How Agricultural Economists Increase the Value of Agribusiness Research

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Abstract

Historically, there has been declining cooperation between agribusiness firms and agricultural economists. In new product marketing research, firms tend to conduct their own analyses, partially due to confidentiality, usually consisting of simple univariate or bivariate statistics such as chi-squared tests of independence. The primary objective of this paper is to demonstrate, through a case study, one way in which agricultural economists can add value to agribusiness firms' research. Results from the econometric model offer a richer explanation of consumer behavior and may be more useful to agribusiness firms.

Introduction

Company X is an agribusiness firm that wants to introduce a product that is new to its brand, but would have to compete with established firms in the meat segment. Nearly 22,000 products are introduced in supermarkets, drugstores, mass merchandisers, and health food stores each year and an estimated 33 to 90 percent of these new products are failures (Peter and Donnelly, 2003). In an effort to decrease product failure, Company X must conduct a significant amount of research on the size, preferences, and requirements of the market it plans to enter and successfully identify the consumers that are willing to purchase the product (Hoffman, 1969). This research examines the assistance agricultural economists can provide agribusiness firm(s), such as Company X, through analyzing critical market information with the use of econometric analyses.

Historically, there has been declining cooperation between agribusiness firms and agricultural economists. According to Hoffman (1969), the majority of published agricultural research focuses on agricultural policy, international aid, and development, which are areas that are of little interest to agribusinesses. Shaffer suggests that university research is not useable by agribusiness firms because it is usually dated once published or irrelevant for decision making (as referenced in Dodson and Matthes, 1971). As a result there is little coordination between agricultural economists and agribusinesses, firms tend to conduct their own analyses usually consisting of the simple univariate or bivariate statistics such as, chi-squared test of independence. The chi-squared test

analyzes the frequencies of two variables with multiple categories to determine if the two variables are independent. This statistical test and similar techniques are often deemed less "pure" by economists in academia (Scroggs, 1975). It is believed that if firms solicit technical assistance from agricultural economists, both entities will benefit from the collaborative effort (Dodson and Matthes, 1971 and Scroggs, 1975). Agricultural economists can provide firms with model-oriented analyses that supply the firm with market intelligence that allows the firm to make business decisions more efficiently and effectively. Likewise, working with firms provides economists with an opportunity to observe how the economy actually functions (Scroggs, 1975).

The primary objective of this paper is to demonstrate, through a case study, one way in which agricultural economists can add value to agribusiness firms' research. Using proprietary data, this paper will compare the results from an econometric analysis versus the chi-squared test of independence. It is believed that variables with a significant relationship based on the chi-squared analysis of independence may not demonstrate significance when analyzed by the econometric model. Thus, the null hypothesis is as follows: All variables that exhibit a statistically significant relationship with the dependent variable using the chi-squared approach will also be significant in the econometric model. Additionally, it is assumed that the results from the econometric analysis will provide Company X with valuable information which allows it to identify the target market and develop product positioning strategies more successfully. Secondly, this study aims to identify the benefits both parties can reap from their cooperative efforts.

Literature Review

Several studies have analyzed the factors that impact the decision to consume meat products. These studies can provide information on strategies that may assist Company X in dissecting the meat market and developing market strategies. Hui et al. (1995) rated the importance of 12 selected meat attributes, which included low fat content, low sodium content, low cholesterol, lack of

chemical additives, taste, red meat, white meat, appearance, price, freshness, USDA labels, and tenderness, among various demographic, geographic, or socioeconomic characteristics. According to the results, retailers, wholesalers, and processors should develop a marketing plan that emphasizes the tastiness, appearance, and freshness of the meat and include recipes when promoting meats. In addition, the marketing channels should minimize transportation and holding time to ensure freshness.

Melton et al. (1996) conducted experimental auctions to evaluate the significance of attributes and how to develop effective marketing plans for pork. The willingness to pay results suggested that the appearance of the meat is most important for first-time buyers and repeat purchasers were interested in the pork chop's taste. Melton et al. (1996) concluded that first-time buyers of fresh pork chops may be misled by relying on appearance when making purchases, and selecting chops that were less desirable when eaten. As a result, theses consumers were unlikely to make repeat purchases, hampering the product's long term market success.

