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by

Boris E. Bravo-Ureta and Tsoung-Chao Lee

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This paper compares socioeconomic and technical characteristics of dairy cooperative members and nonmembers based on a sample of New England dairy herd improvement association participants. Descriptive statistics indicate there is little difference between the two groups. A high proportion of members stated cooperatives were helpful primarily because they provide a safe or guaranteed market. Estimates of a Cobb-Douglas production function suggest membership in one specific cooperative was positively and significantly associated with average farm efficiency. Results of a logit analysis indicate the probability of being a cooperative member was positively related to extension contacts and negatively related to output per cow and per farm.

Cooperatives play an important role in the U.S. food system, especially in the dairy subsector. Total dairy cooperative membership reached 167,895 in 1985, and 78 percent of the dairy products marketed in 1985 passed through cooperatives at the first-handler level (Richardson et al.). A recent study shows that nearly 63 percent of the dairy farmers in the Northeast held two or more cooperative memberships in 1980 and that dairy marketing cooperatives are the most important type of cooperative in the Northeast (Kraenzle and Wilkins).

Cooperatives have sought to equalize bargaining power at factor and product pricing points through pooling input purchases and output sales by many farmers. In addition, some cooperatives provide a variety of services and information regarding new practices and technical innovations to their members. The ultimate goals of farmer-owned cooperatives have been to enhance farm income, increase price stability, and provide reliable

Boris E. Bravo-Ureta and Tsoung-Chao Lee are respectively associate professor and professor of agricultural economics, University of Connecticut, Storrs.

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input and output markets (Dunn, Ingalsbe, and Armstrong). However, several large and small northeastern dairy cooperatives have encountered financial difficulties, which have led many dairy farmers to either shift memberships from one dairy cooperative to another or to give up membership altogether (Wilkins and Stafford).

The performance of cooperatives and farmers' attitudes toward cooperatives seem to be important factors in determining the size of membership. Although farmers' attitudes and perceptions about cooperatives and their performance have been studied in Indiana (Babb), Iowa (Gensch and Ling), Texas (Black and Knutson), and northeastern states as a whole (Wilkins and Stafford), little is known about the socioeconomic characteristics and performance of dairy cooperative members and nonmembers in New England.

The purpose of this study is to investigate and compare the characteristics of farmers who are members of dairy cooperatives with those of nonmembers. Knowledge of these characteristics can be useful in determining who are the beneficiaries of dairy cooperatives and in developing programs designed to serve members and/or to increase membership. This type of information is of special significance when public support of cooperatives has been challenged (Lang et al.). The specific objectives of this study are:

1. To make socioeconomic and technical comparisons between dairy farmers who are cooperative members and nonmembers.
2. To evaluate dairy cooperative members' perceptions of the benefits associated with membership.
3. To determine the relationship between cooperative membership and average farm efficiency.
4. To explore some factors that might explain dairy cooperative membership.

This paper is organized into six sections. The first section presents the data used in the study. The second and third sections present a description of selected characteristics of dairy cooperative members and nonmembers and the perceived benefits received by members from their cooperative(s), respectively. The fourth section contains an analysis of the impact of dairy cooperative membership on average farm efficiency. The fifth section presents the results of a model formulated to investigate the variables that explain dairy cooperative membership. The final section presents a summary and some conclusions stemming from the analysis.

Data

A survey was mailed to a randomly selected sample of 50 percent of the New England Dairy Herd Improvement Association (DHIA) membership list for 1984, excluding the membership from Rhode Island. Total membership for that year included 2,772 herds; therefore, 1,386 surveys were mailed, 697 of which were returned. To perform the analysis, the data collected with the survey document were combined with input-output data from DHIA records for the calendar year 1984. After screening the combined data sets, it was necessary to discard 160 observations because critical

DHIA variables and/or survey variables were missing. Thus, 537 observations, or 38.7 percent of the surveys initially sent out, are included in the analysis.

The survey contained questions covering the dairy operation, operator's socioeconomic characteristics, operator's participation in and perception of cooperative extension programs, operator's membership in dairy cooperatives, and operator's perceptions of the advantages of being a member of a dairy cooperative. Of the 537 farmers included in the analysis, 438 or 81.6 percent are dairy cooperative members. A few farmers reported membership in more than one cooperative, resulting in 458 memberships from 438 members.[1] Among the various cooperatives reported,[2] one accounted for 62 percent of all memberships and four others jointly accounted for 31 percent.

