0.3629
	6	—	—	—	0.4025
	Class mean	0.6457	0.3958	0.3556	0.3225
2	1	−0.3017	−0.6148	−0.4444	−0.5321
	2	−0.2507	−0.3924	−0.4444	−0.6933
	3	−0.3430	−0.4040	−0.4444	−0.7102
	4	−0.3017	−0.5672	−0.4444	—
	5	−0.3430	—	—	—
	6	−0.3964	—	—	—
	Class mean	−0.3228	−0.4947	−0.4444	−0.6452
	Average of class means	0.1614	−0.0494	−0.0444	−0.1614

The system consisting of equations 1.L, 2.H, 3.H, 4.M, 6.L and 7.L was used in another way. Equation 9 was computed, and each cooperative was classified for each objective according to whether or not est Y_{kjt} exceeded Y_{k0}. The reduced-form equations for objectives 1 and 7 misclassified no cooperatives. The equations for objectives 2, 3, 4 and 6 misclassified 3, 1, 1 and 3 cooperatives, respectively.

ECONOMIC INTERPRETATION OF REGRESSION AND DISCRIMINANT RESULTS

For brevity in this dicussion, regression analysis results will be termed R.A. and discriminant analysis, D.A. For a given objective R.A. and D.A. are consistent concerning X_{ijt} if its R.A. coefficient is of opposite sign from its D.A. coefficient. In interpreting the regression results, remember that a small value of the dependent variable indicates a high rank.

Objective 1 (Negotiating High Price)

X_6 (= distance from Eau Claire)

The coefficient of X_6 was positive in D.A., but negative and nonsignificant in R.A. The finding that cooperatives located at a greater distance from Eau Claire place objective 1 relatively high can be explained on the following grounds.

The volume of grade A milk produced far exceeds the consumption of products that must be made from grade A milk; there is much surplus grade A milk. The heart of this surplus-production area is around Eau Claire, Wisconsin. Federal-order formula prices and actual prices received by farmers for milk for fluid uses are low in the Minnesota-Wisconsin area and tend to rise with increasing distance from this area.

In discussing objective 1, managers may have been thinking of unconstrained maximization—of "high" net returns. The ability to negotiate a high price is limited by nearness to the surplus grade A production area. The managers' and cooperative members' recognition of their lesser ability to negotiate for high prices may have affected the aspiration level of managers and cooperative members relatively close to Eau Claire and have led them to place less importance on objective 1. It has been established that aspiration level is a function of expectations (9).

Probably managers had in mind maximization subject to constraints imposed by the physical productivity of the cooperative and its members, by factor prices, by constraints subject to the control of the cooperative, such as size of processing plant, and by "average" or "normal" conditions in processing and marketing fluid products. The degree of attainment of this constrained maximum is affected by the ability of the bottlers to obtain milk economically from alternate sources. The ability of the bottlers close to Eau Claire to do this is generally greater than the ability of distant bottlers to do it. On this interpretation, as on the preceding one, the ranking of objective 1 is affected by expected achievement.

X_8 (= average class I price)

R.A. of equation 1.A indicates that cooperatives with high class I prices tend to rank objective 1 relatively high. This may be related to aspirations and expectations. Cooperatives whose members have received relatively high class I prices in the past expect to receive them in the future. High expectations tend to lead to high aspirations. High class I prices are an important factor in high net returns.

A positive R.A. coefficient of X_{8j} indicates that receipt of low class I prices leads to placing more importance on objective 1. This is inconsistent with the evidence on aspiration levels—unless, in the markets with low class I prices, the prices still exceed production costs by more than class I prices exceed production costs in markets with high class I prices.

X_{13} (= size of cooperative's processing plant)

Cooperatives that own processing facilities sufficient to handle large proportions of their members' milk tend to rank objective 1 relatively high. The two are probably related in this way: Cooperatives for whom maximum net member returns are important tend to have large processing plants because this is one way of increasing returns. The cooperative receives a greater return from producing manufactured products in a large plant of its own than it receives from sale of milk to other processing plants. Possession of a processing plant may also be a tool for bargaining for higher prices. If a cooperative withholds milk from bottlers, the milk must normally go into lower-valued manufactured products. The resulting loss to members is less for cooperatives owning their own processing facilities. Two-thirds of the cooperatives we studied would not call a milk strike. Most had facilities for processing only a small portion of their milk. The cooperatives who would call a milk strike had facilities for processing much of their own milk.

