Factors Influencing Farmers' Selection of a Milk Handler

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Abstract

A structural probit model is estimated to determine the change in the probability of selecting a milk handler. Cooperatives are thought to have lower prices and higher deductions than independent milk handlers and these factors reduce the probability that a farmer will select a cooperative by 0.39 and 0.32. Cooperatives are thought to have better services and an assured market and payment than independent milk handlers and these factors increase the probability that a farmer will select a cooperative by 0.20 and 0.26. This indicates that many cooperative members value monetary characteristics over non-monetary characteristics.

Key Words: cooperatives, dairy, processors, attributes, selection, probit

Milk marketing cooperatives provide many services for their members. These may include extensive on-farm field services, milk hauling, supply balancing, and providing an assured market for their member's milk. For some of these services, such as supply balancing, the cooperative members pay for the service while the independent dairy farmers may not. The value of belonging to a milk marketing cooperative has been estimated by Berry, et al, and Liebrand and Ling. Berry et al. found that the maximum difference between cooperative and non-cooperative milk handler prices without cooperatives losing members was about $0.20 per cwt. Liebrand and Ling found that farmers, who were satisfied or very satisfied with their cooperative and were receiving lower prices and knew it, were receiving about $0.57 per cwt less than non-cooperative members (p. 1).

A national survey of milk marketers reported that security and market access were important attributes of cooperatives in that 95 percent of the cooperatives guaranteed a market for dairy farmers versus 51 percent of the proprietary processors (Schrader, et al). Wilkins and Stafford found that the most important factors that dairy farmers indicated for selling milk to cooperatives or proprietary handlers were price received, hauling charges, deductions, assessments, and market assurance. Hamlett and Roach found that an assured market was the primary reason for joining a cooperative (p. 1). Boynton and Babb found that a guaranteed market and payment for milk were the most important functions to farmers selling to a cooperative (p. 9). However, no one has quantified these factors according to their impact on the probability of a farmer selecting a cooperative or non-cooperative milk handler.

The objective of this paper is to quantify the qualitative factors according to their impact on a dairy farmer's selection of a cooperative or non-cooperative milk handler. Following Lee, a structural probit model is estimated to determine the change in the probability of selecting a handler based on the farmer's reasons for selecting their

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current milk handler. The farmer's reasons include (a) pays highest price, (b) services are better, (c) friendly people, (d) other farmers recommend, (e) lowest deductions, and (f) an assured market.

The Model

A dairy farmer can become a member of a dairy cooperative or remain an independent and sell directly to a processing or manufacturing plant. Each dairy farmer faces two milk prices, the cooperative price and the non-cooperative price. The choice of cooperative membership may not be without cost. For example, the mail box price may be lower if the farmer joins a cooperative; however, the farmer is assured of a market for his milk, while there is not an assured market for the milk of many non-cooperative members. With these and other factors, the individual farmer decides to become a cooperative member or not. With cooperative or non-cooperative status determined, the farmers' prices from selling milk are set according to the type of cooperative joined or proprietary handler chosen.

Following Lee, let P_{ci} and P_{ni} be the cooperative and non-cooperative milk prices for individual farmer i and ρ_i the reservation price which summarizes his specific preferences. Individual farmer i is assumed to join the cooperative if the cooperative-non-cooperative price differential exceeds his reservation price, i.e.,

$$(1) \qquad (P_{ci} - P_{ni})/P_{ni} > \rho_i$$

The reservation price, ρ_i, can be either positive or negative. In this article, it is assumed that ρ_i is a function of the farm characteristics, the farmer's reasons for choosing their current milk handler, and the location of the farm, i.e.,

$$(2) \qquad \rho_i = \alpha_0 + \alpha_1 k_i + \alpha_2 r_i + \alpha_3 l_i + \varepsilon_i$$

where k_i is a vector of farm characteristics, r_i is a vector of the farmer's reasons for choosing their current milk handler, l_i is a vector of farm locations, and ε_i is the error reflecting unobservable random factors which is normally distributed with zero mean and variance σ_ε^2. Thus, the individual farmer i joins the cooperative if

$$(3) \qquad (P_{ci} - P_{ni})/P_{ni} > \alpha_0 + \alpha_1 k_i + \alpha_2 r_i + \alpha_3 l_i + \varepsilon_i \ .$$

By subtracting the left hand side of equation (3) from both sides of the inequality, this criterion may be written in the form of a probit model. If $I_i^* > 0$, farmer i is in the cooperative, otherwise not, where

$$(4) \qquad I_i^* = \alpha_0 + \alpha_1 k_i + \alpha_2 r_i + \alpha_3 l_i - \alpha_4 ((P_{ci} - P_{ni})/P_{ni}) + \varepsilon_i \ .$$

The respective prices for cooperative members and non-cooperative members are

$$(5) \qquad P_{ci} = \delta_{c0} + \delta_{c1} k_{ci} + \delta_{c2} l_{ci} + e_{ci} \quad \text{if } I_i^* > 0$$
$$P_{ni} = \delta_{n0} + \delta_{n1} k_{ni} + \delta_{n2} l_{ni} + e_{ni} \quad \text{otherwise,}$$

where e_{ci} and e_{ni} are random residuals which are assumed to be $N(0, \sigma_c^2)$ and $N(0, \sigma_n^2)$, respectively.