Data

The data were collected by a research firm in the fall of 2005. Using a combination of sensory evaluation and written surveys, in two cities, a total of 94 respondents were probed with the goal of developing an understanding of how, when, where, how-often, and why, the participants purchase the meat product that Company X desires to introduce. All participants met criteria set forth in a screener questionnaire developed by the marketing firm in conjunction with Company X. These criteria included age (25-65), gender (approximately half of the participants were female, half male), and recent consumption of similar products.

In addition to providing information on the nature of the purchases through a survey, taste test evaluations were conducted in which the participants discussed and ranked four products, which consisted of the prototype, the leading competitor, the secondary competitor, and the black label

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competitor. After consuming each product, the participants rated each product based on various meat attributes (i.e. appearance, juiciness, tenderness, etc.) and ranked each sample from the most preferred to the least preferred.

Model Specification

Ordered probit models estimate the probability of the ordered qualitative dependent variable, y, occurring given K observable, explanatory variables. Ordered probit analysis requires that each of the observations on y_i is statistically independent of each other and that there is no exact linear dependence among $\mathbf{x}_{ik}$'s (Aldrich and Nelson, 1984). The expected outcomes of the dependent variable, y_i, are considered to be mutually exclusive and exhaustive (Gujarati, 2003).

An ordered probit model is used to estimate the effect of various demographic, socioeconomic, psychographic characteristics and preference variables on the consumers' willingness to purchase Company X's new product. The model assumes that a consumer's personal utility function U is a latent variable, and is observed through y_i, which is obtained from the survey. Ordered probit models can be defined as follows:

$$U_i = \chi_i' \beta + \varepsilon_i, \ \varepsilon_i \sim NID(0, \sigma^2)$$

$$y_i = 0 \text{ if } U_i \leq \mu_0$$
$$= 1 \text{ if } \mu_0 < U_i \leq \mu_1,$$
$$= 2 \text{ if } \mu_1 < U_i.$$

The μs are unknown threshold parameters which separate the adjacent categories and are estimated with the βs. The probability that an observed outcome is in a category is observed as follows:

$$P(y_i = 0) = \Phi(-\mathbf{x}_i' \beta)$$
$$P(y_i = 1) = \Phi(\mu - \mathbf{x}_i' \beta) - \Phi(- \mathbf{x}_i' \beta)$$
$$P(y_i = 2) = 1 - \Phi(\mu - \mathbf{x}_i' \beta)$$

where Φ denotes the cumulative distribution of ε_i (Verbeek, 2004).

Maximum likelihood estimation techniques are used to obtain the value of the parameters, β, that maximize the probability of observing the outcome, y. Maximizing log likelihood function

with respect to the explanatory variable produces the maximum likelihood estimator for each of the independent variables. The parameters derived from the log likelihood function are known as marginal effects or marginal probabilities. The marginal probabilities measure the change in probabilities resulting from a unit change in one of the regressors while holding the other regressors constant. Predicted marginal probabilities assist in understanding the relationship between the dependent and independent variables and the signs of the parameter estimates and their statistical significance indicate the direction of the relationship (Verbeek, 2004).

Demographic and socioeconomic factors (i.e. age, gender, income, and educational attainment), preferences for substitutes, psychographic characteristics and meat attributes are believed to impact the willingness to purchase the new meat product. Participants were separated into four psychographic cluster based on a series of questions about food behavior. These clusters were developed by Company X and confirmed by factor analysis in this study. Specification of the ordered probit model is as follows:

$$U_{ki}^* = \beta_0 + \beta_{k1}\,\text{GENDER} + \beta_{k2}\,\text{AGE} + \beta_{k3}\,\text{INC} + \beta_{k4}\,\text{EDU} + \beta_{k5}\,\text{C2} + \beta_{k6}\text{C3}$$
$$\beta_{k7}\,\text{C4} + \beta_{k8}\,\text{FLAV} + \beta_{k9}\,\text{APP} + \beta_{k10}\text{JUIC} + \beta_{k11}\,\text{OVER} + \beta_{k12}\,\text{TASTEL} + \beta_{k13}\,\text{TASTES} + \beta_{k14}$$
$$\text{TASTEB} + \varepsilon_i$$

$$Y_i = \begin{cases} 0 \text{ if unwilling to purchase} \\ 1 \text{ willing to purchase in addition to current products} \\ 2 \text{ willing to purchase instead of current products} \end{cases}$$

A description of the explanatory variables can be seen in Table 1.

