The Performance of Vegetable Marketing Cooperatives in Taiwan: Evidence from Cross-Sectional Studies*

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ABSTRACT

Marketing environments affecting the performance of Vegetable Marketing Cooperatives (VMC) are numerous, and are changing at all time. This paper reports the results of research undertaken to:

(1) Identify the factors that influence the farmers' decision to pick VMC's as their vegetable outlets at farm gates.

(2) Estimate the factors that affect the changes of VMC operating quantity of the associations.

Data employed are from an April 1989 mail survey. The weighted least square estimation and the maximum likelihood logit analysis are used to evaluate the performance of the farmer's model, and the association's model, respectively. Main findings of this paper are: (1) When the price differential between a VMC and other alternatives is wider, the probability that a farmer will choose the VMC decreases; (2) Education level, assembly place, assembly time, the amount

* A speech presented in Seoul on June 21, 1989 at the International Seminar on the Improvement of Vegetable Marketing by Producers' Cooperatives, sponsored jointly by the Food & Fertilizer Technology Center for the Asian and Pacific Region and the National Agricultural Cooperative Federation, Korea.

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of service charge, and the executing of subsidiary programs are likely to generate a positive impact on farmers' intentions concerning the selection of VMC's as their vegetable marketing outlet; (3) The performing of guarantee payment programs does contribute significantly to the quantity operation trend of the association; (4) The more work experience in agriculture of the VMC manager, the higher VMC profit rate, the smaller the farmer's tillage scale, and the shorter the payment day are all likely to favor the growth of associations' operation of VMC's.

INTRODUCTION

Using cooperatives as a marketing alternative for vegetables has been in existence in Taiwan since June, 1973. During the past 16 years, the contribution of vegetable marketing cooperatives (VMC's) to the farmer, to the agricultural sector, as well as to the consumer has been generally favorable. Due to the changes of marketing environment, the VMC program, however, has to be researched continuously in order to make it possible for it to fulfill the announced objectives. The marketing environment is a collective term referring to all factors, constraints, and circumstances that surround and impinge on VMC's and over which the VMC farmer and the associations which execute the VMC's have little or no control. More specifically, it includes the physical characteristics of vegetables, seasonality in supply, the existing marketing system, the demographic nature of farmers and their attitude toward the functions of the VMC (including commision, assembly place, assembly time, etc.), the location of individual associations, the quality of the VMC manager, and so on. It is from this environment that marketing alternatives are derived. Of particular interest for this paper is to analyze how these environments connect with the

performance of VMC's. More specifically, the purpose of this paper are to identify the environments that influence the farmers' decisions to pick VMC's as their vegetable outlets at farm gates, and that affect the changes of VMC operating quantity of the association (include farmers' association and of the cooperative farm association).

RESEARCH METHODOLOGY

The main research methodologies employed are: mathematical form, the logistic model, high degree of multicollinearity, heteroscedasticity and weighted least square, and criteria for choice of independent variables.

(1) Mathematical form: This study first to calculate the Box-Cox transformation by means of the maximum likelihood estimation procedure in order to provide the comparison base. The transcendental function (also called the Cobb-Douglas technical function) is finally employed for explaining the changes in VMC participation of the farmer. As for the qualitative model for evaluating the VMC quantity trend of association, the logit is used. The appealing merits of logit technique are numerous: there is no boundary problem, it deals with the logistic probability function directly, sound theoretical justification, it allows hypothesis testing, and is good for classification purposes.

(2) High degree of multicollinearity: The higher the degree of multicollinearity, the higher the estimated standard errors of the regressive coefficient will be, and therefore the estimated coefficients tend to be insignificantly different from zero. The Belsley, Kuh, and Welsch diagnostic method is employed. This procedure follows double conditions (Belsley, Kuh, and Welsch P. 112): a. A singular value judged to have a 'large' condition index, and which is associated with b. 'High' variance-decomposition proportion for two or

more estimated regression coefficient variances.

The condition indices are the square root of the ratio of the largest eigenvalue, sometimes called the characteristic roots of each individual eigenvalue. The rule of thumb of 'large' condition indices and 'large' variance-decomposition proportions proposed by Belsley et al. are values of '30-100' and 'greater than .5' respectively (Belsley et al. p. 105).

(3) Heteroscedasticity and Weighted Regressions: Heteroscedasticity, or unequal variances, does usually occur in cross-sectional studies. To correct for heteroscedasticity, the Park-Glejser test is employed (Pindyck and Rubinfeld pp. 150-2). The procedure is first to calculate the regression residuals of individual observation (ε_i), and then use the absolute value of the residuals to estimate $|\varepsilon_i| = a + b x_i + W_i$. If two or more than two estimated parameters of independent variables are statistically significant, the linear correlation of residual $|\varepsilon_i|$ and all possible combinations of those variables revealed significantly are tested in order to decide the most proper variance. The weight is the inverse of the variance.

