The Use of Discriminant Analysis in Measuring Cooperative Growth Factors

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Vermont agricultural cooperatives were surveyed to investigate key factors contributing to cooperative success. Most of the cooperatives were formed within the last 15 years. Financial, organizational, and operational data were collected for selected years from 1974–1984.

Average annual changes in gross sales were used to divide cooperatives into low-growth and high-growth groups. Selected variables were identified to classify individual cooperatives into low- or high-performance groups with discriminant analysis.

Management experience and adoption of multi-year plans were the two factors found to have the most significant influence on cooperative sales growth.

Introduction

An emerging diversified farm economy is evolving in the Northeast as both established and new part-time farmers look at potential farm enterprises to produce a variety of farm products. This recent phenomenon in Northeast agriculture has been a subject of considerable interest in State Departments of Agriculture and Land Grant Universities (Butcher et al. and Kerr et al.).

The development of new agricultural cooperatives in the Northeast mirrors this shift towards a more diversified farm economy. In Vermont, there has been an increase in the number of cooperatives starting up business during the past 15 years (Henehan). Most of these recently formed cooperatives are marketing associations which were established to meet the needs of members who had outgrown their local markets.

Cooperatives have played a major role in Northeast agriculture for well over 100 years. A vast body of empirical literature exists with respect to the financial conditions of larger, established cooperatives. For example, the performance of the top 100 cooperatives is studied on an annual basis by the Agricultural Cooperatives Service of the USDA which collects and summarizes data on cooperative business activity (Davidson et al.). Of the top 100 cooperatives, 85 had sales of over $100 million. Numerous studies have been performed on the feasibility of cooperative mergers and cooperative finance (Cramer and Griffin). Again the majority of work done involved large, established cooperatives.

Most emerging Northeastern agricultural cooperatives have sales of under $5 million and face the unique problems of a new business. Much of the research being done on large, established cooperatives located in the West and Midwest has limited relevance to newly formed cooperatives in the Northeast.

At the same time, a number of newly formed cooperatives in the Northeast has come on line during the past 15 years. At least 11 marketing and processing cooperatives were formed since 1970 which serve Vermont farmers alone. Similar cooperatives have been established in other northeastern states.

These newly formed cooperatives have met with mixed financial success. Seasonal fluctuations in member production as well as a sporadic supply have caused numerous marketing and financial problems. Although total sales of these cooperatives is relatively small, there appears to be substantial potential for growth in the markets which these coopera-

tives are entering. The purpose of this article is to investigate and determine the major factors which influence the success of these cooperatives. Given the potential for increased sales and the importance of these cooperatives to their members' financial success, it is important to better understand the key factors for cooperative success.

Objectives

The two basic objectives of this study are to (1) develop a methodology to evaluate the influence of selected variables on cooperative growth and (2) identify those factors which are significantly associated with either the low-growth or high-growth group of cooperatives. It is assumed that those variables which consistently place an individual cooperative in the high-growth group of cooperatives would, if effectively used, increase the likelihood of cooperative financial success.

Methodology

The Study Group

The cooperatives selected for the study were limited to those serving Vermont farmers, and all were involved in marketing Vermont farm products. All of the cooperatives either had their headquarters in Vermont or were located in an adjoining state and had Vermont farmer-members. Each of the cooperatives which began operations within the past 15 years was still operating at the time of the study.

Financial, organizational, and operational data were collected by personal interview for selected years from 1974–1984. Financial reports including annual operating statements and balance sheets were requested from cooperatives. The interviews were conducted with the manager of the cooperative or with a director of the cooperative if they did not have a manager.

Growth Performance

Cooperative growth is commonly used as a criterion for comparing cooperative performance. The question then becomes: what is a useful measure of cooperative growth? This question has been answered differently by several economists. Garoyan and Mohn de-

scribe separate measures for relative and absolute cooperative growth. Number of employees, number of members, sales volume, assets, earnings, and return on investment are key indicators of absolute growth. Market share, price leadership, innovations, and market value of stock are key indicators of relative cooperative growth.