The representativeness of the sample was assessed by comparing average herd size, output per cow, and farm distribution by state with published information for New England's total DHIA membership and total dairy farm population (*Northeast Improver;* Zucchi). A detailed listing of these data can be found in appendix table 1. The data suggest that, based on these three characteristics, the sample represents the entire DHIA membership well but represents the entire dairy farm population poorly. The reader should keep this limitation in mind when interpreting what follows.

Selected Characteristics of Dairy Cooperative Members and Nonmembers

Table 1 presents the mean, standard deviation, and range for the entire sample, dairy cooperative members, and nonmembers for the number of cows and workers per farm, operator's age, education, years in farming, years in dairy farming, spouse's education, and extension contacts. The latter variable is defined as the number of extension meetings attended plus farm visits by extension agents during 1982, 1983, and 1984.

To compare the characteristics of cooperative members and nonmembers, statistical tests for means (t-tests) and variances (F-tests) were performed on all pairs of variables. Among all variables, only the variances of cows and workers were significantly different at the .05 level, with nonmembers showing the larger variance in both cases.

The survey asked questions regarding four farm characteristics that provide technical information about the operation. These characteristics are: (1) barn type (stanchion, freestall, and others); (2) milking system (pipeline, herringbone parlor, dumping station, bucket-and-carry, other parlor, and others); (3) herd type (registered, grade, and mixed); and (4) herd breed (Holstein, Jersey, Ayshire, and others). Table 2 presents the number and percentage of farms with the various technical characteristics for the entire sample, members, and nonmembers. A comparison of the technical characteristics of the two groups of farms reveals little difference except that bucket-and-carry milking systems are more than twice as common for members (7.1 percent) as for nonmembers (3.0 percent). Regarding herd breed, Holstein herds are predominant among both groups of farmers, but Holstein cows are somewhat more common among nonmembers and Jersey herds are more prevalent among members.

Perceived Benefits from Dairy Cooperatives

Two general questions were asked in an attempt to ascertain if members thought dairy cooperatives were helpful to them (table 3). The first question asked whether being a dairy cooperative member was helpful in running the farm, and 70.5 percent of the members in the sample, or 309 farmers, answered yes. The remaining 29 percent answered no. The second question was a bit more specific and read, "Do you feel that being a dairy cooperative member helps you to keep informed of new developments in dairy technology and herd management practices?" The answers were: "Yes, very much"—17 percent; "Yes, a little"—35 percent; and "No"—35 percent. Those members who answered yes to the first question were asked to provide two reasons justifying their answer. By far the most often cited reason was "Cooperatives provide a safe or guaranteed market," which was given by 230 farmers. This figure represents 74 percent of the 309 farmers who thought membership in a dairy cooperative was helpful in running the farm. A detailed account of the reasons given is presented in table 4.

Average Technical Efficiency of Dairy Cooperative Members and Nonmembers

The purpose of this section is to determine whether cooperative membership is related to the average technical efficiency of dairy farms. The procedure used is to estimate the parameters of a Cobb-Douglas production function using binary variables to account for the impact membership in a particular dairy cooperative might have on farm efficiency. A positive coefficient for the binary variable for membership indicates relatively higher average efficiency, and a negative coefficient indicates relatively lower efficiency. Examples of Cobb-Douglas production function studies for milk include work by Heady et al.; Hoch; Bravo-Ureta; and Tauer and Belbase, and support for using binary variables to account for average efficiency can be found in Schmidt.

The specific model estimated is:

$$\begin{aligned} \ln Y = {} & \beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + Y_1 D_1 + Y_2 D_2 + Y_3 D_3 \\ & + Y_4 D_4 + Y_5 D_5 + Y_6 D_6 + Y_7 C_1 + Y_8 C_2 + Y_9 C_3 \\ & + Y_{10} C_4 + Y_{11} C_5 + e \end{aligned} \tag{1}$$

where:

- Y = annual pounds of milk produced per cow adjusted to a 3.5 percent butterfat basis;
- X_1 = annual consumption of purchased dairy concentrate feed in pounds per cow;
- X_2 = annual consumption of forage equivalent feed in pounds per cow;
- X_3 = annual labor used per cow including hired, operator, and family labor, measured in full-time worker equivalents;
- D_1 = binary variable equal to one for registered herds and zero otherwise;

