A Micro-Analysis of U.S. Vegetable Market Penetration In International Markets

by

Gregory A. Ashley
Graduate Assistant
Agricultural Economics Department
University of Georgia
Athens, GA 30602

James E. Epperson
Associate Professor
Agricultural Economics Department
University of Georgia
Athens, GA 30602

Increased shares of foreign markets would help boost the sagging domestic farm/agribusiness economy since the welfare of American farmers and foreign consumers has become closely tied together (Mackie). Mackie also notes that the amount of total U.S. production exported and the amount of acres planted have more than doubled in the past two decades, implying that the maintenance of acceptable farm income levels will be difficult to achieve without continued expansion and growth of export markets. Ames et al. also note the significance of expanded agricultural exports in bolstering a sagging farm economy since the producers of export commodities are a primary beneficiary of international trade, and increased markets for agricultural products translate into higher farm income.

However, there exists a multitude of barriers for commodities in the world market which are not as prominent in the domestic market. For instance, increased transportation difficulties, lack of current and/or accurate information, language and labeling differences, varying governmental policies and restrictions, and cultural acceptance are but a few of the increased barriers complicating export markets. Although most companies do not expect extremely high returns per dollar invested in foreign market development, very little information is available on the effectiveness of these expenditures (Jones).

This study entails a firm level analysis of these factors in order to determine their relative contributions and significance upon the international trade of vegetables to provide information for producers, processors, and marketers to facilitate the evaluation of future marketing alternatives. Specifically this is to be accomplished through a multiple linear discriminant analysis of data obtained from a survey of foreign importers of vegetables and vegetable products. The data are divided into four groups consisting of: 1) the European Economic Community (EC), 2) non-EC European countries (EU), 3) Asian countries (AS), and 4) Latin American countries (LA). Discriminant analysis will then be applied to distinguish those factors differentiating firms among the geographical regions. Conclusions, implications, and recommendations will be inferred from this analysis.

Data Base

The data utilized in this analysis were collected through a mail survey of foreign importers conducted in the fall of 1985. Return postage costs were prepaid. The names and addresses of these firms were obtained from the U.S. Department of Agriculture (USDA), Foreign Agricultural Service (FAS). Of 2,017 mailed surveys, 131 responses were received of which 68 surveys were incomplete. Therefore, 63 responses were available for this analysis. The distribution of completed surveys, by region and country, is shown in Table 1.

Linear Discriminant Analysis

Discriminant analysis is a statistical technique facilitating the analysis of differences between groups with respect to several variables simultaneously. The basic assumptions are (Klecka):

1) the data cases should be members of two or more mutually exclusive groups,

2) the variables should be measured at the interval or ratio level,

3) the number of cases must exceed the number of variables by more than two,

4) no variable may be a linear combination of other discriminating variables,

5) population covariance matrices must be equal for each group,

6) there must be at least two cases per group, and

7) each group should be drawn from a population with a multivariate normal distribution on the discriminating variables.

Assumption number 2 was violated since many factors had to be measured as categorical variables. However, several studies have noted the ability of discriminant analysis to function well under these conditions (Kranowski; Gilbert; Moore; Revo).

Discriminant analysis performs two major analyses: 1) a discriminatory analysis between groups based upon a set of characteristics, and 2) a classification procedure which combines the group characteristics for the purpose of identifying the group which a case most closely resembles.

In order to analyze the nature of group differences canonical discriminant functions are derived. These functions are linear combinations of discriminating variables and are represented as:

(1):

$$f_{km} = V_0 + V_1X_{ikm} + V_2X_{2km} + \ldots + V_pX_{pkm}$$

where:

f_{km} = the value of the canonical discriminant function for case m in group k,

X_{ikm} = the value of the discriminating variable X_i for case m in group k, and

V_i = the standardized coefficients which produce desired characteristics in the function.

