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This study uses an econometric model to explain patronage of farm inputs at cooperatives in a highly diversified agricultural region. The model jointly addresses farmer purchases of six input categories: petroleum, pesticides, fertilizers, services, feed, and seed. Explanatory variables include farm size, farm experience, farm type, membership status farm location, and several attitudinal components.

Using a combination of principal components, coefficients restrictions, and seemingly unrelated regressions, joint estimates were made of purchases of different input groups, based on a data set of highly correlated explanatory variables. The results were mixed. Gross revenue did not play a significant role in the percentage of input purchases made at cooperatives. The use of attitudinal measures was also found to be, in general, an insignificant determinant of purchasing behavior. Membership status, was strongly associated with the percent of purchases made at cooperative, but the type of farm was an insignificant indicator.

AN EVALUATION OF INPUT PURCHASING BEHAVIOR AT FARM SUPPLY COOPERATIVES

by

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INTRODUCTION

Farm supply cooperatives are facing a myriad of problems. These problems range from high debt loads and poor inventory control to stiff competition from "for profit" proprietary firms. These problems have been well documented in the literature. Local cooperatives are attempting to solve their problems by merging with other local cooperatives or with larger regional or federated cooperatives.

Many of the problems facing farm supply cooperatives are epitomized in the diversified agricultural industry of Oregon's Willamette Valley. In 1988 the 125 mile by 30 mile valley, with a population of approximately 1.8 million [Roberts; pp. 373-90], had agricultural sales of over $1 billion [Miles, 1989]. There were 75 crops or kinds of livestock grown with gross sales of over $1 million in the Willamette Valley.

This area hosts a highly developed agribusiness sector. The relatively high population and the large number of farms near population centers create a competitive climate for agricultural suppliers. There are nine full-service farm supply cooperative outlets [Agricultural Cooperative Council of Oregon 1987] in the valley and 53 proprietary outlets of farm supplies [Oregon Feed, Seed, Grain, and Suppliers Association 1988]. Because of increased suburbanization, there also has been a significant entry of large discount department stores which are successfully competing for incidental agricultural input dollars.

Because of the diversity of agricultural activity, many farm supply outlets under proprietary control have streamlined and specialized their operations, catering to the needs of the most profitable sectors of the agriculture market. Alternatively, farm supply cooperatives must necessarily stock a wide range of agricultural products in order to maintain their broad base of membership, and must have employees well versed in the many different farming systems. The egalitarian principles upon which the cooperatives were founded also limit specialization, restricting their ability to serve only the most profitable sectors of the agriculture industry.

If local farm supply cooperatives are to stay independent and competitive they need to discover factors which set them apart from the competition. They need to ascertain their clientele's expectations and demands, and determine what the co-op can do to increase both the number of patrons and the amount of renumerative business they do with each. A key element, in this regard, is determining the perceived economic role cooperatives hold in the minds of patrons.

PREVIOUS RESEARCH

Many studies have sought to understand the dynamics of cooperative patronage. Much of the previous work has examined cooperatives in areas with little agricultural diversification, or has focused on farmers of particular crops and on particular inputs for these crops. While somewhat narrow in scope, these studies nonetheless offer insights into the issue of cooperative member patronage.

Schrader et al. [1983], in a study of corn, soybean, and swine producers in Indiana and Illinois, developed a purchasing loyalty index for farm input commodities. Schrader's model predicted the loyalty of farmers to suppliers moderately well, but did not explain the amount of patronage farmers gave to different outlets. Good indicators of farmer loyalty were: the progressiveness of farming practices, the numbers of different price quotations received, and farmers' age. Economic class was found to be an insignificant determinant of farmer loyalty.

Wissman [1981] surveyed commercial farmers (over $50,000 in sales) in three states (Kentucky, Delaware, and Virginia) regarding their purchases of feed, fuel, pesticides, and fertilizer. The most important factor affecting decisions to buy from a given supplier was found to be the price of the input. Other reasons listed were credit, service, quality, dealer location, dealer characteristics, and product availability. Farmers of all sizes tended to purchase most of their needs from a single supplier and use other suppliers only for supplemental purchases.

In a similar study, Hubbard, Anderson, and Purcell [1983] evaluated the purchasing practices of Georgia wheat producers. The study found that price was the most frequent reason for choosing a supplier. Other reasons for choosing a supplier included: convenience, service, credit, quality of product, a desire to spread their business, or because the supplier was the only local dealer of an input.

The studies mentioned above found price and product quality to be major determinants of patronage of farm suppliers. Each of the studies also attempted to measure and quantify other factors which might also affect patronage. These other factors, such as the farmer's progressiveness, the age of the farmer, and characteristics of the farm supplier, indicate that farmers may be receiving some utility, less explicit than the quality of a product at a low price.

THE MODEL

Previous research has assumed farm input purchase decisions are influenced by factors other than price and product quality. With respect to purchases at farm supply cooperatives, we assume these factors are likely to be found in the personal characteristics of farmers such as age, experience, farm type, and in the attitudes held and relationship with the cooperative. We further hypothesize that these personal characteristics are quantifiable and can be used to estimate purchases of inputs at farm supply cooperatives.

The model used in this research estimated the purchases of six classes of farm inputs: 1) petroleum, 2) pesticides, 3) services, 4) fertilizer, 5) seed, and, 6) feed. Each of six equations regressed the percentage of the input purchased at cooperatives on several personal characteristics: 1) membership status (**MEM**), 2) farming experience (**EXP**), 3) estimated gross farm revenue (**REV**), 4) percent of income from farming (**FIN**), 5) a set of seven dummy variables characterizing farm type ($\mathbf{FT_i}$), 6) a set of responses to four survey statements ($\mathbf{S_j}$) describing farmers' attitudes regarding patronage at farm supply cooperatives , and, 7) a set of three principal components ($\mathbf{ATT_k}$) of combinations of responses to survey statements assumed to measure the farmers attitude about cooperative prices and the strengths and weaknesses of cooperatives. Specifically, the model consists of 6 equations and 114 parameters in the form of:

Eq.1 $$\mathrm{INPUT}_i = \alpha + \beta_{i1}\mathrm{MEM} + \beta_{i2}\mathrm{EXP} + \beta_{i3}\mathrm{REV} + \beta_{i4}\mathrm{FIN} + \sum_h \beta_{i5h}\mathrm{FT}_{ih} + \sum_j \beta_{i6j}\mathrm{S}_j + \sum_k \beta_{i7k}\mathrm{ATT}_{ik} + \epsilon_i$$

where: i = inputs = {petroleum, pesticides, services, fertilizer, seed, and feed};
h = farm types = {vegetables, field crops, grain and grass seed, berries, fruits and nuts, specialty, and livestock};
j = statements = {1,2,3,4}; and
K = attitude components = {1,2,3}.

DATA

The data for this study were collected by means of a mailed questionnaire. Two groups were surveyed: farm supply cooperative members, and non-member farmers. 650 farmers were selected from membership roles of the nine farm supply cooperative outlets in Oregon's Willamette Valley. Another 650 non-member farmers were selected from lists compiled by county agricultural extension offices. Of the 1300 survey sent out, 839 were returned; 674 were complete and were used for preliminary studies [Hartley and Burt, 1989a,b]. A copy of the survey is contained in Appendix A. A table showing the means, standard deviations, and variances of the dependent and independent variables used in the analysis is found in Appendix B.