Table1. Variables and Survey Statistics

Type of Variables	Variants	Variable Names	Description	Mean (Std. Dev.)
Independent Variable	Willingness to Purchase Prototype	WTP	0=unwilling to purchase, 1=willing to purchase in addition to current products, 2= willing to purchase instead of products currently purchased	0.9892 (0.6510)
Demographic Characteristics	Gender	GENDER	1=female , 0=male	0.5376 (0.5013)
	Age	AGE	1=ages 25 to 44, 0=ages 45 to 65	0.4946 (0.5027)
	Income	INC	1= $50,000 and over, 0=$49,999 and under	0.4086 (0.4942)
	Education	EDU	1=college degree and beyond, 0=less the college degree	0.3548 (0.4811)
Psychographic Characteristics	Cluster 1	C1	1=member of cluster 1, 0=otherwise (omitted)	0.3226 (0.4600)
	Cluster 2	C2	1= member of cluster 2,0=otherwise	0.1505 (0.3595)
	Cluster 3	C3	1= member of cluster 3, 0=otherwise	0.2473 (0.4338)
	Cluster 4	C4	1= member of cluster 4, 0=otherwise	0.0753 (0.2653)
Product Attributes	Flavor	FLAVOR	1=liked flavor, 0=otherwise	0.8602 (0.3486)
	Appearance	APPEAR	1=liked appearance, 0=otherwise	0.8602 (0.3486)
	Juiciness	JUICY	1=liked juiciness, 0=otherwise	0.8817 (0.3247)
	Overall Rating	OVERALL	1=liked product overall, 0=otherwise	0.8602 (0.3486)
Taste Test Rankings	Leading Competitor	TASTEL	1= least preferred, 0=otherwise	0.4194 (0.4961)
	Secondary Competitor	TASTES	1=least preferred, 0=otherwise	0.2258 (0.4204)
	Black Label Competitor	TASTEB	1=least preferred, 0=otherwise	0.1720 (0.3795)

Summary Statistics

The dependent variable was created from a sequence of questions where respondents were asked if they were unwilling to purchase the meat product, willing to purchase the meat product in addition to current product, or willing to purchase the meat product instead of their current purchase. Nearly 58 percent of the participants expressed a willingness to purchase the new product in addition to their current purchases, while 20 percent of the respondents indicated they would purchase Company X's product instead of their current meat product. Finally, the prototype product ranked higher than all existing product in the meat market, with more than 33 percent of the respondent ranked Company X's as the most preferred product (Figure 1).

Figure 1: Taste Test Rankings
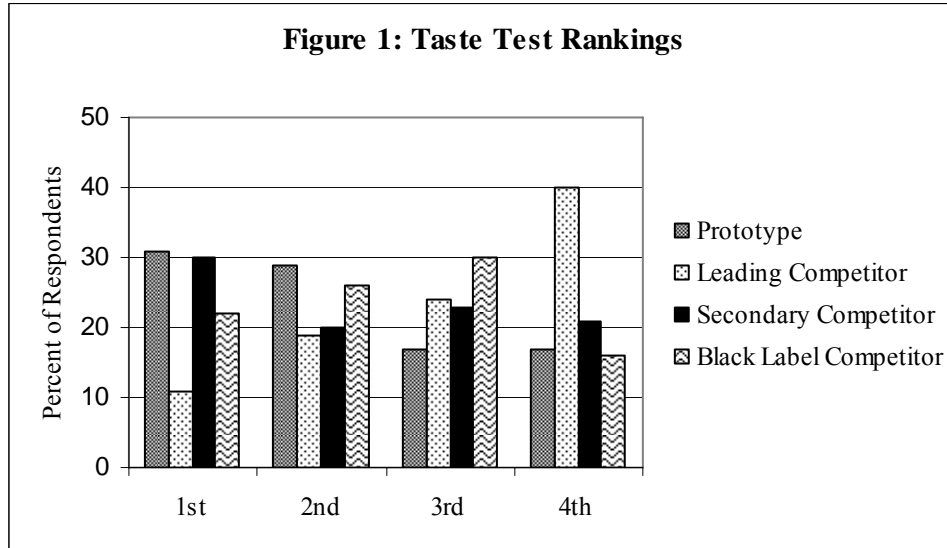
Empirical Results

Chi-squared Test of Independence

The chi-squared test of independence, a statistical technique used by marketing researchers, was used to analyze the relationship between the dependent variable and each of the independent variables discussed earlier. The results from the chi-squared analysis suggested that 8 variables exhibited a significant relationship with the dependent variable (Table 2). The taste rating of the leading competitor, participants in cluster 1, and all meat attributes (appearance, juiciness, flavor, and overall rating) were determined to be significant with the dependent variable at the 0.01 significance level. Age and income were found to have a relationship with the dependent variable at the 0.05 significance level. Finally, participants in cluster 4 were found to exhibit a significant relationship with the dependent variable at the 0.10 significance level.