The standardized coefficients (V's) are derived such that the group means are as different as possible. The coefficients for the second function are also derived such that the group means are as different as possible, given the values for the second function are not correlated with the values of the first function. Other functions can be derived under the same criteria provided that the number of functions are at least one less than the number of groups or the number of discriminating variables, whichever is smaller. Specifically this is accomplished by solving the simultaneous equations defined by:

Table 1

Countries From Which Responses Were Received and Number of Responses According to Geographic Region

European Economic Community	Europe Non-EC	Asia	South America and the Caribbean
Denmark (2)	Austria (4)	Hong Kong (1)	Chile (1)
France (1)	Norway (3)	Japan (7)	Columbia (3)
Greece (2)	Spain (2)		Ecuador (1)
Italy (1)	Sweden (3)		Guatemala (1)
Netherlands (4)	Switzerland (6)		Mexico (2)
U.K. (13)			Peru (1)
West Germany (2)			Trinidad (1)
			Venezuela (1)

$$\Sigma b_{1i} V_i = \lambda \Sigma W_{1i} V_i$$

$$\Sigma b_{2i} V_i = \lambda \Sigma W_{2i} V_i$$

. .
. .
. .

$$\Sigma b_{pi} V_i = \lambda \Sigma W_{pi} V_i$$

where:

b_{pi} = the elements of the between-groups sums of squares and cross products matrix,

W_{pi} = the elements of the within-group sums of squares and cross products matrix,

V's = a set of p coefficients, and

λ = a constant called the eigenvalue.

In order to obtain unique solutions, the sum of the squared values of the V's must equal one. There are a maximum of q (maximum number of functions) unique, nontrivial solutions to these equations. Each solution yields its own λ and set of V's, and corresponds to one canonical discriminant function (Klecka).

The meaning of the derived canonical discriminant functions is determined by studying the relative locations of the data cases and group centroids (grand function means) and by analyzing the relationships between different variables and the functions. There are also several statistics which are useful in determining the relative importance of the canonical functions' discriminatory power (Lower):

(1) the eigenvalue - a measure of the functions' discriminatory power (the greater the eigenvalue the greater the discrimination),

(2) the relative percentage - a percentage derived from the eigenvalue representing the relative discriminatory power of each function to the total discriminatory power all the functions (the larger the relative percentage the more important the function relative to others),

(3) the canonical correlation - the degree of relatedness among the groups and the discriminating variables,

(4) Wilk's Lambda - a multivariate measure of group differences over several variables representing the degree of separation among group centroids, and

(5) Chi-square - utilized to measure the significance of Wilk's lambda.

Based upon the information obtained by the canonical discriminant functions a classification procedure is employed which maximizes group differences while minimizing the variation within the groups. The classification functions are derived as a linear combination of the following form:

(3):

$$C_k = a_{k0} + a_{k1}X_1 + a_{k2}X_2 + \ldots + a_{kp}X_p$$

where:

C_k = the classification score for group k,

a's = the coefficients derived to satisfy the specified conditions, and

X_p = the value of variable p.

The values of variables for each case are substituted into the classification function, and the case is then classified into the group indicated by the function yielding the highest classification score.

Although classification is typically used to predict membership for cases associated with unknown group membership, it can also be utilized indirectly to confirm the degree of group separation (Klecka). A high degree of separation among the groups is substantiated when the classification procedure significantly outperforms random assignment.

Results of the Discriminant Analysis

In order to facilitate analysis, the data were divided into three categories. These included: 1) company organization, background and attitudes, 2) experience with U.S. suppliers (exporters), and 3) general marketing information. The contributing variables for each section were:

1) Company organization and background:

X1 - dummy variable representing whether or not the importing firm was an intermediary/broker,

X2 - dummy variable reflecting whether or not the head of the company made the decision for an import purchase,

X3 - dummy variable indicating whether or not the final buyer of the commodity made the decision for an import purchase,

X4 - the annual volume of the importing firm specified in metric tons (MT),

X5 - dummy variable denoting whether or not the importing firm is predicting the expansion of vegetable imports,

X6 - dummy variable reflecting whether or not the importing company is planning to maintain current vegetable import levels,

X7 - the percentage of the firm's total domestic vegetable sales that is imported,

X8 - the percentage of the importing firm's total domestic sales which is imported from the United States.

2) Importing firms' experience with U.S. suppliers (exporters):

X9 - dummy variable reflecting importing companies having marginal experience with new U.S. exporters of fresh vegetables,

X10 - dummy variable denoting importers indicating satisfactory experience with new U.S. exporters of processed vegetables,

X11 - dummy variable representing those foreign importers expressing marginal satisfaction with new U.S. exporters of processed vegetables,

X12 - dummy variable reflecting those foreign importers indicating less than satisfactory experience with new U.S. export sources of processed vegetables.