The problem of measuring cooperative growth of newly formed cooperatives becomes more difficult than for established cooperatives. Emerging cooperatives are at a distinct disadvantage when most of the relative growth indicators are used. Several of the absolute indicators also would put emerging cooperatives at a disadvantage: i.e., assets, numbers of members, and numbers of employees.

A major consideration for this study was the availability of data. Total dollar sales was the most readily available and comparable information which could be consistently collected. Cooperative managers most often use the change in dollar sales as a measure of cooperative performance (French et al.).

Growth in total sales was used as the measure of financial performance for this study. A variable labeled AVEGR% was calculated using the following formula:

$$AVEGR\% = \frac{LYSALES - FYSALES}{N(FYSALES)} \times 100$$

Where:

AVEGR% = Average yearly percentage growth in sales,

LYSALES = Last observed year dollar sales,

FYSALES = First observed year dollar sales, and

N   = Number of years of observed sales

A 10% annual growth figure was selected as the cut-off point for minimum cooperative growth for financial success. The 10% figure allows for minimal cooperative growth over the average annual rate of inflation for the same period. We do not imply any guarantee for success if the 10% growth figure is attained. Those cooperatives with average annual growth rate greater than 10% were classified as high-growth cooperatives, while those cooperatives with growth equal to or less than 10% were classified as low growth.

Discriminant analysis was then used to de-

termine which variables best classified an individual cooperative as a high-growth or low-growth cooperative. The combination of variables which provide the best fit for the model of cooperative classification is the final result of the analysis.

Selecting Variables for Discriminant Analysis

Twenty-four factors were identified that were thought to influence the nature and extent of financial success for a cooperative. These factors had to be quantifiable. The group of factors were divided into two sets. One set contained the discrete variables, and the second set was comprised of continuous variables.

The discrete variables were as follows:

ORGTYPE	Type of legal organization of cooperatives
MEMEQTY	Type of member equity plan
MEMCON	Member production contract required
ADS	Does cooperative advertise products
TRUCKMKT	Does cooperative truck products to market
QC	Does cooperative have quality control program
GOALMET	Have sales goals been met in the past
COORD	Type of coordination with other cooperatives
ADMNSTE	Type of administrative staff employed
MANAGER	Part-time, full-time, or no manager
MYPLAN	Does cooperative have a multi-year plan
MEMPART	Degree of member participation
EXPAND	Type of expansion plans

The following variables comprise the continuous group.

MEMDUES	Dollar amount of member dues
MEMEQVAL	Average dollar value of individual member equity
VTSALES	% of total sales sold in Vermont
NESALES	% of total sales sold in New England
ONESALES	% of total sales sold outside New England
WHOLE	% of total sales sold to wholesale market
RETAIL	% of total sales sold to retail market
BROKER	% of total sales sold to brokers
MEMGR	Average annual percent growth in members
AGE	Number of years cooperative in business
MANEXP	Number of years of management experience acquired by a cooperative manager

Preliminary statistical tests were performed on each variable to select those which would be the most useful for the discriminant analysis. The discrete variables were tested by constructing contingency tables for each variable comparing high-growth and low-growth groups. The chi-square test statistic was used as a test statistic at the $\alpha = .10$ confidence level to test for goodness-of-fit.

Group means for the continuous variables were compared by using the t-test statistic for the two growth groups. Significant differences in group means for variables were noted at the $\alpha = .10$ confidence level.

Those variables which showed a significant relation to cooperative growth were selected for use in the stepwise discriminant analysis.

Stepwise Discriminant Analysis

The selected variables were then tested using the stepwise discriminant analysis. Discriminant analysis theory has evolved from Fisher's work in 1936. Afifi and Clark provided the working model for the analysis.

Hypotheses to Be Tested

Each variable was tested for its contribution as a classification variable. The null hypothesis was formulated such that the variable did not improve the classification capability. Afifi and Clark describe the test this way:

"Equivalent null hypotheses are that the population means for each variable are identical, or that the population D^2 [squared difference between the means of the standardized values of Z] is zero."

One can then determine whether each variable improves the discrimination by testing if there is a significant increase in D^2 as each variable enters the analysis. The null hy-

pothesis is that the two population D^2 values are identical.