Table 1.—Selected Socioeconomic Characteristics of a Sample of New England Dairy Farmers

Variable	Unit	Mean	Standard Deviation	Minimum	Maximum
All Farmers (N = 537):					
Cows	Head	65.03	40.28	20.2	340.00
Workers	Worker Equiv.	2.02	0.93	0.81	10.01
Operator's Age	Years	45.75	12.59	17.00	82.00
Operator's Education	Years	12.98	2.32	4.00	20.00
Years in Farming	Years	26.61	12.85	1.00	66.00
Years in Dairy Farming	Years	23.51	13.80	1.00	66.00
Spouse's Education [a]	Years	13.10	2.38	4.00	20.00
Extension Contacts	Meetings & Visits	10.76	12.31	0.00	84.00
Cooperative Members (N = 438):					
Cows	Head	63.52	36.35**	20.20	262.70
Workers	Worker Equiv.	1.98	0.81**	0.81	5.01
Operator's Age	Years	45.66	12.67	17.00	82.00
Operator's Education	Years	13.01	2.34	4.00	20.00
Years in Farming	Years	26.61	12.94	1.00	66.00
Years in Dairy Farming	Years	23.29	13.85	1.00	66.00
Spouse's Education	Years	13.03	2.42	4.00	20.00
Extension Contacts	Meetings & Visits	11.16	12.44	0.00	84.00

Nonmembers (N = 99):					
Cows	Head	71.72	54.06**	22.40	340.00
Workers	Worker Equiv.	2.20	1.32**	1.01	10.01
Operator's Age	Years	46.18	12.29	22.00	74.00
Operator's Education	Years	12.85	2.25	8.00	18.00
Years in Farming	Years	26.60	12.44	4.00	58.00
Years in Dairy Farming	Years	24.53	13.62	1.00	58.00
Spouse's Education	Years	13.43	2.17	8.00	20.00
Extension Contacts	Meetings & Visits	8.98	11.06	0.00	50.00

[a]Surveys where spouse's education was left blank or reported as zero were deleted when calculating the descriptive statistics for this variable. The resulting sample sizes after the deletions are as follows: all farmers N = 459, cooperative members N = 375, and nonmembers N = 84.
**Significant at the .05 level.

D_2 = binary variable equal to one for Holstein herds and zero otherwise;
D_3 = binary variable equal to one for farms located in Maine or Massachusetts and zero otherwise;
D_4 = binary variable equal to one for farms with technology A and zero otherwise, where technology A is defined as the combination of a stanchion barn and a pipeline milk system;
D_5 = binary variable equal to one for farms with technology B and zero otherwise, where technology B is defined as the combination of a stanchion barn and a bucket-and-carry milking system;
D_6 = binary variable equal to one for dairy cooperative members and zero otherwise;
C_j = binary variable equal to one for members of dairy cooperative j and zero otherwise ($j = 1, \ldots, 5$);
β_i, Y_k = parameters to be estimated ($i = 0, \ldots, 3$; $k = 1, \ldots, 11$); and
e = normally distributed error term with mean zero and variance σ^2.

Table 2.—Technical Characteristics of a Sample of New England Dairy Farms

Variable	All Farmers (N=537)		Cooperative Members (N=438)		Nonmembers (N=99)	
	Number	Percent	Number	Percent	Number	Percent
Barn Type:						
Stanchion	319	59.4	258	58.9	61	61.6
Freestall	134	25.0	110	25.1	24	24.2
Other Types	84	15.6	70	16.0	14	14.1
Milking System:						
Pipeline	211	39.3	167	38.1	44	44.4
Herringbone Parlor	113	21.1	90	20.5	23	23.2
Dumping Station	110	20.5	91	20.8	19	19.2
Bucket and Carry	34	6.3	31	7.1	3	3.0
Other Parlor	34	6.3	29	6.6	5	5.1
Other Systems	35	6.5	30	6.9	5	5.1
Herd Type:						
Registered	210	39.1	173	39.5	37	37.4
Grade	170	31.7	141	32.2	29	29.3
Mixed	157	29.2	124	28.3	33	33.3
Herd Breed:						
Holsteins	439	81.8	351	80.1	88	88.9
Jerseys	72	13.4	66	15.1	6	6.1
Ayshires	16	3.0	14	3.2	2	2.0
Other Breeds	10	1.6	7	1.6	3	3.0