Objective 2 (= maintaining market for members' milk)

D.A. results indicate that cooperatives that rank objective 2 relatively high tend to rank objective 1 relatively low. This suggests a competitive relationship between these two objectives.

Objective 6 (= negotiating for value of services provided handlers)

The D.A. results indicate that cooperatives ranking objective 6 high also tend to rank objective 1 high. It costs a cooperative money to perform services for handlers. If it is not adequately reimbursed by the handlers, it is losing money for its members by performing these services; it could increase members' net returns by discontinuing these services.

Objective 2

X_2 (= average volume per handler)

In R.A. equations not containing X_{27} (the square of X_2), the coefficient of X_2 was positive. In equations containing X_{27}, the coefficient of X_2

was negative, the coefficient of X_{27} was positive. From R.A. of equation 2.B

$$d = \frac{\partial Y_2}{\partial X_2} = -0.29 + 0.022\, X_2$$

Setting d equal to zero

$$X_2 = 13.2 \text{ and}$$

$$\frac{\partial d}{\partial X_2} = 0.022$$

According to these results, the importance of objective 2 rises as X_2 rises to 13.2; as X_2 rises further, the importance of objective 2 falls. Only two of the nine cooperatives studied had values of X_2 smaller than 13.2.

It is difficult for me to see why increasing X_2 would first raise, then lower the importance of objective 2. It seems more reasonable to believe that, at small values of X_2, the rank assigned objective 2 is independent of X_2; at larger values of X_2, the rank assigned objective 2 falls with X_2. X_2 was used in some D.A.; its coefficient was negative, but X_2 was not a significant discriminator.

It may be that, if handlers are large, it is harder for them to obtain milk from alternate sources, and the cooperative need not concern itself so much with maintaining a market. In any case, objective 2 was ranked quite high by each cooperative.

X_9 (= percentage of milk used in class I products)

In D.A. the coefficents of X_9 and X_{26} (the square of X_9) were positive. In R.A. the coefficient of X_9 was negative if X_{26} (the square of X_9) was included and was positive otherwise. The coefficient of X_{26} was negative. From R.A. of equation 2.B,

$$d = \frac{\partial Y_2}{\partial X_9} = 0.097 - 0.00148\, X_9$$

Setting $d = 0$

$$X_9 = 66$$

$$\frac{\partial d}{\partial X_9} = -0.00148$$

According to these results, the importance of objective 2 falls as X_9 rises to 66, then rises as X_9 rises beyond 66. Only three cooperatives had values of X_9 smaller than 66; for one of these, the value of X_9 was nearly 66.

Cooperatives selling large proportions of their milk for class I use rank objective 2 relatively high. This may be because it hurts more to lose a market when much of the milk is used in class I products than when most milk is used in class II products, since class I price exceeds class II price. This would be a situation in which a firm's environment influences the ranking of its objectives. It may also be that vigorous efforts to maintain a market tend to lead to high class I usage, but this does not seem so likely an explanation as the first one since cooperatives usually have little control over the proportion of milk going into class I uses. The cooperative does not limit the production of its members, and the volume of class I sales is mainly determined by pricing and merchandising activities of bottlers.

It may be that the importance of objective 2 is relatively independent of X_9 at small values of X_9 but that, for values of X_9 above about 66, its importance rises as X_9 rises.

Objective 3 (Maintain Class I Sales)

X_4 (= dummy variable)

I have not found any satisfactory behavioral explanation for the D.A. finding of a relation between X_4 and ranking of objective 3.

X_9

The reason for the finding that high values of X_9 lead to placing a relatively high rank on objective 3 is perhaps the same as the explanation for the relation between X_9 and ranking of objective 2: When a cooperative has a high class I use, it hurts more to lose class I sales than when the cooperative has a low class I use. The coefficient of X_9 was negative and nonsignificant in R.A. equations containing α_3 (the intercept term). In equations in which α_3 was assumed zero, the coefficient of X_9 was positive and significant. This can be interpreted as meaning that cooperatives with low class I use place more importance on class I sales.