(4) Criteria for Choice of Independent Variables: a. Number of independent Variables: To insure model performance, the size of the obsveration has to be placed as a priority for the choice of the number of independent variable. The rule of thumb is that the observations for each independent variable be at least equal to five. The numbers of independent variables both in farmers' and associations' models are decided accordingly.

b. Economic Meaning: It means that the proposed independent variables are vital in explaining the variation of dependent variable and the sign of parameter is consistent with what is expected. If the sign of the estimated parameter violates the expectation, it could be due to a model specification error, a high degree of multicollinearity, etc.

c. Enough Dispersion: A variable is said to have limited dispersion when (mean-minimum)^/^range is not between 0.05 and 0.95. Such a variable has little chance of being declared significant. Tables 2 and 4 offer the descriptive statistics (minimum, maximum, mean, standard deviation) of each variable.

d. Goodness-of-Fit: The F-statistic of WLS is the counterpart of the likelihood ratio test statistic: $-2\ln \lambda \sim \chi^2$, where λ = likelihood ratio for Ho: $\underline{\beta} = 0$. The λ value ranges from 1 to 0 and has a smaller value as the goodness of fit improves. Therefore, both λ and McFadden's R^2 are analogous to that of $\overline{R}^2$ in WLS. The criteria of $| t | \geqq 1$ proposed by Houthakker and Taylor (1970) is employed for testing the significance of individual estimated parameters.

DATA AND VARIABLE CHARACTERISTICS

Data used in this study are from an April 1989 mail survey. The investigation was conducted primarily for this conference. Data form 44 vegetable farmers and 30 associations (including 29 farmers' associations and one cooperative farm) were collected through random selection from the regions which were executing the VMC program. Two out of 30 association samples were discarded due to their incomplete nature. Descriptive statistics of these two sample groups are respectively shown in table 2 and table 4. The variation, one standard deviation, is especially important because it makes it possible to estimate the proposed factors that explain differences in the changes of the correspondent dependent variable for both models. Only variables included in the model will be interpretated in more detail. Others could be explained accordingly.

(1) Farmer: The independent variable, PROP, represents the percentage of the individual farmer's vegetable in the

sample through VMC. Roughly 79% of the vegetables adopted cooperatives as their marketing alternative, ranges from 5% to 100%. The standard deviation of PROP 0.25, shows that about 67% of the total 44 farmers accepting VMC is between 54% and 100%. The samples' education falls in between three and twenty years. 67% farmers' education are in between four and ten years. A-PL, A-TI, and COM are indicators of farmers' attitudes toward the assembling place, the assembling time, and the service charge of the VMC. The degree of satisfaction of these three variables, in order, are A-TI, COM, and A-PL with the mean value equal to 3.89, 3.52, and 3.02, respectively on a scale of five. 67% of A-TI, COM, and A-PI are between 3.24 and 4.54, 2.12 and 3.92, and 2.50 and 4.54, respectively. The ordinal numbers from one to three are employed for the measurement of P-NE which refers to the degree of negative attitude towards VMC price in comparison with other marketing outlets. The mean and standard deviation of P-NE are 2.07 and 0.79, respectively. SUB, which used a binary variable, is the last independent variable included in the model and represents whether or not the subsidiary program is performed. The mean of the binary variable refers to the proportion of farmers taking on the particular qualitative attribute. The SUB of 0.64 indicates that 64% of the farmers expressed a positive reply.

Variables not included in the model are numerous. Their meanings are the same as those mentioned above, and are easily understood. The interpretation of PEAR, for example, is 4.16 out of 5, or approximately 78% of farmers agree with this statement. It takes roughly 6.32 days for the farmers to receive payment after selling their product. The mean value of 2.14 for QUAL implies that 2.14 out of 3, or vegetable through VMC outlet is the top 30% quality.