Table 3.—Extent to Which Members Think Dairy Cooperatives Are Helpful to Them

Question 1	Yes		No	
	Number	Percent of Total	Number	Percent of Total
Do you feel that being a dairy cooperative member is helpful in running your farm?	309	70.5	129	29.5

Question 2	Yes, Very Much		Yes, a Little		No	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Do you feel that being a dairy cooperative member helps you to keep informed of new developments in dairy technology and herd management practices?	73	16.7	212	48.4	153	34.9

Table 4.—Reasons Given by Members of Why Cooperatives Are Helpful in Running the Dairy Farm

Reason	Number of Responses		
	First Reason	Second Reason	Total
Cooperatives provide a safe or guaranteed market.	196	34	230
Cooperatives provide information that is helpful in solving problems.	40	34	74
Cooperatives provide strength in numbers, market control, bargaining power.	15	27	42
Cooperatives assist with quality control, production standards, milk inspection.	2	30	32
Cooperatives incorporate members into decision making, are owned and operated by farmers. Management answers to farmers.	3	21	24
Cooperatives provide a better price for the product.	16	5	21
Cooperatives enhance production and marketing efficiency.	6	8	14
Others	14	33	47
No Answer	17	117	134
Total	309	309	618

Four versions of the model shown in equation (1) are considered. Model 1 restricts Y_6 through Y_{11} to be equal to zero, and thus no cooperative membership effect is introduced. Model 2 restricts Y_7 through Y_{11} to be equal to zero and thus introduces an overall dairy cooperative membership effect via D_6. In model 3, it is hypothesized that the cooperative membership effect manifests itself through individual cooperatives. Hence five binary variables, representing the major cooperatives, are included, and Y_6 is set to zero. Finally, in model 4 a cutoff point was imposed at the .05 significance level for the individual cooperative effect.

The empirical results for the four models, presented in table 5, show that all variables not related to cooperative effects are highly significant and that each model explains around 50 percent of the variation in the dependent variable. The only exception is labor, which is statistically not significantly different from zero in all four models. The coefficient for the overall dairy membership effect (Y_6) in model 2 is negative but not statistically different from zero. The latter result indicates that, when no distinction is made among cooperatives, membership has no significant impact on efficiency. By contrast, the results for model 3 show that the coefficient for cooperatives 1 through 5 are −0.010, −0.035, −0.043, 0.034, and 0.016, respectively. These results suggest that some cooperatives have a positive impact on farm efficiency, and others have a negative effect; however, t-tests reveal that each of these parameters is not significantly different from zero at the .05 level. Finally, model 4 shows that only cooperative 4 has an impact on average technical efficiency when the parameter significance cutoff level is set at .05. Specifically, members of cooperative 4, which is a medium-size manufacturing cooperative, are on average 4.2 percent[3] more efficient than the rest of the farmers in the sample. It should be noted that these results are consistent with those reported by Lee, Bravo-Ureta, and Ling, who used a methodology requiring pooled cross-sectional time series data.

Explaining Dairy Cooperative Membership

This section presents a model formulated in an attempt to explain the factors that are associated with dairy cooperative membership. The dependent variable is cooperative membership, which takes the value of one if the farmer is a dairy cooperative member and a value of zero otherwise. The model estimated is:

$$\text{MEM} = f(\text{OUTCOW, Y, EXTEN, Maine Farms, Vermont Farms}) \quad (2)$$

where:

MEM = binary dependent variable equal to one if the farmer is a dairy cooperative member and zero otherwise,
OUTCOW = milk production per cow,
Y = milk production per farm, and
EXTEN = extension contacts as defined previously.

Equation (2) was formulated as a logit model and was estimated using the LOGIST procedure from SAS (Statistical Analysis System). Recent applications of logit regression in farm-level econometric studies include work

by Garcia, Sonka, and Mazzacco; Kauffman and Tauer; and Lines and Morehart.

Alternative specifications of equation (2), including operator age, education, and farming experience, also were estimated. However, the parameter estimates associated with these variables were not statistically significant at conventional levels, and the sign of the parameters included in equation (2) were unchanged.