Data

A survey of southern dairy farmers was conducted in January and February of 1989 to evaluate dairy farmer opinions of their buyers (cooperatives and proprietary firms) and to determine reasons for changing or not changing buyers. Agricultural economists from twelve southern states, the Economic Research Service and the Agricultural Cooperative Service participated in the study (Carley, et al.). Data were obtained from a random sample of dairy farmers in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia. The questionnaire was mailed to 5,660 dairy farmers in these states. Useable responses were obtained from 2,536 dairy farmers for a return rate of 44.8 percent. This represents approximately 25 percent of the total Grade A farmers in the twelve southern states. From the sample, 1,438 useable questionnaires were obtained from eleven states excluding Florida[1]. The mail box price data are based on prices received by farmers during December 1988. The mail box price is defined as the gross price paid by handlers to farmers minus the cost of hauling milk from the farm to a plant, minus the national dairy board assessment, minus a state milk commission

fee, minus market service costs, minus cooperative capital retains, and minus miscellaneous deductions.

Information on the milk price received by dairy farmers, farm characteristics (k), the farmer's reasons for choosing their current milk handler (r), and the location of the dairy farm (l) were collected in the survey (Table 1). The farmer's reasons for choosing their current milk handler were obtained by asking "Why did you choose to sell your milk through your current cooperative or milk plant?". Farmers were asked to circle the applicable reasons for choosing their current milk handler.

Of the 1,438 farmers in this study, the most frequently mentioned reasons for choosing a milk handler are (1) assured market and payment (57.6 percent), (2) services are better (36.6 percent), and (3) pays highest price (36.0 percent)(Table 1). Of the 1438 farmers, 1,169 were cooperative members and 269 were not cooperative members. Cooperative members most frequently mentioned reasons are (1) assured market and payment (63.9 percent), (2) services are better (39.9 percent), (3) friendly people (29.2 percent), and (4) pays highest price (28.9 percent)(Table 1). Non-cooperative farmers most frequently mentioned reasons for choosing to sell directly to a processor are (1) pays highest price (66.9 percent), (2) friendly people (37.9 percent), and (3) assured market and payment (30.5 percent)(Table 1).

Model Estimation

The dependent variable in the price equation (equation (5)) is the natural logarithm of the price to farmers and Log P_{ct} - Log P_{mt} was used to approximate $((P_{ct} - P_{mt})/P_{mt})$ in equation (4) (Lee, p. 418). The model can be rewritten as

$$I_t^* = \gamma_0 + \gamma_1 k_t + \gamma_2 r_t + \gamma_3 l_t - \gamma_4 (\log P_{ct} - \log P_{mt}) + e_t$$

$$\log P_{ct} = \delta_{c0} + \delta_{c1} k_{ct} + \delta_{c2} l_{ct} + e_{ct} \tag{6}$$

$$\log P_{mt} = \delta_{n0} + \delta_{n1} k_{mt} + \delta_{n2} l_{mt} + e_{mt}$$

where $e_t \sim N(0, \sigma_e)$, $e_{ct} \sim N(0, \sigma_c)$ and $e_{mt} \sim N(0, \sigma_n)$.

In this model, one observes the exogenous variables, the cooperative status variable I_t^*, and either the dependent variable P_{ct} or P_{mt}. The observed price depends on the farmer's status, i.e., one observes P_{ct} when $I_t^* = 1$, and P_{mt} when $I_t^* = 0$, but never both. Note that the price equations in (6) cannot in general be consistently estimated by ordinary least squares using the observed prices due to selectivity bias (Lee). Substituting the price equations from equation (6) (i.e., equations representing Log P_{ct} and Log P_{mt}) into the cooperative status equation I_t^* in (6), one has a typical probit model

$$I_t^* = \theta_0 + \theta_1 k_t + \theta_2 r_t + \theta_2 l_t + e_t^* \tag{7}$$

where k_t is a vector of farm characteristics, r_t is a vector of the farmer's reasons for choosing their current milk handler, l_t is a vector of farm locations (Table 1). Thus one can estimate the θ's by probit analysis and obtain consistent estimates after normalizing $\sigma_{e^*}^2 = 1$ (Lee; Maddala).