Table 2. Empirical Results from chi-squared
tests of independence.

Variable	Chi-squared Value
Gender	1.3333
Age	8.2105**
Income	6.8149**
Education	2.5765
Cluster 1	10.4390***
Cluster 2	0.8128
Cluster3	2.6270
Cluster 4	5.4671*
Flavor	35.7931***
Appearance	9.5504***
Juiciness	13.8578***
Overall Rating	20.3925***
Leading Competitor	11.4424***
Secondary Competitor	0.2631
Black Label Competitor	1.0431

* statistical significance at the 0.10 level of
probability, ** at the 0.05 level, and *** at 0.01
level

Ordered Probit Results

Using data collected from the surveys and the specification set forth in the previous section,

maximum likelihood procedures, and LIMDEP 7.0, an ordered probit model was estimated with the

dependent variable representing the consumers' willingness to purchase Company X's new meat

product. The ordered probit model coefficients and marginal probabilities are shown in Table 3.

White's Test was applied to ensure that the heteroscedasticity was not present in the data set and the

results indicated the variances of the error term were homoscedastic. The log likelihood ratio, LR=

2(-58.4024- (-90.2676)) = 63.7306, is greater than the 99 percent critical value for 14 degrees of

freedom, 29.14, which reveals the model is statistically significant. The model predicts 81.7 percent

of the observations correctly. The μ value was significant which implies that the categories for the

dependent variable are ordered. Various demographic, socioeconomic and geographic variables

included in the model were significant. Specifically, those individuals that were included in cluster

3 and were between the ages of 25 and 44 with an income of $50,000 or greater impacted the

respondents' degree of willingness to purchase the new meat product. The model also indicates that the individuals' with a fondness for competing products, and the appearance of the product had significant effects on the willingness to purchase.

Table 3. Empirical Results from ordered probit model.

	Standard Error	t-ratio	Marginal Effects Y=0	Y=1	Y=2
Constant	1.1195	-1.5356	0.3779	-0.0626	-0.2853
Gender	0.4047	0.1947	-0.0160	0.003	0.0130
Age	0.3368	-1.7507*	0.1240	-0.0219	-0.0985
Income	0.3713	-1.9869**	0.1618	-0.0478	-0.114
Education	0.4698	0.6058	-0.0549	0.005	0.0500
Cluster 2	0.4942	-1.2201	0.1523	-0.0768	-0.0755
Cluster 3	0.4872	-1.7577*	0.2171	-0.1087	-0.1084
Cluster 4	0.6801	-0.1166	0.0167	-0.0041	-0.0126
Flavor	1.4180	1.4676	-0.6614	0.5116	0.1497
Appearance	0.4627	2.4516**	-0.3321	0.221	0.1111
Juiciness	0.9089	0.1723	-0.0339	0.0099	0.0240
Overall Rating	1.3908	-0.7358	0.1330	0.1243	-0.2573
Leading Competitor	0.6097	3.5165***	-0.3872	-0.068	0.4552
Secondary Competitor	0.7172	2.8309***	-0.2368	-0.3236	0.5604
Black Label Competitor	0.6575	2.3085***	-0.1753	-0.2413	0.4166
Mu(1)	0.3001	8.2949***			

Log likelihood function = -58.4024   Restricted log likelihood = -90.2676
Chi-squared = 63.7306   Degree of Freedom=14   Significance level=.01
* statistical significance at the 0.10 level of probability, ** at the 0.05 level, and *** at 0.01 level

Non-Purchasers

The first category in the dependent variable analyzed the likelihood of the respondent to be unwilling to purchase Company X's meat product. Individuals that were between the ages of 25 to 44 were 12 percent more likely than those 45 to 65 to be unwilling to purchase the product. Also, persons with an income of $50,000 or greater were 16 percent more likely than those with incomes less than $50,000 to express an unwillingness to purchase. Likewise, participants in cluster 3 were nearly 22 percent more likely than cluster 1 to be unwilling to purchase the Company X's meat product.