The results of the logit regression, shown in table 6, indicate that the probability of being a dairy cooperative member is positively related to the number of extension contacts and with being located in Vermont. By contrast, the probability of being a dairy cooperative member is negatively related to output per cow and with being located in Maine. In addition, a negative but statistically weak association was found between the probability of being a member and output per farm. The pseudo-R^2 for equation (2), which is a measure of goodness of fit analogous to the coefficient of determination in conventional regression analysis, is .10.[4] The model χ^2 (50.72) provides strong evidence against the hypothesis that all slope parameters are equal to zero. Table 6 also shows the impact that individual variables have on the probability of being a dairy cooperative member expressed in elasticity form. Output per cow has the greatest impact, in absolute terms, on the probability of being a member.

Summary and Conclusions

The purpose of this paper was to compare several characteristics of dairy cooperative members with those of nonmembers based on a sample of 537 New England dairy farmers. Of the total farmers in the sample, 438, or just under 82 percent, were members, and the remaining 99 farmers were nonmembers. The means and variances of various socioeconomic characteristics were compared, but only the variance of farm size, measured by the average number of cows, and worker equivalents per farm proved to be significantly different between the two groups. In other words, farm size among members was more uniform than among nonmembers. An analysis of the technical characteristics of the two groups revealed little difference except that bucket-and-carry milking systems and Jersey herds were more than twice as common for members as for nonmembers.

A large majority of the members in the sample indicated dairy cooperatives were helpful to them. When members were asked to provide specific reasons why cooperatives were helpful, by far the most often cited reason was that cooperatives provided a safe or guaranteed market.

A production function analysis to determine the impact of dairy cooperative membership on average technical efficiency showed insignificant differences between members and nonmembers. However, when the effect of different cooperatives was considered separately, the analysis showed that membership in one specific cooperative had a positive significant effect on average technical efficiency. The results of a logit regression analysis indicated that cooperative membership varies by farm location. The probability of being a member is negatively related to farm size and output per cow and positively related to the number of extension contacts.

Table 5.—Least Squares Estimates of Cobb-Douglas Production Functions for Milk Based on a Sample of New England Dairy Farmers

Variable[a]	Mean	Model 1[b]	Model 2	Model 3	Model 4
Intercept		6.751***	6.807***	6.763***	6.741***
		(0.245)	(0.247)	(0.246)	(0.244)
Con. Feed/Cow (X_1)	5,311.968	0.258***	0.256***	0.256***	0.258***
		(0.018)	(0.018)	(0.018)	(0.018)
Rough. Equiv./Cow (X_2)	7,010.414	0.058***	0.056***	0.059***	0.058***
		(0.020)	(0.020)	(0.020)	(0.020)
Labor/Cow (X_3)	0.035	−0.012	−0.012	−0.013	−0.015
		(0.016)	(0.016)	(0.016)	(0.016)
Herd Type (D_1)	0.391	0.061***	0.061***	0.061***	0.059***
		(0.011)	(0.011)	(0.011)	(0.011)
Breed (D_2)	0.818	0.144***	0.144***	0.146***	0.015***
		(0.016)	(0.016)	(0.016)	(0.016)
Mass. & Maine (D_3)	0.300	−0.061***	−0.063***	−0.053***	−0.055***
		(0.011)	(0.012)	(0.012)	(0.011)
Technology A (D_4)	0.300	0.024**	0.024**	0.026**	0.025**
		(0.011)	(0.011)	(0.011)	(0.011)
Technology B (D_5)	0.054	−0.071***	−0.070***	−0.071***	−0.074***
		(0.023)	(0.023)	(0.023)	(0.023)
Coop. Members (D_6)	0.816		−0.020		
			(0.013)		

Cooperative 1 (C_1)	0.529			−0.010	
				(0.012)	
Cooperative 2 (C_2)	0.067			−0.035*	
				(0.021)	
Cooperative 3 (C_3)	0.043			−0.043*	
				(0.026)	
Cooperative 4 (C_4)	0.091			0.034*	0.041**
				(0.020)	(0.018)
Cooperative 5 (C_5)	0.063			0.016	
				(0.023)	
R^2		0.5009	0.5031	0.5120	0.5057
$\overline{R}^2$		0.4933	0.4946	0.4998	0.4973
F-statistic		66.234***	59.285***	42.205***	59.916***

[a]Variables are defined in the text. Cooperatives do not necessarily follow alphabetical order.
[b]Figures in parentheses are standard errors of estimates.
*Significant at the .10 level.
**Significant at the .05 level.
***Significant at the .01 level.