To correct for selectivity bias, the price equations in (6) can be written as

$$\log P_{ct} = \delta_{c0} + \delta_{c1} k_{ct} + \delta_{c3} l_{ct} - \sigma_{ce^*}(-f(\psi_t)/F(\psi_t)) + \eta_{ct} \tag{8}$$

$$\log P_{mt} = \delta_{n0} + \delta_{n1} k_{mt} + \delta_{n3} l_{mt} + \sigma_{ne^*}(f(\psi_t)/(1-F(\psi_t))) + \eta_{mt} \tag{9}$$

where $\psi = \theta_0 + \theta_1 k_t + \theta_2 r_t + \theta_2 l_t$, F is the cumulative distribution of a standard normal random variable and f is its density function. The parameters of the price equations can be estimated consistently by regressing the observed farmer prices (Log P's) on the k's, l's and $-f/F$ or $f/(1-F)$ as specified by equations (8) and (9) (Lee; Maddala).

To obtain the structural parameters γ of the cooperative status equation I_t^* in equation (6), predicted values for Log P_{ct} and Log P_{mt} for all observations were used in re-estimating the cooperative status equation I_t^* in (6) (Maddala, p. 237).

Table 1. Variable definitions and sample statistics

NAME	DEFINITION	COOPERATIVE	NONCOOPERATIVE
		Mean (standard deviation)	
MAIL BOX PRICE	Gross pay price at 3.5% butterfat minus hauling cost, market service costs government assessments, cooperative deductions ($ per CWT)	13.13 (.64)	13.46 (.57)
FARM CHARACTERISTICS (k)			
# COWS	Number of cows milking	96 (82)	103 (106)
YRS DAIRY FARMER	Number of years as a dairy farmer	21.74 (12.39)	20 94 (12.68)
% INCOME DAIRY	Percent of farm sales from dairy enterprise	92.10 (15.06)	89.84 (17.29)
EQUITY	Current value of farm operation minus debt as a percent of current value	70.68 (30.03)	69.85 (31.54)
BARG COOP	=1 if milk cooperative that only bargains; =0 otherwise	308	–
BARGPRO	Milk cooperative that bargains and processes milk (base for comparison)	861	–
CLASS 1 UTIL	Percentage of milk used for Class 1	71.21 (10 83)	73.74 (8.60)
DEDUCTIONS	Hauling, National Dairy Board, State Milk Commission, Marketing service cost, Capital retains, Other ($'s per CWT)	.88 (.17)	.90 (21)
OVER-ORDER PREM	Dollars above the Federal Marketing Order Class 1 minimum price ($'s per CWT)	.51 (.38)	–
FARMER'S REASONS (r)		Frequency	
PAYS HIGHEST PRICE	=1 if handler pays the highest price =0 otherwise	338	180
SERVICES BETTER	=1 if handler provides better services =0 otherwise	466	61
FRIENDLY PEOPLE	=1 if handler has friendly personnel =0 otherwise	341	102
FARMERS RECOMMEND	=1 if farmers recommended handler =0 otherwise	285	59
LOWEST DEDUCTIONS	=1 if handler has lowest deductions =0 otherwise	119	51
ASSURED MKT/PAYMENT	=1 if handler provided assured market payment; =0 otherwise	747	82
FARM LOCATION (l)			
AL	=1 if Alabama =0 otherwise	37	38
AR	=1 if Arkansas =0 otherwise	73	11
GA	=1 if Georgia =0 otherwise	90	7
KY	=1 if Kentucky =0 otherwise	167	56
LA, MS, TX	Louisiana, Mississippi, Texas (Base for comparison)	135, 87, 120	4, 10, 16
NC	=1 if North Carolina =0 otherwise	127	41
SC	=1 if South Carolina =0 otherwise	52	6
TN	=1 if Tennessee =0 otherwise	91	72
VA	=1 if Virginia =0 otherwise	190	8

Results

Two-stage parameter estimates and related statistics for the above model are presented in Tables 2 through 3. The consistent two-stage estimates for the mail-box price equations (equations (8) and (9)) are obtained by dividing the sample into dairy farmers who were members of a milk marketing cooperative (regime one) and dairy farmers who were not (regime two) during the survey period (Table 2).