3) General marketing information:

X13 - dummy variable denoting those foreign importers who chose price as a criteria in selecting new import suppliers,

X14 - dummy variable reflecting those importers who listed reliability, reputation, and established companies as criteria in selecting new import suppliers,

X15 - dummy variable indicating importers who listed many criteria (excluding price) for selecting new import suppliers,

X16 - dummy variable representing importers who obtain primary international market information from trade publications and wire services,

X17 - dummy variable denoting those importers utilizing multiple sources for international market information,

X18 - dummy variable indicating importing firms stating the price of vegetable imports is determined by comparing the price among exporters,

X19 - dummy variable reflecting whether or not restrictions are imposed on

vegetable imports (in addition to tariffs)

X20-dummy variable showing whether or not importers always favor the elimination of tariffs, duties, and restrictions,

X21-dummy variable denoting whether or not importing firms believe promotional activities are effective in increasing sales of little known vegetables.

As shown in Table 2, the measurements of the discriminant functions indicate that over 80 percent of the power of the discriminant model is accounted for by the first and second functions. Canonical correlation values of 0.93 and 0.89 for the first and second functions, respectively, indicate a high degree of relatedness between the groups and the discriminating variables. This relationship implies that the functions are good discriminators as are the discriminating variables. Wilk's lambda values of 0.009 for the first function, and 0.06 for the second function further substantiate the significant discriminant power of the functions. The significance levels associated with the chi-square values for functions 1 and 2 were 0.01 and 0.07, respectively.

The ability of the model to discriminate among the four geographical regions is further substantiated by the results of the classification procedure summarized in Table 3. The procedure correctly classified the cases 93.94 percent of the time. The chi-square value and associated significance level show that the procedure greatly outperformed random classification.

The relative contributions of the factors (defined earlier) can be assessed when combined with univariate statistics depicting the percentage response rates for the geographic regions for each variable, which were derived from the total sample size of 63 cases. Preliminary to this it is interesting to examine a question from the survey which was not included in the discriminant analysis due to a marginal response rate (approximately 49%). This question asked "how U.S. exporters might adapt to better suit importing firms' needs." Inspection of simple univariate statistics reveals notable differences. For instance, 50 percent to 75 percent of the respondents from the EC, non-EC Europe, and Latin America suggested that U.S. exporters should decrease prices and costs of exports. Conversely, Asian importers (66.7%) suggested an increase in the quality of exports and more market interest and market knowledge.

These responses are quite interesting when coupled with most of the variables found to contribute by the discriminant analysis. A definite pattern emerges exhibiting a polarization of the responses of Asian firms versus the other three regions. For example, the percentage of respondents indicating that they were intermediaries/brokers (X1) ranged from 16.7 percent to 20 percent for the EC, EU, and LA regions; however, respondents in the AS region reported no firms of this nature. The greatest percentage of Asian firms were importers (50%) and the types of businesses specified by the other three regions tended to be more diversified. Similar results were found with the "decision power for an import buy." Respondents of the EC, EU, and LA reported this power to be vested in the head of the company (X2) almost three times more often than Asian firms. The greatest percentage of Asian firms noted this power to be controlled by the head of the importing department. Asian firms reported no restrictions (X19), although import regulations are in force on vegetable imports, while 28 percent of the EC firms, 56 percent of the EU firms, and 67 percent of the LA firms indicated that some restrictions were in effect for imports. Of the firms in the four regions predicting expanded import activity (X5), those in Asia substantially differed from the other three regions with 87.5 percent indicating increased future imports. Those predicting expanded imports in the other regions were: the EC, 60 percent; EU, 55.6 percent; and LA, 33.3 percent. Closely related is the percentage of those companies planning to maintain current import levels (X6). These were: EC, 36 percent; EU, 44.4 percent; LA, 41.7 percent; and AS, 12.5 percent.

Table 2

Results of Discriminant Analysis

Variable[a]	Function 1	Function 2
	Standardized Canonical Discriminant Function Coefficients	
X1	-0.96[b]	0.87[b]
X2	0.76	0.54
X3	0.67	-0.19
X4	0.67	-0.41
X5	1.09[b]	2.72[b]
X6	1.15[b]	3.03[b]
X7	-0.49	-0.11
X8	0.27	-0.72[b]
X9	1.36[b]	-0.37
X10	0.75	-0.40
X11	-0.86[b]	-0.20
X12	0.74	0.09
X13	1.52[b]	0.44
X14	0.78	-0.38
X15	1.08[b]	-0.45
X16	-0.93[b]	-0.43
X17	0.53	-0.16
X18	-0.29	0.03
X19	-0.54	-0.33
X20	0.30	1.23[b]
X21	1.54[b]	-0.17
Group centroids[b]		
EC	-1.77	1.16
EU	1.55	0.76
AS	4.67	-1.06
LA	-1.88	-3.92
Function measurements[c]		
Eigenvalue	5.96	3.66
Relative percentage	49.98	30.76
Canonical correlation	0.93	0.89
Wilk's lambda	0.009	0.06
Chi-squared	91.14	53.30
Significance	.01	0.07

[a]The variables are defined in the text.