The variables used in computing the classification functions are chosen in a stepwise manner. Variables are selected at each step by testing whether D^2 is significantly altered by adding or deleting variables. The user specifies the F-to-enter and F-to-remove values in the stepwise discriminant analysis variable selection process.

There is always the possibility of making an incorrect placement of a cooperative into the wrong growth group when using the selected variables to classify cooperatives as low or high growth. Verification of cooperative assignment can be performed by calculating the posterior probability of the individual cooperative falling into the assigned group.

The posterior probability expresses the probability of a given cooperative belonging to a particular group using the values for the selected variables from the discriminant analysis. Posterior probabilities can also be used to interpret the classification results. A high probability favoring classification into one group over the other can be used to verify a cooperative's classification into one of the groups. Judgment might be withheld on cooperatives with probabilities close to .5, the chance probability for falling into either of the two groups.

The posterior probability of belonging to either group can be computed for each cooperative in the sample. The prior probability for each group can also be factored into the computation. The prior probability for a given growth group is the probability that a cooperative selected at random actually comes from that group. It is the proportion of cooperatives in the sample that fall in a given growth group.

Two cooperatives could not be included in the performance analysis. One did not provide the necessary data, and the second cooperative was in its first year of operation. Seven of the sample cooperatives were classified in the low-growth group (AVEGR% $\leq$ 10%), and six were classified in the high-growth group (AVEGR% > 10%).

Only three of the 24 variables suggested any potential for distinguishing between high- and low-growth cooperatives. These variables were MYPLAN (cooperative had a multi-year plan), MEMPART (extent of member participation in cooperative) from the set of discrete variables, and MANEXP (years of management experience for cooperative manager) from the continuous group. Accordingly, only these three variables were used in the discriminant analysis.

The existence and use of a multi-year planning document appeared to be associated with the more successful cooperatives. The greater the extent to which the members participated in and supported their cooperative, and the more years of experience acquired by the manager, the more likely would a cooperative have average annual sales growth exceeding 10%.

It would appear that many of the other variables would have been just as useful in distinguishing between high and low performance. But upon reflection of the data, their inability to do so may have been caused by the relatively few years of available data. Their short span of operation may have prevented any strong associations between the variables and the cooperative's growth performance from being sufficiently established to be measured by statistical analysis.

Stepwise Discriminant Analysis

Discriminant analysis was used to analyze the ability of the selected variables MANEXP, MEMPART, and MYPLAN to accurately classify cooperatives into the two groups, low-growth and high-growth cooperatives. Although each of the variables already showed some relation to cooperative growth, stepwise discriminant analysis further explores this relation and can show which combination of variables maximizes the difference between low-growth and high-growth groups of cooperatives. By systematically observing the correct classification of each cooperative into a particular group, an empirical measure of the success of the discriminant analysis can be developed and used to test the accuracy of the analysis.

The stepwise discriminant analysis was performed using all three of the selected variables. At the first step, the variable MYPLAN showed the highest explanatory power. At step two, the variable MANEXP was combined with MYPLAN. The variable MEMPART was removed from the analysis at the next step with an F value below the chosen F-to-remove tolerance level.

The F statistic is used to test the null hypothesis that the selected variable does not improve the classification. The associated probability values for the F statistics for MYPLAN and MANEXP are approximately .01 and .025 respectively. Therefore, we can re-

Table 1. Classification of Cooperatives into Growth Groups Using Variables MYPLAN and MANEXP

| Group | Percent correct | No. of co-ops in each group | |
		Low growth	High growth
Low growth	85.7	6	1
High growth	83.3	1	5
Total	84.6	7	6

ject the null at α = .10 and conclude that the two variables significantly improve the classification between the two groups of cooperatives.

Table 1 shows the classification of cooperatives into the two growth groups by using the selected variables MYPLAN and MANEXP to classify individual cooperatives. The associated percentages of correct classifications are included in the table.

The use of the variables MANEXP and MYPLAN in the discriminant model to classify each cooperative in the appropriate growth group results in a high percentage of correct classifications. More than 80% of all the cooperatives were correctly classified using the discriminant model.

The number of years of management experience coupled with the adoption of a multi-year plan by a cooperative provided a good indication of whether a cooperative attained a low or

high rate of sales growth for the cooperatives in this study.