The appearance of Company X's products and the taste of the competing products impacted the purchasing decision. Respondents that indicated they liked the appearance of the product were

33 percent less inclined to indicate an unwillingness to purchase the product when compared to individuals that expressed a less positive opinion about the product's appearance. Finally, individuals that rated the leading competitor, secondary competitor, or black label competitor as their least preferred product were 38 percent, 24 percent, and 18 percent, respectively, less likely to express an unwillingness to purchase.

Potential Purchasers That Were Willing to Purchase In Addition to Current Products

The second category in the dependent variable analyzed the likelihood of the respondent to be willing to purchase Company X's meat product in addition to current products. Individuals that were between the ages of 25 to 44 were 2 percent less likely than respondent between the ages of 45-65 to express a willingness to purchase the new meat product in addition to current purchases. Individuals with an income of $50,000 or greater were 5 percent less likely than those with an income less than $50,000 to express a willingness to purchase Company X's product along with current meat products. Participants in cluster 3 were nearly 11 percent less likely than cluster 1 to be willing to purchase the Company X's meat product with current products.

Respondents that possessed a favorable opinion about the appearance of the product were 22 percent more likely than those that perceived the appearance as negative to indicate a willingness to purchase Company X's product in addition to their current purchases. Finally, individuals that rated either taste of the leading competitor, secondary competitor, or black label competitor as the least preferred product were 7 percent, 32 percent, and 24 percent, respectively, less likely to express a willingness purchase the new product along with current purchases.

Potential Purchasers That Were Willing to Purchase Instead of Current Products

The final category in the dependent variable analyzed the likelihood of the respondent to be willing to purchase Company X's meat product instead of current products. Individuals that were between the ages of 25 to 44 were 10 percent less likely than someone between the ages of 45-65 to

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be willing to purchase Company X's meat product instead of current products. Likewise, participants with an income of $50,000 or higher were 11 percent less likely than those with an income less than $50,000 to be willing to purchase the new product instead of the products currently purchased. Participants in cluster 3 were nearly 13 percent less likely than cluster 1 to demonstrate a willingness purchase Company X's meat product instead of current products.

Respondents that indicated they liked the appearance of the product were 11 percent more inclined to purchase the new meat product instead of current products than someone who disliked the appearance. Finally, individuals that rated either taste of the leading competitor, secondary competitor, or black label competitor as the least preferred were 46 percent, 56 percent, and 42 percent, respectively, less likely than someone that ranked the taste more favorably to demonstrate a willingness to purchase Company X's rather than current products.

Discussion and Conclusion

The null hypothesis which stated variables that demonstrated a significant relationship with the dependent variable based on the chi-squared test of independence would also show signs of significance within the econometric model, is rejected. For example, the flavor and juiciness variables exhibited significant relationships with the dependent variable using the chi-squared test but not in the regression model. An explanation for this outcome is that the degree of interrelatedness amongst all explanatory variables in the econometric model may affect the relationship between the independent variable that demonstrated a significant relationship with the dependent variable based on the chi-squared test of independence. Economic theory suggests consumers' behavior is impacted by both individual preferences and available information (prices, income, etc.) and not a single variable. Therefore, it seems that the results from the econometric model offer a richer explanation of consumer behavior and may be more useful to agribusiness firms.

Findings from the econometric analysis can be used by Company X to develop marketing strategies that allow for a successful entrance of its new product in an existing market. The results also revealed potential consumers that should be targeted by the firm. The target market should consist of consumers between the ages of 45 and 65 with incomes less than $50,000. In addition, consumers that eat breakfast on a regular basis during the week (qualifying characteristic for cluster 1) should also be targeted. Similar to previous meat studies, Hui et al and Melton et al, appearance was found to be a significant factor in the willingness to purchase this meat product. This finding suggests that this firm should position the product so that is appearance is appealing to consumers (i.e. the labels on the package should allow for a clear view of the product). Finally, the results suggested the consumers are not willing purchase to Company X's product in conjunction with competing brands of the same product. Thus, the company must develop strategies that will allow it to take away market shares from existing firms.

It has been illustrated both agribusiness firms and agricultural economists can benefit by collaborating on research efforts. Firms can draw more detail inferences pertaining to the nature of the market it seeks to enter with econometric tools rather than the simple statistical tests which are normally used. Additionally, agricultural economists are able to gain insight on how the firms actually operate and the manner in which consumers really behave.

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