Table 6.—Logit Analysis for Dairy Cooperative Membership Based on a Sample of New England Dairy Farmers

Variable	Regression Parameter	Standard Error	Chi-square	Mean[a]	Elasticity at Mean
Intercept	3.05694***	0.82460	13.74		
Output per Cow	−0.01069**	0.00519	4.24	155.45	−.2692
Output per Farm	−0.00003*	0.00002	3.45	10,342	−.0495
Extension Contacts	0.02505**	0.01128	4.94	10.79	.0438
Farms in Maine	−0.78703***	0.29659	7.04	0.18	[b]
Farms in Vermont	0.91725***	0.28661	10.24	0.51	[b]
Pseudo-R^2	0.10				
Model χ^2 (5 degrees of freedom)	50.72***				

[a]The variables are measured in the following units: output per cow and per farm in cwt., extension contacts in number of contacts, and farms in Maine and Vermont as a percentage of total farms in the sample.
[b]Not applicable.
*Significant at the .10 level.
**Significant at the .05 level.
***Significant at the .01 level.

The structure of dairy production clearly has trended toward fewer but larger farms. Contrary to other types of farming, data indicate that the structural transformation in milk production has been primarily at the expense of small instead of medium-size operations (Forste and Frick). Hence, our analysis suggests that if dairy cooperative membership is in fact prevalent among small farms, dairy cooperatives may experience a decline in membership in the future as dairy production continues to shift toward fewer and larger farms. In addition, the data suggest that large farmers tend to have fewer extension contacts and that fewer extension contacts reduce the probability of being a cooperative member. Thus a continuing move toward fewer and larger operations also may lead to a drop in dairy farmer participation in cooperative extension service programs. Of course, dairy cooperatives as well as the cooperative extension service may undergo changes of their own that could lead to different membership and participation outcomes.

Notes

1. This paper deals exclusively with membership in dairy cooperatives; thus the percentage of farmers in our sample reporting more than one membership cannot

be compared with the 63 percent rate reported by Kraenzle and Wilkins because the latter figure refers to all types of cooperatives.

2. Membership was reported in the following cooperatives marketing dairy products, listed in alphabetical order: Agri-Mark, Cabot Farmers' Cooperative Creamery Co., Dairylea Cooperative, Eastern Milk Producers Cooperative Association, Hancock County Creamery, Independent Dairymen's Cooperative Association, Maine Potato Growers, Massachusetts Cooperative Milk Producers Federation, National Farmers Organization, and St. Albans Cooperative Creamery.

3. To calculate efficiency, it is necessary to convert from the log linear form back to the original Cobb-Douglas function. In particular, the efficiency of being a member of cooperative 4 is given by $\exp(0.041) - 1 = 0.0418$ and is rounded to 0.042.

4. The pseudo-R^2 is calculated as $1 - [\log(Lu)/\log(Lr)]$ where Lu is the maximum of the likelihood function when maximized with respect to all parameters and Lr is the maximum when maximized with respect to the intercept only. (For a complete discussion, see Maddala, pp. 37–41.)

References

Babb, E. M. *Performance of Cooperative and Proprietary Cheese Plants.* Agr. Exp. Stat. Bull. 299, Purdue University, Nov. 1980.

Black, W. E., and R. D. Knutson. *Attitudes and Opinions of Texas Agricultural Cooperative Members.* Texas Agr. Extens. Serv. B-1483, Texas A&M University, Aug. 1984.

Bravo-Ureta, B. E. "Technical Efficiency Measures for New England Dairy Farms Based on a Probabilistic Frontier Function Model." *Canadian Journal of Agricultural Economics* 34(1986):399–415.

Dunn, J. R., G. Ingalsbe, and J. H. Armstrong. "Cooperatives and the Structure of U.S. Agriculture." In *Structure Issues of American Agriculture*, pp. 241–48. Washington, D.C.: USDA ESCS Agr. Econ. Rep. 438, Nov. 1979.

Forste, R. H., and G. E. Frick. "Dairy." In *Another Revolution in U.S. Farming?*, L. P. Schertz et al., pp. 119–47. Washington, D.C.: USDA ERS Agr. Econ. Rep. 441, Dec. 1979.

Garcia, P., S. T. Sonka, and M. A. Mazzacco. "A Multivariate Logit Analysis of Farmers' Use of Financial Information." *American Journal of Agricultural Economics* 65(1983):136–41.

Gensch, D. H. *Iowa Cooperative Fertilizer Retail Outlets: Farmers' Attitudes and Perceptions*, ed. K. C. Ling. Washington, D.C.: USDA ACS Res. Rep. 29, Aug. 1983.