Patronage Percentages

Farmers were asked in the survey to indicate the percentage of total purchases made at farm supply cooperatives for 23 different items. This study focused on six of the surveyed inputs which can be quantified on a yearly basis: 1) petroleum, 2) fertilizer, 3) pesticides, 4) services, 5) feed, and 6) seed. Farm equipment purchases are excluded, for example, because they not undertaken every year and are not always estimable. The same logic excluded items such as hardware, automotive supplies, irrigation equipment, housewares, and home equipment are also excluded from the analysis.

Only farms which conceivably would have made purchases of all six input types were included in the estimation. This requirement eliminated the

need to differentiate between a farmer who did not purchase any of a needed input at cooperatives, and those farmers who would not need to purchase the input at all. To quantify input needs and to subsequently eliminate farmers who would not have needed to purchased any of the six inputs, cost estimates for each of the surveyed farms were made [Hartley and Burt, 1989b]. Of the 674 completed questionnaires, 176 were eliminated based on this criteria. For the remaining 498 observations, purchase percentages of pesticides, services, feed, and seed were taken directly from the survey. Purchase percentages of petroleum were weighted averages of diesel fuel, and oil and lubricants. Bagged, liquid, and bulk fertilizer purchases were weighted and averaged to form a single fertilizer purchase percentage.

Gross Revenue Estimates

Estimates of gross farm revenue were made using enterprise data supplied by farmers through the survey. There were 111 different enterprises listed by the surveyed farmers ranging from wheat to primrose seed, and from cattle to mink ranching. This demonstrates the diversity of input demands faced by farm supply cooperatives in the Willamette Valley. The gross revenue estimates for each farm were computed using per acre sales data compiled primarily from the 1985 Oregon County and State Agricultural Estimates [Miles, 1986].

Farm Type

Categories of farm type were based on information regarding the farmers' enterprises. Most farmers in the survey listed more than one enterprise, for example, a farmer may have grown 50 acres of corn, 100 acres of grass seed, and 100 head of cattle. To assign a farm type to the respondent, each enterprise was classified into one of seven crop types: 1) vegetables, 2) field crops, 3) grain and grass seed, 4) berries, 5) fruit and nuts, 6) specialty, and, 7) livestock. Gross revenues from each enterprise were summed over crop type. Each farm was classified as the crop type accounting for at least 67 percent of the total farm revenue. If no crop type met this criteria, the farm was classified as an eighth category deemed mixed.

Percent of Income from Farming

Survey responses stating the percent of household income derived from farming (**FIN**) were included in the analysis. Any responses that listed zero percent of household income from farming were dropped from the analysis.

Experience

Experience was modeled using variables of age, and years farming. These variables were found to be highly correlated ($r=.86$), yet both imparted slightly different information to the analysis. Including both variables in a regression leads to a high degree of multicollinearity, and therefore would lead to a high variance and covariance for the estimated coefficients [Kmenta; pp 430-42]. To include information from both variables and reduce the possibility

of multicollinearity, this study used principal components analysis to create the farm experience variable, (**EXP**). For an explanation of principal components see Appendix C.

Attitudes Toward Farm Supply Cooperatives

The attitudes of farmers toward farm supply cooperatives will significantly affect patronage if farmers are concerned with for more than just the lowest cost inputs. Measurement of individuals' attitudes is an inexact science. The survey used in this study asked farmers to respond to 26 statements about farm supply cooperatives. Possible responses were: strongly agree; agree; neutral; disagree; strongly disagree. Each response was assigned a numerical value ranging from +2 for strongly agree, to 0 for neutral, and -2 for strongly disagree.

Responses to four of the statements (**Sj**), 9, 10, 11, and 14.6, have been included in the estimation, because of their direct implications on the issue of patronage. These were:

9) There are few significant differences between cooperatives and other competing businesses.

10) Cooperative prices for services and products should be the same regardless of quantities purchased.

11) Generally, cooperative members should patronize their cooperatives even if they pay higher prices than at other competing businesses.

14.6) Cooperatives would get more business if they were more competitively priced.

Responses to three different sets of highly correlated statements, ATT_k, were grouped and included in the analysis as additional dependent variables. To avoid multicollinearity, principal components analysis was used to reduce each set to 3 independent variables. The first attitude component (ATT_1) combined responses to the four parts of statement 13. This statement was assumed to measure farmers' attitudes regarding the importance of price as opposed to other aspects of cooperatives. Statement 13 asked farmers to agree or disagree with each part of the following:

13) It would be better to have lower co-op prices instead of:
    1) good service.
    2) patronage refunds.
    3) cooperative principles.
    4) easy credit.

The second attitude component (ATT_2) combined responses to the first five parts of survey statement 14. This component was assumed to be a measure some of the shortcomings of cooperatives. Specifically, statement 14 read:

14) Cooperatives would get more patronage if they:
    1) located closer to other shopping needs.
    2) lowered membership requirements.
    3) lowered patronage refund revolve time.
    4) had more advertising.
    5) hired friendlier personnel.

The third attitude variable (ATT_3) combined the responses to survey statements 1, 2, 3, 5, 7, and 15, and was assumed to be a measure some of the perceived benefits of cooperatives. These six statements read:

1) Cooperatives are instrumental in introducing new products and technology to local farmers.

2) Cooperatives help their members attain a higher standard of living through increased profits.

3) Young farmers should expect to receive as many benefits from cooperatives in the future as others have in the past.

5) Members generally benefit by patronage refunds of cooperatives.

7) Farmers would generally pay higher prices for supplies if not for competition from cooperatives.

15) Cooperatives offer better service than other competing businesses.

ESTIMATION PROCEDURES

The model used to quantify the factors influencing the purchase of inputs at farm supply cooperatives has been outlined above. Specifically, a set of six equations, one for each of the inputs considered, was estimated. The estimation procedure was complicated however, by two factors.

1. The dependent variables were percentages and thus limited to values between zero and one.

2. There were 114 unknown parameters to be estimated.

Logistic Transformation

The model to be estimated quantified selected determinants of patronage at farm supply cooperatives. The measures of patronage used in this study are the percent of purchases of needed farm inputs (p) made at cooperatives. Percentage data are restricted to be $0 \leq p \leq 1$, and are, therefore, termed **limited dependent variables,** which in a regression analysis require special handling.

A major concern when using limited dependent variables is that predicted values may fall outside the range [0,1]. For example, given a parameter vector β, a vector of responses of an individual farmer could be found, such that the predicted percentages of input purchases would be less than zero. A negative percent of purchases is nonsensical. To prevent this from happening, the dependent variables (input purchase percentages) were converted using a logit transformation as follows:

Eq. 2 $$y = \log \left[\frac{p}{1 - p} \right]$$ where y = the transformed variable, and p = the percentage purchased.

The means, standard deviations, and variances of the transformed dependent variables are shown at the bottom of Appendix B.