Evaluating the Results of the Discriminant Analysis

The discriminant analysis procedure simply places an individual cooperative into either the low-growth group or the high-growth group according to the strength of its association with other factors. Because the possibility exists that a cooperative will be placed in the wrong classification, we may wish to compute the probability that a given cooperative belongs to the growth group in which it was placed. The posterior probability, which expresses the probability of belonging to a particular population after performing the analysis, may be used to evaluate the results of a discriminant analysis.

The posterior probability provides a useful measure for interpreting classification results. The researcher may wish to classify only those cases whose probabilities clearly indicate placement in one group over the other. For the purposes of this study, we may have less confidence in the classification of cooperatives with a posterior probability closer to the chance probability of .5.

Table 2 lists the calculated posterior probability for each cooperative classified in a given growth group. The individual cooperative data for the variables MYPLAN and MANEXP

Table 2. Posterior Probabilities for Each Cooperative Classified in Low and High Growth Groups

| Case no. | Multi-year plan | Management experience | Posterior probability | |
			Low growth	High growth
		(years)		
Low-growth group				
3	no	2	0.936	0.064
4	no	2	0.936	0.064
5	no	1	0.947	0.053
7	no	4	0.922	0.078
9	no	16	0.794	0.021
10*	no	6	0.190	0.810
11	no	4	0.929	0.071
High-growth group				
1	yes	5	0.261	0.739
2	yes	32	0.027	0.973
6*	yes	7	0.915	0.085
8	yes	11	0.029	0.971
12	yes	31	0.029	0.971
13	yes	17	0.113	0.887

* Indicates cases incorrectly classified.

were also included. The two cooperatives incorrectly classified by the discriminant model are noted with an asterisk next to their case number.

Upon reviewing the data summarized in Table 2, we may have less confidence in the classification of Case No. 9 in the low-growth group and Case No. 1 for the high-growth group. Both cases were correctly classified, but each has a substantially lower probability than the other correctly classified cooperatives in their respective groups.

A cooperative with no multi-year plan in place and a manager with two years or less of related management experience would have nearly a 95% chance of being classified in the low-growth group, while a cooperative with a multi-year plan and a manager with over 10 years of management experience would have a better than 88% chance of being a high-growth cooperative.

Summary

The resurgent interest in diversified farming and in small-scale, part-time farming has fostered a new interest in establishing cooperatives to assist in the production and marketing of the resulting output. Many of these new cooperatives start out with a relatively small, and oftentimes shaky, financial base with the expectation that business volume will grow providing a more secure financial future.

There are a number of factors that influence the financial performance of a cooperative. This study attempted to determine those factors which appeared to be most closely associated with cooperatives exhibiting low and high rates of growth. Cooperatives exceeding a 10% annual growth rate in sales were identified as high-growth cooperatives and those with 10% or less as low-growth cooperatives.

Twenty-four variables were selected which were thought to be important factors affecting performance and were at the same time quantifiable. Both continuous and noncontinuous variables were identified and tested for the nature and extent of their association with the high- and low-growth cooperative groups. Only three variables showed statistically significant associations with performance. The three variables were MEMPART, the extent of member participation in the cooperative; MYPLAN, the existence and use of a multi-

year plan; and MANEXP, the number of years of management experience by the manager.

These three variables were then incorporated in a discriminant analysis to determine if a particular combination of these variables would satisfactorily assign the cooperatives to their appropriate performance categories. In 11 of the 13 cases, the two variables MYPLAN and MANEXP correctly placed the cooperatives in their appropriate category.

While the development and use of a multi-year plan and a well-experienced cooperative manager in no way guarantee financial and operational success for a cooperative, they certainly should increase the likelihood of outperforming those cooperatives not having those features.

We were somewhat surprised and at first puzzled that at least some of the other variables were not equally helpful in suggesting those characteristics associated with high-performing cooperatives. We concluded that their failure to do so may have been caused by the relatively short existence of some of the cooperatives not permitting sufficient time to establish the presumed associations between those variables and performance characteristics. We believe the method of analysis is valid and that subsequent investigations with more complete data will increase the usefulness of discriminant analysis in studies of this type.

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