Heady, E. O., N. L. Jacobson, J. A. Schnittker, and S. Bloom. "Milk Production Functions and Marginal Rates of Substitution Between Forage and Grain." In *Agricultural Production Functions*, E. O. Heady and J. L. Dillon, pp. 404–51. Ames, Ia.: Iowa State University Press, 1961.

Hoch, I. "Returns to Scale in Farming: Further Evidence." *American Journal of Agricultural Economics* 58(1976):745–49.

Kauffman, J. B., III, and L. W. Tauer. "Successful Dairy Farm Management Strategies Identified by Stochastic Dominance Analyses of Farm Records." *Northeastern Journal of Agricultural and Resource Economics* 15(1986):168–77.

Kraenzle, C. A., and P. C. Wilkins. "Membership in and Use of Marketing and Farm Supply Cooperatives in the Northeast." Unpublished paper, USDA ACS, Washington, D.C., 1983.

Lang, M. G., E. M. Babb, R. D. Boynton, and L. F. Schrader. *Performance Dimensions for Cooperative and Proprietary Firms: Perceptions and Research Priorities.* Agr. Exp. Stat. Bull. 281, Purdue University, May 1980.

Lee, T. C., B. E. Bravo-Ureta, and K. C. Ling. *Technical Efficiency of Dairy Production in New England: Co-op Members Versus Nonmembers.* Washington, D.C.: USDA ACS Res. Rep. 57, Dec. 1986.

Lines, A. E., and M. Morehart. "Financial Health of U.S. Farm Businesses in 1984: A Region, Type, and Size Analysis." *Agricultural Finance Review* 47(1987):43–52.

Maddala, G. S. *Limited Dependent and Qualitative Variables in Econometrics.* Cambridge: Cambridge University Press, 1983.

Northeast Improver, Apr. 1985, p. 12.

Richardson, R. M., et al. *Farmer Cooperative Statistics, 1985.* Washington, D.C.: USDA ACS Serv. Rep. 17, Dec. 1986.

Schmidt, P. "Frontier Production Functions." *Econometric Reviews* 4(1985–86):289–328).

Tauer, L. W., and K. P. Belbase. "Technical Efficiency of New York Dairy Farms." *Northeastern Journal of Agricultural and Resource Economics* 16(1987):10–16.

Wilkins, P. C. *Marketing and Farm Supply Cooperatives: Livestock Producer Membership and Use, 1980.* Washington, D.C.: USDA ACS Res. Rep. 33, Jan. 1984.

Wilkins, P. C., and T. H. Stafford. *Dairy Farmers' Evaluation of Northeastern Dairy Cooperatives.* Washington, D.C.: USDA ACS Res. Rep. 19, Apr. 1982.

Zucchi, O. *New England Milk Market Statistics for the Year 1984.* Boston: Federal Milk Market Administration, 1985.

Appendix

Table 1.—Comparison of 1984 Average Herd Size, Output per Cow, and Farm Distribution for Five New England States from Three Data Sources

State	Data Source		
	Our Sample	DHIA Population[a]	State Averages[b]
Average Herd Size (cows):			
Connecticut	83.0	89.0	88.72
Maine	57.7	56.5	97.36
Massachusetts	62.9	60.0	70.89
New Hampshire	77.3	66.5	72.12
Vermont	62.5	62.5	62.05
Output per Cow (lbs.):			
Connecticut	16,242	16,460	12,708
Maine	15,497	15,977	12,441
Massachusetts	15,350	15,655	12,234
New Hampshire	16,282	16,278	12,100
Vermont	15,338	15,619	12,568
Farm Distribution by State (percent):[c]			
Connecticut	9.68	12.83	10.45
Maine	18.06	19.00	11.71
Massachusetts	11.92	13.44	12.81
New Hampshire	9.50	9.33	8.00
Vermont	50.84	45.38	56.98

[a]Source: *Northeast Improver.*
[b]Source: Zucchi.
[c]Chi-square tests show that the farm distribution by state for our sample is the same as the DHIA population but different from the state distribution at the .01 level. The corresponding computed chi-square statistics are 8.88 and 24.13, which compare with the tabulated value of 13.28 with 4 degrees of freedom. Statistical tests cannot be performed for average herd size and output per cow because the variance for these variables for the DHIA population and the state averages are not available.