The logistic transformation was used to insure predicted values of the dependent variable would fall within the feasible range from zero to one. This transformation, however, produces elasticities which are difficult to interpret. The elasticity, ϵ_{ij}, is the percentage change in dependent variable i resulting from a one percent change in the independent variables, j. In this case, however, the dependent variables are logarithms. In order for the elasticities to be interpreted as changes in purchase percentage, they must be calculated in terms of the original dependent variables. The elasticities listed in Table 1 on pages 18-20, are in terms of the original dependent variables, calculated at the means as:

Eq. 3 $$\epsilon_{ij} = (1 - \bar{p}_i) \cdot \beta_{ij}\bar{x}_{ij} .$$ [Ben-Akiva; p. 111]

$\bar{p}_i$ are the means of the original dependent variables,
$\bar{x}_j$ are the means of the independent variables, and
β_{ij} are the regression coefficients.

Cross Equation Restrictions and Zellner Estimation

The six equations with logit transformed dependent variables were estimable using ordinary least squares (OLS). However, the large number (114) of independent and unknown parameters increases the total variance of the estimates. For many of the parameters however, there were no a priori reasons to believe they should differ across equations. For example, it was

expected that the number of years farming should have the same magnitude of effect on the purchases of fertilizer as on the purchase of pesticides. Therefore, it was hypothesized that imposing cross-equation restrictions and using an iterated Zellner estimation, a simultaneous procedure also known as seemingly unrelated regression (SUR), would produce more efficient results [Zellner].

SUR is carried out by first estimating the separate equations using OLS, and obtaining the sample error, e_i, where:

Eq. 4 $$e_i = [I - X_i(X_i'X_i)^{-1}X_i']y_i \qquad i = \{1, 2, 3, 4, 5, 6\}$$

The variance σ_{ii} and the covariance σ_{ij} (where $i \neq j$) are estimated for each of the equations, providing an estimated variance-covariance matrix for the system, $\hat{\Sigma}$. The parameters, $\hat{b}$, are re-estimated by:

Eq. 5 $$\hat{b} = (X'V^{-1}X)^{-1}X'V^{-1}y, \text{ where}$$

$V = \hat{\Sigma} \otimes I$,
I is an identity matrix,
X and y are stacked matrices of the X_i and y_i matrices, and
i = {petroleum, pesticides, services, fertilizer, seed, feed}.

A new variance-covariance matrix, $\hat{\Sigma}$, is produced, and the process is repeated until the changes in $\hat{b}$ and $\hat{\Sigma}$ are negligible.

The use of Zellner estimation allowed linear restrictions to be imposed across equations. For each restricted variables, there were 5 restrictions:

Eq. 6
$$\beta_{1r} - \beta_{2r} = 0$$
$$\beta_{1r} - \beta_{3r} = 0$$
$$\beta_{1r} - \beta_{4r} = 0$$
$$\beta_{1r} - \beta_{5r} = 0$$
$$\beta_{1r} - \beta_{6r} = 0,$$ where β_{ir} are the restricted variable parameters.

Practically, this forces the regression coefficients to be the same in each of the six input purchase estimates, reducing the number of estimated parameters by five.

Restrictions are acceptable if the maximized likelihood function of the unrestricted model does not differ significantly from the maximized likelihood function of the restricted model. Therefore, the null hypothesis was that the restrictions imposed on the estimation had no effect on the maximum likelihood function. The null hypothesis was tested using the "likelihood ratio test" which compares the restricted likelihood function (RLF) and the unrestricted likelihood function (URLF). The test statistic is calculated as: 2 • [log(URLF) - log(RLF)], and has X^2 distribution with the degrees of freedom equal to the number of imposed restrictions [Kmenta; p. 491].

The estimated model constrained the parameters of 8 variables to be equal across equations and therefore imposed 40 restrictions. The restricted variables were: experience (**EXP**), estimated gross revenue (**REV**), the four individual attitude statements (S_9 S_{10} S_{11} and S_{14}), and two of the attitude variables derived from principal components (ATT_1 and ATT_2). The critical value of the X^2 distribution with 40 degrees of freedom, above which the null hypothesis can be rejected (α = .05%), is 55.76. The value of the likelihood ratio test statistic for these restrictions was 28.0, which was well below the critical value. The null hypothesis could not be rejected and the restrictions were accepted.

Restrictions on membership status (**MEM**), the percent of household income from farming (**FIN**), and on the third attitude component variable (**ATT_3**) were not accepted, using the same likelihood ratio test. Accepting these additional parameter restrictions would have significantly worsened the fit of the likelihood function. Cross equation restrictions on farm types (**FT_i**) were not considered as it was surmised, a priori, that the parameters should vary for different farm inputs.

ESTIMATION RESULTS

The model was estimated using the iterative Zellner estimation algorithm in **Shazam**.® Regression results for each of the six equations corresponding to the six input types are found in Table 1.

The following discussion of the regression results tests the null hypotheses that the coefficients of the independent variable are equal to zero. The null hypotheses may be rejected depending on the willingness to accept a type I error; that is, the willingness to accept the chance (the alpha level) of a false rejection. Unless there are strong prior reasons to believe a variable to have a positive (or negative) effect, all reported alpha (α) values are for two-tailed t-tests. The discussion will describe the significance (or lack thereof) of the independent variables in the model. Further interpretation of the results are provided in the summary discussion in the following section.

Cooperative membership status (**MEM**) has a highly significant and positive effect on the percentage of patronage at cooperatives for all six inputs. There was a strong prior belief that membership would have a positive effect, and therefore one-tailed t-tests of significance were conducted. The alpha levels were less than 0.001 for all six equations. The elasticities varied from a high of 3.91 with respect to petroleum to a low of 1.3 with respect to service purchases. The elasticities can be interpreted as the percentage increase in the input purchased at the cooperative that would result from a one percent increase in the chance that an individual is a cooperative member.

TABLE 1 Estimation Results

Dependent Variable = PETROLEUM PURCHASES

R-Square = 0.2265
Variance = 90.290
Standard Error = 9.5021
Mean of Petroleum = -6.7953

Variable Name	Estimated Coefficient	Standard Error	T-Ratio	Alpha[1]	Elasticity At Means[2]
EXP	-8.2076	3.9274	-2.0898	0.0367	-8.4470e-10
REV	-0.8488e-06	0.7160e-06	-1.1854	0.2360	-0.09704
S_9	-0.17479	0.23095	-0.75684	0.4423	-0.32447
S_{10}	0.22767	0.19385	1.1744	0.2404	0.53819
S_{11}	-0.37453	0.27618	-1.3561	0.1751	-1.08633
$S_{14.6}$	0.7283e-01	0.30195	0.24121	0.8334	0.10794
ATT_1	-4.6120	3.6980	-1.2472	0.2122	-2.3990e-09
ATT_2	-0.22633	3.7267	-0.6073e-01	0.9517	-2.5201e-04
ATT_3	25.120	6.0528	4.1501	0.0000	4.3882e-03
FIN	7.0357	1.2282	5.7286	0.0000	2.43096
MEM	7.3342	1.0014	7.3242	0.0000	3.91420
FT_1	0.94587	2.1366	0.44269	0.6581	0.07407
FT_2	1.2217	2.0781	0.58787	0.5568	0.11694
FT_3	0.77654	1.9936	0.38951	0.6970	0.09685
FT_4	1.1218	2.3923	0.46890	0.6393	0.05206
FT_5	-1.2978	2.2668	-0.57250	0.5672	-0.07905
FT_6	-0.31830	2.1030	-0.15136	0.8787	-0.02908
FT_7	-0.74136	1.9280	-0.38452	0.7007	-0.13224
Constant	14.520	2.5307	-5.7375	0.0000	0.00000