Table 1. Variable Definitions: Farmer

Variable Name	Description	Expected Impact
Variable in The Model		
PROP	Farmer's VMC participating rates	
EDU	Years of formal education	+
A-PL*	Satisfaction with VMC assembling place	+
A-TI*	Satisfaction with VMC assembling time	+
P-NE*	Degree of negative attitude toward the price of VMC in comparison with any others	—
COM*	Satisfaction with VMC service charge	+
SUB	1 if subsidiary program is performed in case of vegetable unable to be sold out ;0 otherwise	+
Variable not Included in The Model		
PERS*	Indicator represents competency of VMC manager	
P-DAY	How long, on average, the payment is received (Day reported)	
QUAL*	Quality of vegetable in comparison with any others	
G-PR	Guarantee price program 1---Yes 0---No	
G-PA	Guarantee payment program 1---Yes 0---No	
P-ST*	Price stability of VMC in comparison with any other3	
BUTI*	Reduced handling burden and concern time saving	
TECH*	Participating VMC is helpful to production technology	
AGE	Age of farmer (Age reported)	
SIZE	Vegetable planting size (In hectares reported)	
V/A	Porportion of vegetable return of agricultural income (% reported)	
V/T	Proportion of vegetable return of total income (% reported)	

* Data are treated as ordinal numbers from one to five. For A-PL, A-TI, P-NE, COM, BUTI, and TECH, one represents definitely disagree and five represents definitely agree. For PERS, one stands for poor, and five stands for excellent. For QUAL, one indicates the best, and five indicates the worst. As for P-ST, one represents definitely unstable, and five represents definitely stable.

Table 2. Descriptive Statistics of the Variables: Farmer

N = 44

Variable Name	Minimum	Maximum	Mean	Standard Deviation
Variable in The Model				
PROP	0.05	1	0.79	0.25
EDU	3	20	6.77	2.74
A-PL	1	5	3.52	1.02
A-TI	2	5	3.89	0.65
P-NE	1	3	2.07	0.79
COM	1	4	3.02	0.90
SUB	0	1	0.64	0.49
Variable not Included in The Model				
PERS	3	5	4.16	0.68
P-DA	1	9	6.32	1.64
QUAL	1	3	2.14	0.85
G-PR	0	1	0.52	0.51
G-PA	0	1	0.84	0.37
P-ST	1	5	3.07	1.11
BUTI	2	5	3.68	0.83
TECH	1	5	3.82	0.87
AGE	26	70	49.75	9.58
SIZE	0.1	5	1.02	0.92
V/A	0.1	1	0.59	0.27
A/T	0.1	1	0.46	0.28

(2) Association: For the purpose of this study, the dependent variable is designed as a dichotomous form -- quantity operation is INCREASE versus DECREASE. About 79% of the associations indicate positive response, i.e., reveal that the annual VMC quantity is increasing over time. The independent variables include WOK (work experience in agriculture of VMC manager), PROF (profit rate of VMC), SCAL (relative tillage size of VMC farmer in comparison with otherwise), P-DAY (length of payment), G-PA (guarantee payment program). The work experience variable was defined as number of years engaged in an agricultural job of VMC manager, for the purpose of discerning whether or not work experience in agriculture affects the growth of the VMC. The managers, on average, have about twelve years experience in agriculture, ranging from one to thirty-seven years. The profit rate of the VMC is about 3.55%, ranging from zero to ten percent. The tillage area of the VMC farmer is slightly smaller than that of otherwise, with the indicator 2.71 on a scale of five. The result indicates that small farmers have a higher probability of selecting cooperatives for marketing their vegetables. The P-DA of 6.25 indicates that it takes farmers 6.25 days to receive their payment. The fastest time is four days, and the slowest is, however, 10 days. The mean value of 2.79 for G-PA, implies that 2.79 out of 3, or roughly 93% of associations carry out guarantee payment programs.

The interpretation of variables not in the model, for example, is that the manager's age is about 39.36 years old, has received 13.39 years of education, and spends 3.3 hours per day doing work other than for the VMC. Approximately 39% of the vegetables that pass through the VMC are in the respondent's county. The mean value of G-PRI and A-PAY are 1.86 and 1.50, and indicate that roughly 62% and 50%, respectively, carry out guarantee price, and advanced payment programs. The quantity of VMC's in the summer is

about 58.82% of that of the winter season due to over supply nature and relatively low prices in the winter.

Table 3. Variable Definitions: Association

Variable Name	Description	Expected Impact
Variable in The Model		
OPER	1 if operate quantity of VMC is increased over time;0 if decreased	
WORK	Years engaged in agricultural work of VMC manager	+
PROF	Profit rate from executing VMC (% reported)	+
SCAL	Relative tillage size of VMC farmer is larger than those choosing other marketing alternatives (Employ ordinal numbers from one to five. One represents definitely agree, and five represents definitely disagree)	?
P-DA	Number of days after assembling that farmer is paid (Days reported)	—
G-PA	Guarantee payment 1. No 2. Around 50% 3. Yes	+
Variable Not Included in The Model		
AGE	Age of VMC manager	
EDUC	Years of formal education of VMC manager	
YEAR	Years of association in sponsoring VMC	
O-JOB	Manager works at other jobs besides VMC (Hours per day)	
Q-SA	Quantity of VMC production as a proportion of total vegetable supply (% reported)	
G-PRI	Guarnatee price program 1. No 2. Around 50% 3. Yes	
A-PAY	Advanced payment program 1. No. 2. Around 50% 3. Yes	
S/W	Summer season's quantity of VMC as a proportion of winter season's quantity of VMC (% reported)	