X_{16} (= number of dairy cows per crop acre)

Coefficients of X_{16} were positive and significant in R.A. Its coefficient was negative in D.A., but it was not a significant discriminator.

The relative importance a cooperative places on various objectives may be affected by the importance of dairying as a source of members' income relative to other enterprises. X_{16} was included as a measure of this importance. Number of cows producing grade A milk per crop acre would be a better measure. If X_{16} were really a good measure of this importance, one would expect a negative coefficient in R.A., meaning that it is more important to maintain class I sales if dairying is an important source of income.

Objective 4 (Control All Milk In Area)

X_2

According to D.A. and R.A. of equations 4.A and 4.C, as X_2 rises, objective 4 becomes more important. This relation may exist because a bottler's incentive and financial ability to obtain milk from cooperative nonmembers nearby rise as the bottler becomes larger. To protect itself, the cooperative must place more importance on inducing nonmembers to become members. According to R.A. of equation 4.B, objective 4 becomes more important as X_2 rises to about 21; as X_2 rises above 21, objective 4 becomes less important. Only two cooperatives had values of X_2 larger than 21. This suggests that, as a bottler's volume rises above 21 million pounds per year, he cannot rely on nearby nonmembers to supply all the milk he needs; and he will have to go a greater distance to obtain the needed milk. Then the cooperative's need to control all the milk in its procurement area may be less.

X_7 (= percentage of cooperative's volume replaceable by alternative sources)

When bottlers can replace a high proportion of the cooperative's volume by milk from more distant sources, the cooperative is less able to protect itself by inducing nonmembers to become members, and the cooperative may then place less importance on objective 4. This may explain the negative coefficient of X_7 in D.A., although X_7 does not differentiate between distant producers and nearby nonmember producers.

If bottlers can obtain most or all the milk they need from nearby nonmember producers, this may indicate that the cooperative has failed by a wide margin to achieve objective 4, and this failure has led the cooperative to reduce its aspiration level; i.e., to reduce its ranking of objective 4. It may be that those bottlers who can obtain milk from nearby nonmembers can do so because the cooperative has not placed much importance on objective 4.

X_9

R.A. of equation 4.A indicates that objective 4 becomes less important as X_9 rises. R.A. of equations 4.B and 4.C indicate that objective 4 becomes less important as X_9 rises to a level of 89 and 77; as X_9 rises above 89 or 77, objective 4 becomes slightly more important. If class I use is between 80 and 100 percent, the benefits obtained from cooperative control of all milk may be less than if class I use is low. Cost of handling class II milk may be lower, and returns from this milk higher, if the class II milk is controlled by one organization rather than by several (14, 15).

Other objectives

Objectives 4 and 5 both represent a desire on the part of the cooperative to increase its size. The R.A. indicate that cooperatives placing relatively high importance on expanding in one of the two ways also place relatively high importance on expanding in the other way. R.A. also indicates a positive relation between rankings of objectives 2 and 4. A cooperative will have difficulty increasing the proportion of milk produced in the procurement area that it controls unless it can maintain a market for its members' milk. Also, a cooperative may have trouble maintaining a market for its members' milk unless it controls a large proportion of the milk in its procurement area.

I have found no satisfactory explanation of the negative coefficent of Y_{6j} in D.A.

Objective 5 (Increasing Procurement Area)

There was little variation in the rankings assigned this objective; it was assigned ranks of 6, 6.5 or 7. The low rank of this objective may be related to the high rank assigned to objectives 1, 2 and 3. The attainment of these latter objectives may be more difficult if the procurement area is enlarged. If the cooperative enlarges its procurement area, its class I utilization ratio will fall unless it finds additional markets for class I milk.

X_6

I have not found any satisfactory behavioral explanation for the significant negative coefficient of X_6 in R.A.

X_8

Increasing the size of a cooperative's procurement area will usually bring more grade A milk into a market. This will tend to reduce class I price and class I utilization ratio. Both of these are undesirable in view of the importance of objectives 1 and 3.

Objective 4

The negative relation between Y_{4j} and Y_{5j} in R.A. equation 5.D seems less meaningful than the positive relation in equation 4.E.

Objective 6 (Negotiating Value Of Services Provided Bottlers)

Two managers assigned ranks of 3; all others assigned ranks of 5 or 6.