The results show that the selectivity bias (estimated coefficient of $(-f(\psi_i)/F(\psi_i))$ in equation (8)) between the participation equation (equation (7)) and mail-box price equation for cooperative

Table 2. Price equation for dairy farmers

Variable	Coefficient[a]	
	Cooperative	Non-Cooperative
INTERCEPT	2.5345**	2.54460**
	(0.01331)[b]	(0.045630)
# COWS	0.000054**	0.000016
	(0.000013)	(0.000021)
BARG COOP	0.033076**	-
	(0.002473)	-
CLASS 1 UTIL	0.000023	0.001158*
	(0.000260)	(0.000706)
DEDUCTIONS	0.032596**	-0.012567
	(0.006092)	(0.011610)
OVER-ORDER PREM	0.021489	-
	(0.020470)	-
AL	0.005175	-0.003867
	(0.006834)	(0.015500)
AR	-0.060438**	-0.088963**
	(0 007745)	(0.022510)
GA	0.004418	-0.000783
	(0.005752)	(0.017710)
KY	-0.078039**	-0.053373**
	(0.004328)	(0.009386)
NC	0.018067	0.010219
	(0.016530)	(0.020020)
SC	0.026337**	0.062718**
	(0.015820)	(0.022400)
TN	-0.036868**	-0.023258**
	(0.005307)	(0.011260)
VA	-0.011031	0.016008
	(0.011230)	(0.026070)
LAMBDA	-0.007598	0.027127*
	(0.008577)	(0.016700)
OBSERVATIONS	1169	269
ADJUSTED R^2	0.564	0.453
F(14, 1154),F(12,256)	109.042**	19.470**

[a]Change in the dollar price for one unit change in the variable.

[b]Corrected standard errors are in parentheses below the parameter estimates. A double (single) asterisk indicates significantly different from zero at the $\alpha = .05$ (.10) significance level. Standard errors were corrected using the estimators in Maddala (p. 252-256)

dairy farmers (equation (8)) is insignificant at α=.10 (Lambda in Table 2). However, the selection bias (estimated coefficient of $(f(\psi_i)/(1-F(\psi_i)))$ in equation (9)) between the participation equation (equation (7)) and mail-box price equation for non-cooperative dairy farmers (equation (9)) is significant at α = .10 level (Lambda in Table 2), which indicates the correction for it was necessary.

The coefficient estimate of the cow numbers variable for cooperative members (Table 2) indicates that larger operations tend to receive a higher price from their milk than smaller operators. This is not the case with a non-cooperative farmer (Table 2). In addition, results show that the net prices from bargaining cooperatives are higher than the prices from a cooperative that also processes milk (the omitted variable). The mail box prices increase as expected as Class 1 utilization increases; however, Class 1 utilization is not significant in the cooperative equation. Furthermore, as deductions increase, mailbox price also increases. This indicates that higher deductions are associated with higher prices. This was not the case for noncooperative members although the coefficient is insignificant. Finally, the over-order premium coefficient is positive but insignificant.

The results also show, that the prices to dairy farmers are different from state to state. Prices to dairy farmers in Arkansas, Kentucky and Tennessee are lower than the prices to dairy farmers in Louisiana, Mississippi and Texas. Alabama, Georgia, North Carolina, and Virginia have prices that are not significantly different from Louisiana, Mississippi, and Texas. Only South Carolina has mail box prices that are higher than Louisiana,

Table 3. Milk cooperative status equation estimates (structural form) and marginal effects

Variable	Coefficient	Change in Probability[a]
INTERCEPT	3.9523**	-.--
	(0.4824)[b]	
# COWS	-0.0050**	-0 00050
	(0.0008)	
YRS DAIRY FARMER	0.0135**	0.00136
	(0.0055)	
% INCOME DAIRY	0.0087**	0.00088
	(0.0039)	
EQUITY	-0.0030*	-0.00030
	(0.0022)	
PAYS HIGHEST PRICE	-1.3082**	-0.39440
	(0 1434)	
SERVICES BETTER	0 8381**	0.20416
	(0.1528)	
FRIENDLY PEOPLE	-0.2957**	-0.08393
	(0.1458)	
FARMERS RECOMMEND	0.1948	- --
	(0.1544)	
LOWEST DEDUCTIONS	-0.9445**	-0.32043
	(0.1929)	
ASSURED MKT/PAYMENT	0 9264**	0.26297
	(0.1347)	
AL	-1.1315**	-0.40238
	(0.2983)	
AR	-1.3446**	-0.48132
	(0.3392)	
GA	-0.1887	-.--
	(0.4179)	
KY	1.3438**	0.22887
	(0.2765)	
NC	0.4597**	0.10504
	(0.2216)	
SC	4.7403**	0.24533
	(0.4747)	
TN	0.2978	-.--
	(0.2460)	
VA	3 9634**	0.36891
	(0.3548)	
Log P_a - Log P_m	92 6220**	9.31661
	(6.506)	

Maximum Likelihood Estimates

Log-Likelihood	-255.71
Restricted (Slopes=0) Log-L	-693.03
Chi-Square (21)	874.64
Significance Level	0.00000

Frequencies of actual & predicted outcomes

		Predicted	
Actual	TOTAL	0	1
TOTAL	1438	228	1210
0	269	202	67
1	1169	26	1143

[a]Change in the probability of switching to a cooperative for one unit change in the variable. For the binary variables, a discrete change is determined at the mean values of the variables.