Table 4. Description Statistics of the Variables: Association

N = 28

Variable Name	Minimum	Maximum	Mean	Standard Deviation
Variable in the Model				
OPER	0	1	0.79	0.42
WORK	1	37	12.14	11.42
PROF	0	10	3.55	2.61
SCAL	1	5	2.71	0.94
P-DA	4	10	6.25	1.76
G-PA	1	3	2.79	0.50
Variable not Included in the Model				
AGE	25	60	39.36	9.89
EDUC	11	18	13.39	1.91
YEAR	2	21	10.39	5.35
O-JOB	0	8	3.30	2.20
Q-SA	5	80	39.11	24.30
G-PRI	1	3	1.86	0.59
A-PAY	1	3	1.50	0.64
S/W	5	100	58.82	28.34

EMPIRICAL MODELS AND RESULTS OF THE ANALYSIS

The proposed statistical models are as follows:

(a) Model of Expolaining Farmer's VMC Participation proportion

$$\ln PRO = \alpha + \alpha_1 \ln EDU + \alpha_2 \ln A\text{-}PL + \alpha_3 \ln A\text{-}TI + \alpha_4 \ln P\text{-}NE + \alpha_5 \ln COM + \alpha_6 SUB \quad \text{i.e.,}$$

$$PROP = e^{\alpha_0}(EDU)^{\alpha_1}(A\text{-}PL)^{\alpha_2}(A\text{-}TI)^{\alpha_3}(P\text{-}NE)^{\alpha_4}(COM)^{\alpha_5} e^{\alpha_6 SUB}$$

(b) Model of Interpretating Binary Changes of Association's VMC Quantity

$$OPER = \beta_0 + \beta_1 WORK + \beta_2 PROF + \beta_3 SCAL + \beta_4 P\text{-}DA + \beta_5 G\text{-}PA$$

Table 5 shows the weighted least square estimates and the corresponding t-ratios for explaining the variation of the proportion of farmers participating in VMC's. The joint null hypothesis is rejected due to the calculated F statistic (6.46) exceeding the correspondent critical value (2.32). All estimates are also significantly different zero. The education level of the farmer is significant because it implies that the more educated farmer has a higher probability of choosing a VMC than the less educated farmer, ceteris paribus. This result shows the importance of education, which does generate a positive influence on the respondent's attitude toward VMC's. The results for both assembly variables were intuitively feasible. Farmers are generally spatially diffused,

and their satisfaction toward the assembly place and time are vital concerns that influence the decision to select VMC. The negative effect of P-NE on VMC is easily understood. The relative price level between cooperative marketing and otherwise is the dominant factor and has to be placed as a priority for accelerating the growth of VMC programs. Associations' service expenses charged is also an important reason with the second largest t-ratio, indicating a sensitive responsiveness of choosing VMC's to the changes at the service charge level. Finally, the subsidiary program does positively influence the choice of VMC outlet. The associated t-ratio is the least important one in the model, however.

The above six variables have proved to be vital according to modeling results. Because it is a transcendental form, the estimated parameters just represent elasticity of individual variables. The 0.294 of EDU, for example, indicates that as length of farmer's education increases 10%, the probability of choosing a VMC is expected to increase 2.94%. Similarly, a 10% increase in satisfaction concerning assembly place and assembly time raised the probability of participation in a VMC 4.03% and 5.36%, respectively. P-NE is the most distinguished variable. The response is a 6.61% increase in participation probability in response to a 10% reduction in the belief that the relative price of a VMC is lower than otherwise. The VMC participation probability is expected to increase 4.82% as an association's service charge mounts by 10%. The positive influence is 2.27% in response to a 10% increase in carrying out a subsidiary program (SUB).