X_1 (= percentage of bottlers who bargained)

The significant positive coefficients of X_1 in R.A. may be because X_1 is effect and Y_6 is cause: A larger proportion of bottlers may be willing to bargain if the cooperative places low importance on this objective. This explanation hardly seems tenable since most of the cooperatives received prices that were more than high enough to reimburse them for the services provided to handlers (2, 5).

X_1 and X_2 are positively correlated; X_2 is positively correlated with the rank assigned objective 6. Small handlers may find it more valuable or useful to have the cooperative perform various services for them than large handlers do. In this case, where bottlers are relatively small, it may be easier for cooperatives to negotiate for the value of their services. This leads to higher expectations of being able to accomplish this objective and, therefore, to placing this objective relatively high.

Objectives 1 and 4

The relations between ranks assigned objectives 1 and 6 and between 4 and 6 have been discussed.

Objective 7 (Maintaining Good Relations With Handlers)

X_7

If a bottler can replace a large proportion of the cooperative's milk with milk from other sources, the cooperative needs good relations with the handler to protect its market. If the bottler cannot easily replace the cooperative's milk, the cooperative is in less need of good relations with handlers.

X_{10} (= negotiated premium on class I milk)

A cooperative placing less importance on maintenance of good relations with handlers may be more aggressive in bargaining for a class I premium. In this case, Y_7 affects X_{10}, but not vice versa. Both high premium and relative unconcern with maintenance of good relations may be symptoms of aggressive management. In this case, Y_7 and X_{10} are determined together.

X_{11} (= number of bottlers who would bargain)

The relation between X_{11} and objective 7 may be because of the size of market, with which X_{11} is correlated. It is likely that the larger the market and the greater the number of bottlers, the more difficult it is for any bottler to develop an alternate source of milk. Good relations with the cooperative are more advantageous to a bottler than if he were in a small market; hence, the cooperative can pay less attention to the quality of relations with bottlers.

X_{13}

If a cooperative has a large processing plant, the need for good relations with handlers may be less. It is also possible, though less likely, that a manager who does not want to be seriously bothered by problems of maintaining good relations with handlers will cause a cooperative to build a large processing plant so there will be less need for good relations.

Objective 1

The significant positive coefficients of Y_1 in D.A. of equation 7.L and in two-stage least-squares equations indicate that managers ranking objective 1 high also ranked objective 7 high. Perhaps the managers more interested in obtaining high net returns for members are more aware of a need for good relations with handlers because handlers are aware of and are unfavorably affected by many of the actions that aggressive management will take in its efforts to achieve high net returns for members.

Errors Of Classification

Three cooperatives were misclassified in table 5. These three cooperatives were the second, third and fourth largest of the cooperatives studied. Size, measured as number of members, was included in some functions and did not make a significant contribution to the discriminant functions. It may be that size is nonlinearly related to ranking objectives or that size above a certain threshold level is related to rankings.

Two of these three cooperatives also are well above average in the percentage of member grade A producers in the area served by the cooperative. The third cooperative is below average in this measure, but this is much the largest and most dominant cooperative in a market served by a number of cooperatives. We lack data on this, but I would estimate that the proportion of grade A producers serving this market who are cooperative members is relatively high. This suggests that there may be a nonlinear relation between this proportion and the ranking of objectives.

PRINCIPAL COMPONENTS[6]

Principal components may be profitably used in the analysis of rankings of objectives.

In working with principal components, it is frequently convenient to use standardized variables. If X_{it} is the t-th observation on the i-th variable, $\bar{X}_i$ is the mean of the i-th variable and

$$s_i = [\sum_t (X_{it} - \bar{X}_i)^2]^{1/2}$$

the standardized variable, is

$$z_{it} = \frac{X_{it} - \bar{X}_i}{s_i}$$

Note that $\sum_t (z_{it})^2 = 1$ and $\sum_t z_{it} z_{jt}$ is the simple correlation between z_i and z_j.

[6] Principal components are discussed in more detail in Anderson (1), Girshick (2) and Tintner (12).