Dependent Variable = PESTICIDE PURCHASES

R-Square = 0.1693
Variance = 131.68
Standard Error = 11.475
Mean of Pesticide = -2.0165

Variable Name	Estimated Coefficient	Standard Error	T-Ratio	Alpha[1]	Elasticity At Means[2]
EXP	-8.2076	3.9274	-2.0898	0.0367	-6.7286e-10
REV	-0.8488e-06	0.7160e-06	-1.1854	0.2360	-0.07730
S9	-0.17479	0.23095	-0.75684	0.4423	-0.25846
S_{10}	0.22767	0.19385	1.1744	0.2404	0.42871
S_{11}	-0.37453	0.27618	-1.3561	0.1751	-0.86534
$S_{14.6}$	0.7283e-01	0.30195	0.24121	0.8334	0.08599
ATT_1	-4.6120	3.6980	-1.2472	0.2122	-1.9109e-09
ATT_2	-0.22633	3.7267	-0.6073e-01	0.9517	-2.0074e-04
ATT_3	38.795	7.1852	5.3992	0.0000	5.3985e-03
FIN	-0.11802	1.4733	-0.8010e-01	0.9362	-0.03248
MEM	7.9004	1.2051	6.5559	0.0000	3.35865
FT_1	-2.4447	2.5787	-0.94803	0.3432	-0.15250
FT_2	-3.4772	2.5078	-1.3865	0.1658	-0.26512
FT_3	-1.3097	2.4050	-0.54458	0.5862	-0.13012
FT_4	3.6060	2.8869	1.2491	0.2115	0.13330
FT_5	1.1668	2.7349	0.42664	0.6698	0.05661
FT_6	0.54297	2.5370	0.21402	0.8131	0.03952
FT_7	-3.8413	2.3255	-1.6518	0.0986	-0.54582
Constant	-5.0939	2.8546	-1.7845	0.0744	0.00000

[1]Alpha levels less than .05 are considered statistically significant. Alpha levels are the chance of falsely rejecting the hypothesis that the parameter is actually equal to zero.

[2]Elasticities are calculated for the mean of the original dependent variables and the mean of the independent variable. Elasticities of restricted variables change across equations.

Shading indicates the variable is restricted across equations.

TABLE 1 Estimation Results (cont.)

Dependent Variable = SERVICE PURCHASES

R-Square = 0.1152
Variance = 29.545
Standard Error = 5.4356
Mean of Serive = -13.835

Variable Name	Estimated Coefficient	Standard Error	T-Ratio	Alpha[1]	Elasticity At Means[2]
EXP	-8.2076	3.9274	-2.0898	0.0367	-1.1170e-09
REV	-0.8488e-06	0.7160e-06	-1.1854	0.2360	-0.12832
S_9	-0.17479	0.23095	-0.75684	0.4423	-0.42905
S_{10}	0.22767	0.19385	1.1744	0.2404	0.71167
S_{11}	-0.37453	0.27618	-1.3561	0.1751	-1.43649
$S_{14.6}$	0.7283e-01	0.30195	0.24121	0.8334	0.14274
ATT_1	-4.6120	3.6980	-1.2472	0.2122	-3.1722e-09
ATT_2	-0.22633	3.7267	-0.6073e-01	0.9517	-3.3324e-04
ATT_3	11.218	3.8254	2.9325	0.0034	2.5914e-03
FIN	1.7431	0.73236	2.3801	0.0174	0.79641
MEM	1.8710	0.58563	3.1949	0.0014	1.32041
FT_1	1.0633	1.2270	0.86659	0.3864	0.11011
FT_2	-0.43568	1.1941	-0.36487	0.7153	-0.05514
FT_3	0.16155	1.1482	0.14070	0.8882	0.02664
FT_4	-1.2594	1.3753	-0.91575	0.3600	-0.07729
FT_5	-1.4982	1.3049	-1.1481	0.2510	-0.12067
FT_6	-0.76200	1.2110	-0.62922	0.5293	-0.09206
FT_7	-1.7636	1.1116	-1.5866	0.1127	-0.41600
Constant	-14.202	1.9608	-7.2430	0.0000	0.00000

Dependent Variable = FERTILIZER PURCHASES

R-Square = 0.1872
Variance = 73.078
Standard Error = 8.5486
Mean of Fertilizer = -5.2363

Variable Name	Estimated Coefficient	Standard Error	T-Ratio	Alpha[1]	Elasticity At Means[2]
EXP	-8.2076	3.9274	-2.0898	0.0367	-8.6623e-10
REV	-0.8488e-06	0.7160e-06	-1.1854	0.2360	-0.09951
S_9	-0.17479	0.23095	-0.75684	0.4423	-0.33274
S_{10}	0.22767	0.19385	1.1744	0.2404	0.55191
S_{11}	-0.37453	0.27618	-1.3561	0.1751	-1.11402
$S_{14.6}$	0.7283e-01	0.30195	0.24121	0.8334	0.11070
ATT_1	-4.6120	3.6980	-1.2472	0.2122	-2.4601e-09
ATT_2	-0.22633	3.7267	-0.6073e-01	0.9517	-2.5843e-04
ATT_3	29.312	5.5138	5.3162	0.0000	5.2511e-03
FIN	0.58268	1.1104	0.52475	0.5999	0.20646
MEM	6.6598	0.90320	7.3735	0.0000	3.64488
FT_1	-1.8762	1.9231	-0.97562	0.3295	-0.15067
FT_2	-3.3267	1.8705	-1.7785	0.0754	-0.32653
FT_3	-1.7080	1.7950	-0.95156	0.3414	-0.21845
FT_4	-2.0342	2.1535	-0.94459	0.3450	-0.09681
FT_5	-3.9677	2.0408	-1.9442	0.0519	-0.24783
FT_6	-1.7047	1.8934	-0.90032	0.3680	-0.15973
FT_7	-4.9404	1.7361	-2.8457	0.0045	-0.90374
Constant	-6.3960	2.3831	-2.6839	0.0073	0.00000

[1]Alpha levels less than .05 are considered statistically significant. Alpha levels are the chance of falsely rejecting the hypothesis that the parameter is actually equal to zero.

[2]Elasticities are calculated for the mean of the original dependent variables and the mean of the independent variable. Elasticities of restricted variables change across equations.

Shading indicates the variable is restricted across equations.

TABLE 1 Estimation Results (cont.)