Table 5. Weighted Least Square Results Explaining the Proprotion of Farmers Participating in VMC*

Independent Variables	Estimates	T-ratios
EDU	0.294	1.190
A-PL	0.403	1.604
A-TI	0.536	1.283
P-NE	-0.661	-2.665
COM	0.482	1.982
SUB	0.227	1.025
F**	6.46	
$\overline{R}^2$	0.43	

* Weight (δ) = 0.3714 − 0.054 A-PL
(4.983) (−2.697)

**F (0.05, 6,44) = 2.32

The association's logit likelihood model was maximized by the Newton-Raphson iterative procedure (Judge et. al. p. 733). The procedure was terminated as soon as the estimated coefficients ratio was less than the convergence tolerance. The likelihood ratio tests, $-2\ln \lambda = 16.99$, is significant at the 5% level (the critical $\chi^2 = 11.07$). The percentage of right prediction is 85.9% and is quite acceptable. Instead of R^2 or $\overline{R}^2$ in the quantitative model, the McFadden's $R^2 = 0.58$ is evaluated. This indicator was judged more approriate in interpretating the explanatory ability of independent variables in the variation of qualitative dependent variables. According to Houthakker et. al.'s criterion ($|t| \geqq > 1$), all of the independent variables are statistically significant. Four out of five indepdnent vaiables

are statistically significant. Four out of five independent variables except P-DA do have a positive impact on the probability of the upward trend of VMC quantity. These four variables are: the work experience in agriculture of the VMC manager, the profit rate, the tillage size, and the guarantee payment program. Results of the finding imply that the longer the work experience in agriculture of the VMC manager, the greater the probability of increasing the quantity of VMC's. Guarantee payment is the leading variable in affecting the association performance due to its biggest absolute elasticity value. The elasticity of G-PA at mean value indicates that for a 10% increase in guarantee payment program, the probability of the upward trend of VMC quantity is anticipated to be increased by 9.7%. More precisely, as the guarantee payment program increases from the sample mean value, 2.79 on a 3.0 scale, to 3.0 (an increase of about 7.5%), the upward trend of VMC quantity, in terms of simulated probability, will be raised from the current mean, 79% to 84.8%, ceteris paribus. As expected, that the estimated coefficient of payment day is negative reveals that farmers' concerns very definitely affect their decision so as to influence the association's performance level.

Table 6. Maximum Likelihood Coefficients of Logit Model Interpretating the Changes of Association VMC Quantity

Independent Variables	Estimates	Asymptotic T-Ratios	Elasticities at mean
WORK	0.694	1.618	0.171
PROF	0.872	1.287	0.063
SCAL	2.465	1.379	0.136
P-DA	-1.156	-1.389	-0.147
G-PA	17.115	1.421	0.970
CONSTANT	-54.785	-1.423	--
-2ln λ *		16.99	
Degree of freedom		5	
McFadden's R^2		0.85	
Percentage of right predictions		0.860	

* $\chi^2(0.05, 5) = 11.07$

SUMMARY AND CONCLUSIONS

Vegetable farmers are quite vulnerable since price elasticities of both demand and supply are generally small, and are subject to high price and quantity risk with changing demands and production conditions. The synergy (the so-called "2+2=5" effect) through VMC's has become an incentive for reducing the inherent weakness of the vegetable farmer who operates as an individual in the market (Barker p. 117). The exploration of the farmer's VMC participation employing weighted least square procedure and the investigation of the VMC quantity trend of the association using

maximum likelihood logit analysis are proposed in order to evaluate the performance of the VMC program. Results of this study show that (1) When the price differential between a VMC and other alternatives is wider, the probability that a farmer will choose the VMC decreases; (2) Education level, assembly place, assembly time, the amount of service charge, and the executing of subsidiary programs are likely to generate a positive impact on farmers' intentions concerning the selection of VMC's as their vegetable marketing outlet; (3) The performing of guarantee payment programs does contribute significantly to the quantity operation trend of the association; (4) The more work experience in agriculture of the VMC manager, the higher VMC profit rate, the smaller the farmer's tillage scale, and the shorter the payment day are all likely to favor the growth of associations' operation of VMC's.

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台灣蔬菜共同運銷之績效：橫斷面研究之證據

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摘 要

本文旨於推估以下課題：(1)影響蔬菜農民選擇共同運銷的理由；(2)探討農會（合作農場）之蔬菜運銷量何以改變。採用民國 78 年 4 月間之郵寄資料，包括農民 44 戶和農會（合作農場）28 戶樣本。主要發現：(1)共同運銷價格較之其他出售方式價格爲低，若價差擴大，農民選擇共同運銷之機率預期減少；(2)蔬菜農民之教育水準、集貨地點、集貨時間以及手續費之多寡對選擇共同運銷之意願均有正面關係；(3)保證付款與否對農會（合作農場）蔬菜營運量有顯著性影響；(4)承辦人員之工作經驗增加、共同運銷之利潤率提高、個別農戶蔬菜種植面積減少以及付款期限縮短均對農會（合作農場）營運量之成長有助益。

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