Let u_j denote the j-th principal component of a set of standardized variables. Then u_1 is that linear combination of the z's such that the sum of squares of the correlation coefficients between each z_i and u_1 is a maximum. And u_j is that linear combination of the z's, independent of the first, second, . . . , (j−1)-st principal components, that possesses the property that the sum of the squares of the correlation coefficients between each z_i and u_j is a maximum.

Let z be the column vector of observations on p standardized variables $z = (z_{1t}, z_{2t}, \ldots, z_{pt})'$ and let $zz' = R$, the matrix of simple correlations among the z's. Then the j-th principal component is $u_j = \alpha'_j z = \sum_i \alpha_{ji} z_{it}$. The principal components are obtained by solving the characteristic equation $(R - \lambda I)\alpha = 0$ for its characteristic roots λ and characteristic vectors α. The characteristic roots are the roots of the p-th degree polynomial det $(R - \lambda I) = 0$ where det denotes "determinant of." If λ_1 denotes the largest characteristic root, α_1 is obtained as the solution for α to the system of homogenous equations $(R - \lambda_1 I)\alpha = 0$. The first principal component is $\mu_1 = \alpha'_1 z$. To obtain the j-th principal component, the j-th largest characteristic root λ_j is obtained, and α_j is obtained as the solution for α to $(R - \lambda_j I)\ \alpha = 0$.

λ_j is the sum of the squares of the correlation coefficients between μ_j and the standardized variables. Dividing the j-th principal component by $\lambda_j^{1/2}$, we obtain $w_j = \mu_j/\lambda_j^{1/2} = \sum_i \alpha_{ji} z_{it}/\lambda_j^{1/2}$; w_j has a variance of one. In the equation $z_{it} = \sum_{j=1}^{p} c_{ij} w_{jt}$, c_{ij} is the simple correlation between z_i and w_j. $\sum_j (c_{ij})^2 = 1$; i.e., the sum of squares of the correlations between z_i and all w_j is unity. Further, $\sum_i (c_{ij})^2 = \lambda_j$; i.e., the sum over all standardized variables of the squares of the c_{ij} involving w_j is λ_j.

The c_{ij} coefficients are the "principal components loadings." These loadings may be used to combine the z_i into common groups. Each group consists of those variables that are highly correlated with one component or a small group of components. The principal components loadings may also be used to identify or interpret each component in terms of variables highly correlated with it. A component that was highly correlated with X_7, X_9, X_{12}, X_{13} and X_{14} could be interpreted as a "cooperative size" component since these variables are various aspects of cooperative size. A component that was highly correlated with X_3, X_4 and X_5 might be interpreted as a "services for bottlers" component.

A characteristic that makes principal components useful in certain circumstances is this: It sometimes happens that the last r $(r < p)$ principal components of p standardized variables have small correlations with the original variables. Then the set of p original variables may be replaced by the smaller set of p−r principal components with little loss of information. Computation of principal components of the rankings of all objectives might show that a small number of principal components "explains" almost all variation in rankings of all objectives. Then one could restrict his attention to the analysis of variation in these principal components. The orthogonality of the principal components makes them convenient to use as independent variables in regression and discriminant analysis.

In multiple equation regression analysis and discriminant analysis models, one might use principal components of rankings of all but the k-th objective as explanatory variables in equations for the k-th objective.

Statistical analysis of objectives is in the exploratory stage. In exploratory work, it may be convenient to use principal components as independent variables rather than use the original variables as independent. See Massy (7) for a discussion of use of principal components in exploratory research.

From the set of X's defined in the Regression Analysis of Rankings section, the nine variables X_1, X_2, X_6, X_8, X_9, X_{10}, X_{11}, X_{13} and X_{16} were selected on statistical grounds. The variables were standardized, and their principal components were computed. The nine characteristic roots are presented in table 7. The value of the j-th characteristic root equals the sum of the squares of the correlations between the j-th principal component and the nine standardized variables z_i $(i = 1, 2, 6, 8, 9, 10, 11, 13, 16)$. The c_{ij} are shown in table 8. The first four principal components "explained" from 85 to 99 percent of the variance of each standardized variable. That is,

$$0.85 \leqslant \sum_{j=1}^{4} (c_{ij})^2 \leqslant 0.99.$$

Table 7. Characteristic roots of matrix of correlations between X_1, X_2, X_6, X_8, X_9, X_{10}, X_{11}, X_{13}, and X_{16}.