Dependent Variable = SEED PURCHASES

R-Square = 0.0913
Variance = 110.47
Standard Error = 10.510
Mean of Seed = -7.7424

Variable Name	Estimated Coefficient	Standard Error	T-Ratio	Alpha[1]	Elasticity At Means[2]
EXP	-8.2076	3.9274	-2.0898	0.0367	-8.9422e-10
REV	-0.8488e-06	0.7160e-06	-1.1854	0.2360	-0.10273
S_9	-0.17479	0.23095	-0.75684	0.4423	-0.34349
S_{10}	0.22767	0.19385	1.1744	0.2404	0.56974
S_{11}	-0.37453	0.27618	-1.3561	0.1751	-1.15001
$S_{14.6}$	0.7283e-01	0.30195	0.24121	0.8334	0.11427
ATT_1	-4.6120	3.6980	-1.2472	0.2122	-2.5396e-09
ATT_2	-0.22633	3.7267	-0.6073e-01	0.9517	-2.6678e-04
ATT_3	23.505	6.6292	3.5456	0.0004	4.3468e-03
FIN	0.18784	1.3533	0.13881	0.8897	0.06871
MEM	4.6565	1.1054	4.2125	0.0000	2.63083
FT_1	0.49921	2.3625	0.21130	0.8111	0.04139
FT_2	-2.2151	2.2977	-0.96403	0.3352	-0.22445
FT_3	-3.6207	2.2038	-1.6429	0.1005	-0.47805
FT_4	-0.51837	2.6450	-0.19598	0.7996	-0.02547
FT_5	-4.5121	2.5060	-1.8005	0.0717	-0.29094
FT_6	-2.2299	2.3248	-0.95921	0.3376	-0.21569
FT_7	-2.4501	2.1311	-1.1497	0.2503	-0.46267
Constant	-7.9089	2.6935	-2.9363	0.0034	0.00000

Dependent Variable = FEED PURCHASES

R-Square = 0.0602
Variance = 110.27
Standard Error = 10.501
Mean of Feed = -8.2348

Variable Name	Estimated Coefficient	Standard Error	T-Ratio	Alpha[1]	Elasticity At Means[2]
EXP	-8.2076	3.9274	-2.0898	0.0367	-9.1370e-10
REV	-0.8488e-06	0.7160e-06	-1.1854	0.2360	-0.10497
S_9	-0.17479	0.23095	-0.75684	0.4423	-0.35097
S_{10}	0.22767	0.19385	1.1744	0.2404	0.58215
S_{11}	-0.37453	0.27618	-1.3561	0.1751	-1.17507
$S_{14.6}$	0.7283e-01	0.30195	0.24121	0.8334	0.11676
ATT_1	-4.6120	3.6980	-1.2472	0.2122	-2.5949e-09
ATT_2	-0.22633	3.7267	-0.6073e-01	0.9517	-2.7259e-04
ATT_3	9.4096	6.6238	1.4206	0.1556	1.7781e-03
FIN	-1.0695	1.3521	-0.79099	0.4277	-0.39972
MEM	4.4204	1.1044	4.0024	0.0001	2.55185
FT_1	1.3241	2.3605	0.56094	0.5750	0.11216
FT_2	0.23861	2.2957	0.10394	0.9173	0.02470
FT_3	-0.11881	2.2019	-0.5395e-01	0.9571	-0.01603
FT_4	-0.19832	2.6427	-0.7504e-01	0.9403	-0.00996
FT_5	-0.82458	2.5038	-0.32933	0.7420	-0.05433
FT_6	-0.36115	2.3227	-0.15549	0.8722	-0.03569
FT_7	2.8949	2.1292	1.3596	0.1740	0.55858
Constant	-10.536	2.6919	-3.9140	0.0001	0.00000

[1]Alpha levels less than .05 are considered statistically significant. Alpha levels are the chance of falsely rejecting the hypothesis that the parameter is actually equal to zero.

[2]Elasticities are calculated for the mean of the original dependent variables and the mean of the independent variable. Elasticities of restricted variables change across equations.

Shading indicates the variable is restricted across equations.

Farm size (**REV**), a restricted variable, is not a significant indicator of the percentage of patronage farmers give to cooperatives. The null hypothesis ($\beta = 0$) cannot be rejected unless one is willing to accept a 23% chance that β is actually zero.

Farm experience (**EXP**) was found to be a significant indicator of cooperative patronage. The coefficient was restricted across equations and therefore only one t-test was necessary. The null hypothesis ($\beta = 0$) could be rejected with less than a 3.7% chance of a false rejection. Although there was no strong prior assumption of sign, the coefficient was negative. The elasticities varied from a high, in absolute terms, of 9.14 æ 10^{-10} for feed purchases to a low of 1.12 æ 10^{-9} for purchases of services. On the surface these elasticities seem quite small. However, the magnitude of the independent variable relative to the untransformed purchase percentages is large, and therefore very small elasticities are expected.

The significance of the percent of household income derived from farming (**FIN**), an unrestricted variable, differed widely across equations. **FIN** was highly significant ($\alpha < 0.001$) with respect to petroleum purchases. The sign was positive, and the elasticity at the means indicated an increase of petroleum patronage at cooperatives of 2.43% for a 1% increase in the percent of household income derived from farming. **FIN** was also significant with respect to services purchased at cooperatives. The elasticity at the means indicated an increase of 0.76% in service purchases, for a 1% increase in **FIN**.

The null hypotheses for farm income percent (**FIN**) on the four remaining inputs could not be rejected.

All of the individual attitude variables (S_9 S_{10} S_{11} & $S_{14.6}$) were restricted across equations. The alpha levels, as shown in Table 1, indicate that for each of these attitude statements the null hypotheses (β = 0) could not be rejected with any certainty. It is unlikely, therefore, that farmer's responses to these statements are good indicators of patronage at cooperatives.

Two of the attitude principal components, ATT_1 and ATT_2, were restricted across equations. Neither were significant at the 5% level, although relatively speaking, ATT_1 (α = .2122) was much more significant than ATT_2 (α = .9517). ATT_1 measured the perceived trade-off of service, patronage refunds, cooperative principles, and easy credit for lower prices. In view of these results, it is questionable whether the perceived trade-offs actually effect the purchase of inputs from cooperatives. The estimation also indicated that the perceived accessibility of cooperatives (ATT_2) was very unlikely to influence purchasing habits.

The third principal component of the responses to questionnaire statements (ATT_3) was not restricted. The component was assumed to measure farmer's general attitudes toward cooperatives. It was hypothesized that a higher value for ATT_3 would indicate a greater likelihood to purchase from cooperatives. ATT_3 was significant at alpha levels less than .005 for five of the six input categories. Only with respect to feed purchases was this component insignificant (α = .1556). For all six equations, the parameter of ATT_3 was

positive. The elasticity at the mean ranged from a low of 0.0026 with respect to service purchases to a high of 0.0054 for pesticide purchases.

Dummy variables of farm type (FT_i) were not restricted across input equations. We believed different types of farms would purchase more of certain commodities than other types of farms. For example, it was thought, a priori, that livestock farms (FT_7) (those farms which derive at least two-thirds of their estimated farm income from livestock) would tend to have large herds/flocks, and therefore would purchase bulk rather than bagged feed. Farm supply cooperatives in the Willamette Valley do not generally sell bulk feed and therefore livestock farmers would purchase a smaller percent of their feed from farm supply cooperatives.