[b]Standard errors are in parentheses below the parameter estimates. A double (single) asterisk indicates significantly different from zero at the $\alpha = 0.05$ (0.10) significance level.

Mississippi, and Texas. These results are the same for both cooperative and noncooperative members.

The second column of Table 3 shows the probit structural estimates for the decision equation I_i^* (equation (6)). In general, the signs of the coefficient estimates are consistent with expectations. In addition, all but three coefficients are statistically significant.

Of the four farm characteristics, three are significant at the $\alpha = 0.05$ level and one at the $\alpha = 0.10$ level. As the number of cows increase and as equity increases, the likelihood of the farmer becoming a cooperative member decreases (Table 3). The likelihood of the farmer becoming a cooperative member increases as the number of years the farmer has been in dairy increases and as the percent of income from dairy increases (Table 3).

Of the six variables representing a dairy farmer's reasons for choosing their current milk handler, five are significant at the α =0.05 level. Reasons concerning pays highest price, friendly people, and lowest deductions decrease the probability that farmers will choose to join a cooperative by 0.39, 0.08, and 0.32 (Table 3). Variables that represent monetary attitudes (i.e., pays highest price and lowest deductions) about a milk handler have the greatest impact on reducing the probability of a farmer choosing a cooperative milk handler.

Factors that positively influence a farmer's decision to join a cooperative include services are better and an assured market and payment for the farmer's milk. These factors increased the farmer's probability of choosing a cooperative by 0.20 and 0.26. Thus, monetary variables (pays highest price and lowest deductions) have a larger impact on the probability of joining a cooperative than non-monetary variables (services are better and an assured market and payment).

Of the farm location variables, the probability of being in a cooperative was less likely if a farmer lives in Alabama and Arkansas rather than Louisiana, Mississippi, and Texas. The probability is more likely if a farmer lives in Kentucky, North Carolina, South Carolina, and Virginia rather than Louisiana, Mississippi, and Texas. Farmers are equally likely of being in a cooperative if they live in Georgia and Tennessee as well as Louisiana, Mississippi, and Texas.

Finally, if the cooperative-non-cooperative price differential (Log P_{ci} - Log P_{ni}) is positive (negative), the probability of a farmer selecting a cooperative increases (decreases) because the estimated coefficient is positive (92.622)(Table 3). The cooperative-non-cooperative price differential has a sample average that is negative (-0.039 with a standard deviation of 0.024) which indicates that the non-cooperative average price is higher than the cooperative average price. Thus on average, the cooperative-non-cooperative price differential will decrease the probability for farmers to become cooperative members. Furthermore, a small change in the negative average price differential will cause a large change in the probability of selecting a milk handler (Table 3).

Summary and Conclusions

It is generally held that an assured market is the primary reason that dairy farmers switch to a milk marketing cooperative (Hamlett and Roach and Boynton and Babb). Of the 1,438 farmers in this study, the most frequently mentioned reasons for choosing a milk handler are (1) assured market and payment (57.6 percent), (2) services are better (36.6 percent), and (3) pays highest price (36.0 percent). However, the monetary characteristics of a milk handler (e.g., pays highest price and lowest deductions) are more important in influencing farmers to choose a cooperative milk handler than are the non-monetary characteristics (e.g., services are better and assured market and payment). Cooperatives are thought to have lower prices and higher deductions than independent milk handlers and these factors reduce the probability that a farmer will select a cooperative by 0.39 and 0.32. On the other hand, cooperatives are thought to have better services and an assured market and payment than independent milk handlers and these factors increase the probability that a farmer will select a cooperative by 0.20 and 0.26.

Cooperatives must be concerned with milk price and deductions in order to attract and keep members. Services and an assured market and payment can offset low price to a certain extent; however, dollars pay the costs of operating a dairy farm. In order to compete in the market place, cooperatives must maintain a competitive price because monetary factors are more important to dairy farmers than non-monetary factors.

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Endnote

1. Data on milk prices received by producers, premiums, and deductions were not obtained from Florida producers.