j	j-th characteristic root $= \lambda_j$
1	4.3316
2	2.4772
3	0.9386
4	0.8242
5	0.3273
6	0.0736
7	0.0260
8	0.0013
9	0.0001

Table 8. C matrix for principal components of independent variables.[a]

Variable i z_i	Component j, w_j 1	2	3	4	5	6
1	0.12	−0.98	0.07	0.01	0.06	−0.05
2	−0.04	−0.81	−0.56	−0.05	0.12	0.09
6	−0.89	−0.05	−0.12	−0.42	−0.05	0.05
8	−0.84	−0.12	−0.05	−0.50	−0.05	−0.14
9	0.31	−0.56	0.70	−0.27	−0.11	0.08
10	−0.92	−0.001	0.15	0.35	−0.03	−0.09
11	−0.80	−0.30	0.27	0.24	0.37	0.002
13	−0.83	0.51	0.10	−0.07	0.08	0.15
16	−0.73	−0.42	−0.07	0.36	−0.38	0.05

[a] c_{ij} is the simple correlation between z_i and w_j. All c_{ij} ($j = 7, 8, 9$) but one were less than 0.06 in absolute value; $c_{17} = 0.11$.

These nine variables might be classified into three groups: (a) variables 6, 8, 10, 11, 13 and 16, all highly correlated with factor 1; (b) variables 1 and 2, which are highly correlated with component 2 and (c) variable 9, which is highly correlated with component 3. In this study it does not seem possible to identify or interpret the various components since each component is correlated with diverse types of variables.

Although the first four components "explained" most of the variance of the standardized variables, some of the last five principal components were significantly correlated with the rankings. In the following regressions of rankings upon principal components of the X's, Y_{ij} is the rank assigned objective i by manager of cooperative j, and w_{ij} is the value of the i-th principal component of the standardized variables for cooperative j. Y_{1j} and Y_{5j} were not highly correlated with any of the principal components.

$$\text{(2.N)}\quad Y_{2j} = -\underset{(0.120)^{***}}{0.940}\, w_{3j} \qquad r^2 = 0.884^{***}$$

$$\text{(3.N)}\quad Y_{3j} = -\underset{(0.133)^{**}}{0.406}\, w_{1j} - \underset{(0.133)^{**}}{0.373}\, w_{3j} - \underset{(0.133)^{***}}{0.714}\, w_{5j} + \underset{(0.133)^{*}}{0.313}\, w_{6j}, \quad R^2 = 0.911^{***}$$

$$\text{(4.N)}\quad Y_{4j} = \underset{(0.270)^{**}}{0.646}\, w_{3j} \qquad r^2 = 0.418^{**}$$

$$\text{(6.N)}\quad Y_{6j} = \underset{(0.086)^{***}}{0.609}\, w_{1j} - \underset{(0.086)^{***}}{0.544}\, w_{2j} - \underset{(0.086)}{0.089}\, w_{3j} + \underset{(0.086)^{***}}{0.537}\, w_{5j}, \quad R^2 = 0.963^{***}$$

$$\text{(7.N)}\quad Y_{7j} = -\underset{(0.052)^{***}}{0.890}\, w_{1j} + \underset{(0.052)^{***}}{0.292}\, w_{2j} + \underset{(0.052)^{*}}{0.139}\, w_{3j} + \underset{(0.052)^{*}}{0.128}\, w_{5j} - \underset{(0.052)^{***}}{0.276}\, w_{8j}, \quad R^2 = 0.989^{***}$$

The third principal component, w_{3j}, appears in each of these equations; w_{5j} appears in three of them. Although w_3 and w_5 are not highly correlated with variables significant in R.A. or D.A., their coefficients are significant in several of equations 2.N to 7.N. The first principal component, w_{1j}, also appears in three of these equations. w_1 is highly correlated with X_6, X_8 and X_{13} —variables significant in R.A. or D.A. of objective 1; but w_1 is not highly correlated with Y_1. On the other hand, w_1 is highly correlated with X_{10}, X_{11} and X_{13} — variables significant in R.A. or D.A. of objective 7; and w_1 is highly correlated with Y_7. Further, w_1 is not especially highly correlated with X_9 or X_{16} or X_1 — variables significant in R.A. or D.A. of objectives 3 and 6; but the coefficients of w_1 in equations 3.N and 6.N are significant. w_2 is highly correlated with X_1; the coefficient of X_1 was significant in R.A. of objective 6 and the coefficient of w_2 is highly significant in equation 6.N. On the other hand, w_2 is not highly correlated with X_{10}, X_{11} or X_{13} — variables whose coefficients were significant in R.A. or D.A. of objective 7. In equation 7.N, however, the coefficient of w_2 is highly significant. Hence, the results of using principal components of the X's could not have been predicted on the basis of a knowledge of the results of regressions using the X's and a knowledge of the correlations in table 8.