In the Willamette Valley, vegetable producers are usually supplied with seed by vegetable processors, therefore we expected, a priori, that farms classified as vegetable farms, (FT_1), would purchase smaller proportions of their seed from cooperatives. Along the same line of reasoning, grain and grass seed growers (FT_3) would use their own seed or get their seed through contracts with their purchasers. On the other hand, livestock farms which by definition would have limited demands for seed, may be likely to purchase a higher percentage of their seed at cooperatives.

The estimation showed that generally farm types were not significant indicators of the likelihood of purchasing behavior at cooperatives. With respect to petroleum and feed purchases, none of the farm type variables were significant indicators at even the 0.15 level.

With respect to pesticides and services, only farms classified as livestock farms (FT_7) significantly increased the fit of the estimation at the 10% - 12% level. Livestock farms were somewhat significant (α = .0986) predictors of pesticide purchases with a negative coefficient. Accepting a 10% chance that the parameter is actually zero, it could be said that for every 1% increase in the likelihood of a farm specializing in livestock, pesticide purchases will fall 0.54%. Similarly, livestock farms are significant predictors of service purchases at the 11% level with an elasticity of -0.416. No other farm type is significant at less than the 15% level for pesticides and services.

Three farm types were significant predictors of fertilizer purchases at alpha levels less than 0.1. Field crops (FT_2) are significant at the 0.075 level, with negative coefficient and an elasticity of -0.32. Tree fruit and nut farms (FT_5) were also significant (α = 0.05) and negative with an elasticity of -0.24. Livestock (FT_7) farms were highly significant and negative predictors of fertilizer purchases. The alpha level for FT_7 was 0.005 and the elasticity was -0.9, indicating that, for a 1% increase in the probability of a farm specializing in livestock, there is a 0.9% decrease in the purchase of fertilizers.

Grain and grass seed growers (FT_3) were somewhat significant (α = 0.10) and negative predictors of seed purchases. The elasticity was found to be -0.48. Even more significant were tree fruit and nut growers (FT_5) with an alpha level and 0.07 and an elasticity of -0.29.

CONCLUSIONS AND SUMMARY

This study and the resulting analysis provided useful insights into the attitudes and perceptions of farmers, along with the importance of diversity, farm size, and membership status as they jointly relate to patronage patterns at farm supply cooperatives. Such information can be used as a basis for deductive conclusions of interest to cooperative managers, directors, and members.

The findings reinforced the importance of membership status with regard to purchasing behavior. A cooperative could increase business volume by increasing its members. In itself this begs the question of which comes first. Cooperative membership could be, among other things, a function of the amount of purchasing an individual does at the cooperative. A farmer is more likely to join the cooperative if he or she is regularly doing business with the cooperative. If the farmer does not regularly patronize the cooperative, the cost of membership may outweigh the fiscal gain through patronage dividends. Once a farmer has recouped the cost of membership, there may be little incentive to purchase at the cooperative, unless the prices combined with the refund are less than prices found at competing businesses.

We have assumed in this study that the decision to become a member was undertaken in an earlier period, therefore the decision to purchase at the cooperative is not based on a need to recoup membership costs. Thus, the evidence that membership status is a strong indicator of the amount of patronage at cooperatives shows that members believe they are purchasing at

the lowest cost when price and refund are added, or that they receive some other utility from purchasing at their cooperative.

Many cooperative managers told us during the survey they felt the biggest driver of cooperative patronage is the size of the farm. Moreover, some managers expressed the concern that large size farms were not patronizing cooperatives to the same extent as small size farms. We conclude here, however, that gross revenue is not a significant indicator of purchase percentages. The insignificance of gross revenue indicates that farmers in this survey, regardless of the size of the operation, purchase approximately the same percentage of their inputs from cooperatives.

Whether farmer's attitudes, as measured by the survey instrument, are valid indicators of purchasing behavior is still unsolved. Only ATT_3, the attitude component which was assumed to measure farmer's general feelings toward cooperatives, was a good indicator of purchasing behavior. The lack of significance of the other attitude components and statements leads us to conclude that they are unimportant in measuring purchasing behavior. This deduction may contradict conventional wisdom, but it is backed up by the evidence. The insignificance of these measures may indicate that, while farmers have their opinions regarding cooperative principles and policies, they are not revealed in their decisions to purchase.

The inclusion of farm type variables gave mixed results overall. Livestock farms seem to be the most significant of the seven farm type variables. The general lack of significance found in the crop type variables suggests that the agricultural diversity of the Willamette Valley does not

negatively impact farm supply cooperatives. It does not appear that cooperatives are losing the business of any one farm type. On the other hand, these results indicate that marketing schemes directed at different farm types may not be worthwhile.

In summary, this study explored a model of purchasing behavior at farm supply cooperatives. The results were mixed. Our prior expectations were not always met. Gross revenue did not play a significant role in the percentage of input purchases made at cooperatives. The use of attitudinal measures was also found to be, in general, an insignificant determinant of purchasing behavior. Membership status, as expected, was strongly associated with the percent of purchases made at cooperatives, but the type of farm was an insignificant indicator.

Using a methodology combining principal components, coefficients restrictions, and seemingly unrelated regressions, we were able to jointly estimate purchases of different input groups, based on a data set of highly correlated, often subjective, explanatory variables. Although few significant indicators of purchasing behavior were found in this analysis, the general format of the model proved tractable.

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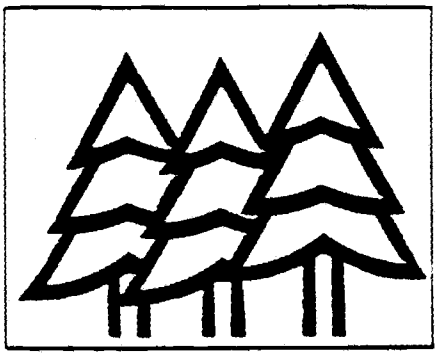
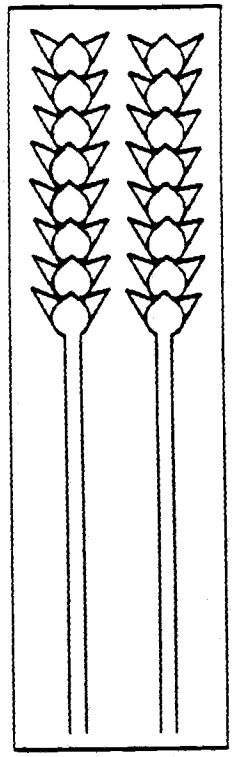
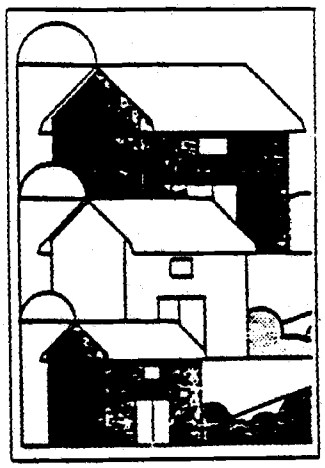
APPENDICES

APPENDIX A The Survey







A 1986 effort to determine if the needs of Willamette Valley agricultural producers are being fulfilled by farm supply cooperatives is underway. Are prices competitive? quality products? reliable service? qualified management?