[b]Major contributing variables.

[c]Thirty-three cases were used in this analysis since 30 cases had at least one missing discriminant variable.

Table 3

Classification by World Region

Actual Group	No. of Cases[a]	Predicted Group Membership			
		EC	EU	AS	LA
Group EC	14	12	2	0	0
		87.7%	14.3%	0.0%	0.0%
Group EU	10	0	10	0	0
		0.0%	100.0%	0.0%	0.0%
Group AS	4	0	0	4	0
		0.0%	0.0%	100.0%	0.0%
Group LA	5	0	0	0	5
		0.0%	0.0%	0.0%	100.0%

Percent of "Grouped" cases correctly classified: 93.94%[b]

Chi-square 83.65
Significance 0.005

[a]Thirty-three cases were used in this analysis since 30 cases had at least one missing discriminant variable.

[b]The classification procedure was performed on the observations used in the formulation of the discriminant functions and is utilized as an additional measure to confirm indirectly the degree of the group separation differentiated by the discriminant functions (as suggested by Klecka), and not as a prognosticative measure. When classification is applied as a forecasting tool, a lower percentage of correct classifications should be expected. This was noted when mean values were substituted for missing values during classification, resulting in a 66.67 percent correct classification rate over all 63 cases.

The responses from Asian importers also differ from the other regions as to their experience with new U.S. supply sources. Of importers reporting marginal satisfaction with U.S. suppliers for fresh vegetable imports (X9), Asian firms made up a slightly higher percentage--12.5 percent as compared with the other three regions' 4 percent to 8 percent. For processed vegetables, most Asian firms responded in the range of least satisfaction and greatest dissatisfaction with new U.S. supply sources (X10-X12).

Three variables were found to contribute concerning the criteria used by importing firms to select new import suppliers. Price (X13) was noted as the primary criterion by 20 percent of the respondents from the EC and by 9 percent from LA. No firms in AS or EU selected price as the primary criterion. Additionally, reliability, company reputation, and established companies (X14) were selected as criteria by 10 percent to 20 percent of the respondents in the EC, EU, and LA. None of the Asian firms reported these as requirements. The vast majority (85.7%) of Asian firms stated they utilized many criteria in the selection of new import suppliers (X15), while only 9 to 15 percent of firms in the other three regions listed many criteria. It is interesting to note that, of all responses for this question, 27 percent of the LA importers, 46 percent of the EU importers, and 50 percent of the EC importers explicitly listed price as a criterion, while only 14 percent of the Asian firms did so.

None of the AS or LA importers noted publications and wire services (X16) as their primary means of obtaining international market information, although roughly 12 percent of EU firms and 22 percent of EC firms did so. Of those firms utilizing many informational sources (X17) the percentage of Asian companies (75%) was more than twice that for each of the other three regions (each approximately 35%).

One contributing variable related to the methods of determining the price of imported vegetables was revealed. Forty-four to 67 percent of the respondents in the EC, EU, and LA noted that they compared prices among exporters (X18). Only 12.5 percent of the AS companies provided this response. Seventy-five percent of the AS importers noted either market forces (37.5%), or they set the price (37.5%) of imports.

Approximately 71 to 77 percent of the respondents in the EC, EU, and AS said that they would always favor the elimination of tariffs, duties, and restrictions (X20). This was roughly twice the number of those in LA. Respondents in all four geographic regions thought promotional activities were effective in increasing the sales of little known vegetables (X21); however, the percentage of EC firms responding favorably was somewhat smaller (EC, 66.7%; 84.3% to 94.1% for the other regions).

The annual volume (X4) of imports revealed median responses of: EC, 600 MT; EU, 769 MT; AS, 260 MT; and LA, 160 MT.