Rankings $Y_{1j}, Y_{2j}, \ldots, Y_{7j}$ were standardized; and their principal components were computed. The characteristic roots are shown in table 9. λ_j is the sum of the squares of the correlations between the seven standardized variables and the j-th principal component. The first four principal components "explained" between 92 and 99 percent of the variance of the rankings of each objective, except objective 5, and "explained" 88 percent of the variance of the rankings assigned this objective. The first five principal components "explained" 99 percent of the variance of the rankings of objective 5. Hence, if one could statistically explain most of the variance of the first four components, he would have explained most of the variance of the rankings of the seven objectives.

SUGGESTIONS FOR FURTHER WORK

Perhaps the single most important requirement in studies of this type is that considerable care be taken to develop an exhaustive list of relevant objectives in terms meaningful to the researcher and to the managers. It is also necessary to

Table 9. Characteristic roots of the matrix of correlations between $Y_1, Y_2, \ldots, Y_7$.

j	j-th characteristic root $= \lambda_j$
1	3.1168
2	1.8414
3	1.1229
4	0.5413
5	0.3127
6	0.0648
7	0.0001

explain the objectives carefully so that managers will understand the objectives and so that their rankings will be meaningful.

Some variables treated as exogenous in the multiple-equation regression model in this study may be endogenous. Some results suggested that the cooperative's size may be nonlinearly related to the ranks assigned to some of the objectives. X_{16} is not a good measure of the importance of dairying as a source of income to members. Data on physical and economic characteristics of the cooperative and its market, such as were used here, could be supplemented with data on psychological or sociological traits of managers or boards of directors.

There are a number of unsettled questions concerning choice of the appropriate statistical methods for analyzing variations in rankings. Many of these questions of statistical method have already been mentioned. One merits further discussion. The variables, Y_{kjt}, used in the discriminant analyses are, in effect, arbitrary dependent variables in regression. The variables, Y_{kj}, used in the regression analyses as dependent variables are also arbitrary dependent variables. Any monotonic transformation of Y_{kj} would serve as well as Y_{kj} to show the order of importance of the seven objectives to cooperative j. In table 1, for example, 3, 1, 2, 4, 7, 6 and 5 are used to show the order of importance of objectives 1, 2, . . . , 7 to cooperative two. However, 7.2, 0.6, 1.8, 7.35, 66, 16.8 and 9.1476 could have been used. These seven numbers preserve the order of the numbers actually used. This difficulty arises because ordinal (ordering) numbers are used for ranking. On a slightly different interpretation of Y_{kj}, however, (if there are no ties), a simple transformation of Y_{kj} is a counting (cardinal) number. If there are no ties in the ranks assigned by cooperative j, $Y_{kj} - 1$ is the number of objectives that are of more importance to cooperative j than objective k is. If there are ties, let $T =$ the number of objectives of the same importance as objective k. Then $Y_{kj} - 1 - T/2 = N_{kj}$ is the number of objectives of greater importance than objective k to cooperative j. N_{kj} is a straightforward counting variable and could be used as a dependent variable in regression analyses. A few such regressions were run; the results were not greatly different from the results obtained by using Y_{kj} as dependent.

There is a fundamental question whether cooperative managers (or economic agents in general) do know and can verbalize (or can recognize another person's verbalization of) their objectives. The number of statistically significant and economically meaningful results obtained in this study strongly indicates that the managers did know several of the more important objectives of their organization. We do not know, however, that the list of objectives used here was exhaustive. We do not know how a cooperative manager's views of the objectives of the organization may differ from the views of the board of directors or the members, nor how any differences affect the behavior of the cooperative.

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