Please answer all of the questions. If you wish to comment on any questions or qualify your answers, please use the margins or a separate sheet of paper.

This research is sponsored by the Oregon State University Department of Agricultural and Resource Economics.

Return the questionnaire to:
Agricultural and Resource
Economics Department
Oregon State University
Corvallis, Oregon 97331

ARE FARM SUPPLY COOPERATIVES MEETING PRODUCER'S NEEDS IN THE WILLAMETTE VALLEY?

ARE FARM SUPPLY COOPERATIVES MEETING PRODUCERS' NEEDS
IN THE WILLAMETTE VALLEY?

AN OREGON STATE UNIVERSITY SURVEY

Please answer all eleven questions.

1. Are you a member of a farm supply cooperative? (Circle one number)
   1. NO (SKIP TO QUESTION 2)
   2. YES
      1a. How many farm supply cooperatives do you belong to? (Circle one number)
      1 ONE
      2 TWO
      3 THREE
      4 MORE THAN THREE

2. Generally, members and non-members can purchase supplies from a farm supply cooperative. For the following supplies, please indicate the percentage of your total purchases of each supply item that you made at a farm supply cooperative in 1985. (Please circle one number for each item)

ITEM	PERCENTAGE												
a) GASOLINE	0	5	10	20	30	40	50	60	70	80	90	95	100
b) DIESEL (FOR FUEL)	0	5	10	20	30	40	50	60	70	80	90	95	100
c) DIESEL (FOR HEATING)	0	5	10	20	30	40	50	60	70	80	90	95	100
d) OIL AND GREASE	0	5	10	20	30	40	50	60	70	80	90	95	100
e) AUTOMOTIVE	0	5	10	20	30	40	50	60	70	80	90	95	100
f) LAWN/GARDEN SEEDS, TOOLS & SUPPLIES	0	5	10	20	30	40	50	60	70	80	90	95	100
g) CLOTHING AND HOUSEHOLD	0	5	10	20	30	40	50	60	70	80	90	95	100
h) ANIMAL HEALTH	0	5	10	20	30	40	50	60	70	80	90	95	100
i) GENERAL HARDWARE (NAILS, PAINT, ETC.)	0	5	10	20	30	40	50	60	70	80	90	95	100
j) HEAVY HARDWARE (FENCING, BALING, ETC.)	0	5	10	20	30	40	50	60	70	80	90	95	100
k) POWER EQUIPMENT	0	5	10	20	30	40	50	60	70	80	90	95	100
l) FEED	0	5	10	20	30	40	50	60	70	80	90	95	100
m) SEED	0	5	10	20	30	40	50	60	70	80	90	95	100

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ITEM	PERCENTAGE												
n) GRAIN SEED	0	5	10	20	30	40	50	60	70	80	90	95	100
o) DRY FERTILIZER (BULK)	0	5	10	20	30	40	50	60	70	80	90	95	100
p) DRY FERTILIZER (BAGGED)	0	5	10	20	30	40	50	60	70	80	90	95	100
q) LIQUID FERTILIZER	0	5	10	20	30	40	50	60	70	80	90	95	100
r) PESTICIDES	0	5	10	20	30	40	50	60	70	80	90	95	100
s) OTHER CHEMICALS (SURFACTANTS, ETC.)	0	5	10	20	30	40	50	60	70	80	90	95	100
t) LABOR/SERVICES	0	5	10	20	30	40	50	60	70	80	90	95	100
u) FARM EQUIPMENT RENTAL	0	5	10	20	30	40	50	60	70	80	90	95	100
v) FARM MACHINERY	0	5	10	20	30	40	50	60	70	80	90	95	100
w) IRRIGATION EQUIPMENT	0	5	10	20	30	40	50	60	70	80	90	95	100

3. There are many reasons why farmers might divide their purchases between supply cooperatives and private businesses. Please read the following statements about farm supply cooperatives and indicate whether you: strongly agree (SA), agree (A), don't know or neither agree nor disagree (N), disagree (D), or strongly disagree (SD). (Please circle one answer for each statement)

a) Cooperatives are instrumental in introducing new products and technology to local farmers.	SA	A	N	D	SD
b) Cooperatives help their members attain a higher standard of living through increased profits.	SA	A	N	D	SD
c) Young farmers should expect to receive as many benefits from cooperatives in the future as others have in the past.	SA	A	N	D	SD
d) Cooperatives should discourage large non-member farmers from patronizing the cooperative.	SA	A	N	D	SD
e) Members generally benefit by patronage refund of cooperatives.	SA	A	N	D	SD
f) Cooperatives generally are not managed efficiently.	SA	A	N	D	SD
g) Farmers would generally pay higher prices for supplies if it were not for competition from cooperatives.	SA	A	N	D	SD
h) Cooperatives should encourage patronage by small non-member farmers.	SA	A	N	D	SD
i) There are few significant differences between cooperatives and other competing businesses.	SA	A	N	D	SD

(PLEASE GO ON TO NEXT PAGE)

Please indicate whether you: strongly agree (SA), agree (A), don't know or neither agree nor disagree (N), disagree (D), or strongly disagree (SD).

j) Cooperative prices for services and products should be the same regardless of quantities purchased.	SA	A	N	D	SD
k) Generally cooperative members should patronize their cooperatives even if they pay higher prices than at other competing businesses.	SA	A	N	D	SD
l) Oregon cooperatives are no longer serving small farmers needs adequately.	SA	A	N	D	SD
m) It would be better to have lower coop prices instead of:					
1) good service	SA	A	N	D	SD
2) patronage refunds	SA	A	N	D	SD
3) cooperative principles	SA	A	N	D	SD
4) easy credit	SA	A	N	D	SD
n) Cooperatives would get more patronage if they:					
1) located closer to other shopping needs	SA	A	N	D	SD
2) lowered membership requirements	SA	A	N	D	SD
3) lowered patronage refund revolve time	SA	A	N	D	SD
4) had more advertising	SA	A	N	D	SD
5) hired friendlier personnel	SA	A	N	D	SD
6) were more competitively priced	SA	A	N	D	SD
o) Cooperatives offer better service than other competing businesses.	SA	A	N	D	SD
p) Cooperative managers and board members care more about the cooperatives' survival than members needs.	SA	A	N	D	SD
q) Most cooperative members are not very informed about the operation of their cooperative.	SA	A	N	D	SD
r) Cooperatives should seek the membership of large farmers over the membership of small farmers.	SA	A	N	D	SD

(PLEASE TURN THE PAGE)

Finally, we would like to ask a few questions about yourself for statistical purposes.