The variable reflecting the percentage of total domestic sales imported by the firms (X7) contributed to the model. The respective median percentages were: EC, 100 percent; EU, 100 percent; AS, 85 percent; and LA, 65 percent. The percentage of total domestic sales imported from the United States (X8) also contributed significantly to the discriminant model. The reported median percentages differentiated AS (12.5%) and LA (20%) from the EC (1.5%) and EU (1%).

Inspection of the discriminant analysis and univariate responses clearly show that differences exist among the market infrastructures of the four geographic regions. Many of these differences may suggest shifts in future trends of U.S. exports of vegetables. Recognition and dissemination of information regarding these trends would aid in future U.S. production, processing, and marketing decisions.

Conclusion

Although the discriminant analysis found differences among all four geographic regions, the polarization observed for the responses of Asian firms versus the other three regions holds the strongest implications for the future

direction of U.S. vegetable exports. These findings suggest that the greatest potential for growth of U.S. exports could be in Asia. This is based on several factors: 1) the percentage of Asian firms predicting increased imports, 2) a lack of emphasis on the price of imports by Asian importers, 3) an emphasis on the price of imports by the other three regions, 4) the ability of U.S. farmers and agribusiness to adapt to the suggested changes of Asian importers (higher quality, more interest, and greater knowledge of markets) despite the current level of dissatisfaction expressed by these importers, and 5) the relative inability of U.S. farmers and agribusiness to decrease the international price of vegetable exports, as was predominantly suggested by the EC, EU, and LA.

Additionally, the least potential for growth of U.S. vegetable exports could be in Latin America. This is primarily due to the low percentage of Latin American firms predicting increased imports and a protectionist attitude. Greatly intensified efforts, both public and private, on behalf of exporters to stimulate trade with Asia are necessary to build and sustain long-term trade relationships. Of central importance is a greater understanding of specific Asian markets and a commitment to establish and maintain long-term relations. Trade delegations, governmental or otherwise, could be successful in promoting exports; research could help provide insight into the specific needs of Asian markets.

The conclusions and implications drawn from this analysis cannot be strongly asserted due to the limitations of this analysis, primarily from a small sample size of both total responses and responses from the Asian region. Additionally, most of the Asian responses were from Japan, resulting in a possible bias reflecting Japanese attitudes. The lack of responses from other world regions (Africa, the Middle East, and the like) is also a limiting factor.

In summary, opportunities exist for the United States to increase its share of the world market for vegetables. Possibilities could be found in all four geographic regions; however, the Asian market (especially Japan) could hold the greatest promise. This analysis differentiated several factors influencing the international trade of vegetables, although not conclusively. Certainly, continual efforts will be required in order to establish and sustain successful long-term trade relations.

References

[1] Ames, G. C. W., F. C. White, R. S. Glover, and D. H. Carley. "Georgia's Role in International Agricultural Trade: An Economic Perspective." Univ. Georgia Col. Agri., Ext. Agr. Econ. Dep., Agr. Econ. Rep., 1, 1 (1985):1-14.

[2] Gilbert, E. S. "On Discrimination Using Qualitative Variables." *J. Amer. Stat. Assoc.*, 63 (1968):1399-1412.

[3] Jones, J. W. "An Economic Evaluation of Foreign Market Promotion Expenditures for Selected Agricultural Commodities." Masters Thesis, Clemson University, 1984.

[4] Klecka, W. R. *Discriminant Analysis.* Sage University Paper Series on Quantitative Applications in the Social Sciences, 07-019, Sage Publications, Beverly Hills and London, 1980.

[5] Krzanowski, W. J., "The Performance of Fisher's Linear Discriminant Function Under Non-Optimal Conditions." *Technometrics*, 19, 2 (1977):191-200.

[6] Lower, M. E. "A Discriminant Analysis of the Grain Merchandising Industry's Structure for Three Regions (Western Corn Belt, Eastern Corn Belt, and South)." Masters Thesis, Ohio State University, 1982.

[7] Mackie, A. B. "The U.S. Farmer and World Market Development." ERS Staf. Rep. No. AGES 830810, IED, ERS, U.S. Dep. Agr., Washington D.C., 1983.

[8] Moore, D. H. "Evaluation of Five Discrimination Procedures for Binary Variables." *J. Amer. Stat. Assoc.*, 63 (1968):399-404.

[9] Revo, L. T. "On Classifying with Certain Types of Ordered Qualitative Data: An Evaluation of Several Procedures." Ph.D. Dissertation, University of North Carolina, Chapel Hill, 1970.