4. How many years have you been farming?
   _____YEARS

5. Which crops and how many acres of each did you grow in 1985?

CROP	# ACRES	CROP	# ACRES

6. Please give the numbers of each kind of livestock raised in 1985, if any.
   a. BEEF CATTLE..... _____
   b. DAIRY CATTLE ..... _____
   c. POULTRY ..... _____
   d. SHEEP ..... _____
   e. SWINE ..... _____
   OTHER (PLEASE LIST)
   f. _____ ..... _____
   g. _____ ..... _____

7. What was your approximate gross household income from all sources, before taxes, in 1985: (Circle the number that most closely approximates your income)
   1 LESS THAN $2,500
   2 $2,501 - $40,000
   3 $40,001 - $100,000
   4 $100,001 - $250,000
   5 GREATER THAN $250,001

8. Of your 1985 income, what percent was used to purchase farm supplies?
   _____PERCENT

9. And, about what percent of your 1985 income was derived from farming?
   _____PERCENT

10. What is your present age?
    _____ _____YEARS

(PLEASE GO ON TO NEXT PAGE)

11. Is there anything else you would like to tell us about how farm supply cooperatives could serve you better? If so, please use this space for that purpose. Also, any comments you wish to make that you think may help us in future efforts to understand what needs Oregon farmers have from their farm supply sources will be appreciated, either here or in a separate letter.

Your contribution to this effort is very greatly appreciated. If you would like a summary of results, please print your name and address on the back of the return envelope NOT on this questionnaire. We will see that you get it.

THANK YOU!

APPENDIX B Means, Standard Deviations, and Variances of Variables.

Variable	Mean	Standard Deviation	Variance
INDEPENDENT VARIABLES			
EXP	0.14250e-09	0.57903e-01	0.33527e-02
REV	0.15830e+06	0.34324e+06	0.11781e+12
S_9	2.5703	0.98279	0.96588
S_{10}	3.2731	1.1841	1.4021
S_{11}	4.0161	0.92785	0.86091
S_{14}	2.0522	0.85420	0.72966.6
ATT_1	0.72022e-09	0.63565e-01	0.40405e-02$_1$
ATT_2	0.15417e-02	0.65155e-01	0.42452e-02$_2$
ATT_3	0.24188e-03	0.75485e-01	0.56980e-02$_3$
FIN	0.47841	0.41930	0.17581
MEM	0.73896	0.43965	0.19329
FT_1	0.10843	0.31124	0.96870e-01
FT_2	0.13253	0.33941	0.11520
FT_3	0.17269	0.37836	0.14316
FT_4	0.64257e-01	0.24546	0.60249e-01
FT_5	0.84337e-01	0.27817	0.77380e-01
FT_6	0.12651	0.33275	0.11072
FT_7	0.24699	0.43169	0.18636
ORIGINAL VARIABLES			
PETROLEUM	0.27778	0.40742	0.16599
PESTICIDES	0.42470	0.43619	0.19026
SERVICES	0.44980e-01	0.15253	0.23264e-01
FERTILIZER	0.25937	0.36203	0.13107
SEED	0.23544	0.36759	0.13512
FEED	0.21878	0.35822	0.12832
TRANSFORMED DEPENDENT VARIABLES			
PETROLEUM	-6.7953	10.815	116.96
PESTICIDES	-2.0165	12.603	158.83
SERVICES	-13.8350	5.7844	33.460
FERTILIZER	-5.2363	9.4917	90.092
SEED	-7.7424	11.037	121.82
FEED	-8.2348	10.843	117.57

APPENDIX C Principal Components

Principal components analysis transforms a set of n variables into a set of n jointly uncorrelated components. The principal components are orthogonal linear combinations of the original variables, and have the property that the first component has the largest variance of any other linear combination, the second has the next largest variance of any linear combination uncorrelated with the first, etc. [Johnston; pp. 536-44] If the n original variables have a high degree of multicollinearity, it is expedient to drop the components which account for little of the variance [Kendall].

Principal components of n original variables are calculated by finding the n eigenvectors and corresponding characteristic roots, λ_n. The characteristic roots are also known as the eigenvalues. The eigenvectors multiplied by the original variables result in the n principal components. The variance-covariance matrix of the principal components is a diagonal matrix, where $\sigma_{nn} = \lambda_n$. If the variables have been standardized the eigenvalues will sum to n[1]. A widely used rule of thumb is to drop components with eigenvalues less than 1 from the estimation. This is justified by the fact that components with relatively small eigenvalues will explain relatively little of the variance found in the original variable [Kendall]. If no components are dropped from the estimation then nothing will have been gained.

[1]This is true, only when using the correlation matrix, as opposed to using the covariance matrix, in calculating the eigenvalues.

This study used the Principal components algorithm in SHAZAM® to compute the components of the variables **AGE** and **YEARS FARMING** from the survey. The eigenvalues for the two new principal components were 1.6663 and 0.3337. Since the eigenvalue of the second vector was much less than 1, it was dropped from the estimation, leaving a single new component:

Eq. 1 **EXP** = .7071 x **AGE** + .7071 x **YEARS FARMING.**

where the coefficients are the elements of the first eigenvector.

Attitudes Toward Farm Supply Cooperatives

Responses to three different sets of highly correlated statements from the survey were grouped based on the subject of the statement. To avoid the problem of multicollinearity, principal components were used to reduce each set to 3 independent variables.

The first attitude component (ATT_1) combined responses to the four parts of statement 13 (see Appendix A). This statement was used as a measure of farmers attitude regarding the importance of price as opposed to other aspects of cooperatives. The vector of eigenvalues for the four parts of the statement 13 were: **[2.0000 0.7943 0.7017 0.5041]**. Only the first eigenvalue was greater than one, so the last three components were dropped from the estimation. The first component was:

Eq. 2 $(ATT_1) = -0.4619 \times S_{13.1} - 0.5146 \times S_{13.2} - 0.5636 \times S_{13.3} - 0.4519 \times S_{13.4},$

where the coefficients are the elements of the first eigenvector.

The second attitude component (ATT_2) combined responses to the first five parts of survey statement 14. The sixth part of statement 14 was not as closely correlated with the first five and was used in the estimation as a single variable (S_4). This component was assumed to be a measure some of the shortcomings of cooperatives. The eigenvalues for the first five parts of statement 14 were: [2.2481 0.8009 0.7715 0.6527 0.5268]. Again, only the first eigenvalue is greater than one, and therefore the component (ATT_2) was:

Eq. 3 $(ATT_2) = -0.4507 \times S_{14.1} - 0.4816 \times S_{14.2} - 0.4377 \times S_{14.3} - 0.4021 \times S_{14.4} - .4601 \times S_{14.5}$

where the coefficients are the elements of the first eigenvector.

The third attitude variable (ATT_3) combined the responses to survey statements 1, 2, 3, 5, 7, and 15, and was assumed to be a measure of some of the benefits of cooperatives. The eigenvalues for the six statements were: [3.0467 0.7646 0.6816 0.5956 0.5071 0.4044]. Only the first eigenvalue was greater than one so the last five components were dropped from the estimation. The resulting component (ATT_3) was:

Eq. 4 $(ATT_3) = -0.3819 \times S_1 - 0.4689 \times S_2 - 0.4011 \times S_3 - 0.3861 \times S5 - 0.4283 \times S_7 - 0.375 \times S_{15}$

where the coefficients are the elements of the first eigenvector.

References

Kendall, M. (1961) A Course in Multi-Variate Analysis, New York: Haeffner Press.

Johnston, J. (1984) Econometric Methods, 3d edition. New York: McGraw-Hill Book Co.