Staff Paper

Consumer Demand for Ecolabeled Apples:
Results from Econometric Estimation

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RESULTS FROM ECONOMETRIC ESTIMATION*

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Abstract

This article presents a theory and empirical estimates of consumer demand for ecolabeled apples. The effect of varying comprehensiveness of environmental claims and amount of proof supporting claims is examined. Data are from telephone interviews with 893 randomly selected U.S. households. Substantial demand for ecolabeled apples is found. Variations in claim comprehensiveness and amount of proof are statistically insignificant.

Introduction

Economic theory assumes uncompensated environmental damage resulting from production affects only individuals external to the market (i.e., an externality). The premise behind ecolabels is that uncompensated environmental damage can affect market consumers (i.e., an internality) and decrease market demand. Producers can reduce the internality, and thus increase demand, by offering an ecolabeled good produced with less environmental damage. They are motivated to do so because producer surplus increases if the marginal cost of ecolabeling is less than the marginal internal cost of damage.

As consumer awareness of internalities has grown, so has interest in ecolabeling. However, there is scant information about what environmental improvements consumers might want, how many consumers might want them, how much they would pay, and what can or should be done to overcome asymmetric information problems.

This article presents a theoretical framework of consumer demand for ecolabeled apples. The framework is used to explain the design of a survey instrument and the development of empirical models of consumer demand for ecolabeled apples. The empirical analysis examines whether ecolabel demand varies with comprehensiveness of the environmental claims or extent of proof given to support the claims. The importance of environmental concerns and food safety concerns in ecolabel demand is also examined.

Theory

Assume a consumer derives utility (U) from consuming fresh apples (X), environmental quality (E), and other goods (Y), so U(X,E,Y) where $\partial U/\partial X>0$, $\partial U/\partial Y>0$, $\partial U/\partial E>0$. Assume only apple production damages the consumer's environmental quality, so the utility function becomes U(X,E(X),Y) where $\partial E/\partial X\leq 0$. Now there is a tradeoff between the marginal utility gained from consuming an additional unit ($\partial U/\partial X>0$) and the marginal utility lost from the environmental damage from that unit ($\partial U/\partial E\cdot\partial E/\partial X\leq 0$).

Suppose an ecolabeled apple (X') is introduced and unlabeled apples (X°) are also offered for sale. The utility function becomes $U(X^\circ,X',E(X^\circ,X'),Y)$ and the consumer's tradeoff changes. The marginal utility gained from consuming an additional unit of X' is the same as X° (i.e., $\partial U/\partial X'= \partial U/\partial X^\circ$), but the marginal utility lost from environmental damage is less for X' than for X° (i.e., $\partial U/\partial E\cdot\partial E/\partial X'<\partial U/\partial E\cdot\partial E/\partial X^\circ$). If the consumer maximizes utility subject to a budget constraint, she will purchase X' instead of X° if the added benefit exceeds the price premium of the ecolabeled apple ($P_{x'}-P_{x^\circ}$).

Since actions to reduce environmental damage may also improve food safety by reducing chemical residues, there is another possible source of utility gain from buying X'. Let R denote the level of residue in a unit of X° or X', so $R(X^\circ,X')$. R has a strictly negative effect upon utility ($\partial U/\partial R<0$) and $X°$ and X' have strictly positive effects upon residue, but residue from X' is less (i.e., $\partial R/\partial X'<\partial R/\partial X°$). The utility function becomes $U(X°,X',E(X°,X'),R(X°,X'),Y)$ and the consumer's tradeoff changes. Now there is a tradeoff between the marginal utility gained from consuming an additional unit ($\partial U/\partial X°>0$) and the marginal utility lost from residue ($\partial U/\partial R \cdot \partial R/\partial X°<0$) and environmental damage ($\partial U/\partial E \cdot \partial E/\partial X° \leq 0$) from that unit.

Observing whether a producer has truly improved environmental quality is costly, so there is an asymmetric information problem. Assume the consumer perceives a π probability function the environmental claim is true. Because residues decline only if the environmental claim is true, R is also weighted by π. Then the utility function becomes $U(X°,X',\pi \cdot E(X°,X'),\pi \cdot R(X°,X'),Y)$ and the consumer's tradeoff changes accordingly.

Producers may increase consumer demand for ecolabeled goods by increasing *claim comprehensiveness* (i.e., by increasing $\partial E/\partial X'$- $\partial E/\partial X°$). Consumers may also believe this action reduces residues (i.e., $\partial R/\partial X'$- $\partial R/\partial X°$). The action adds extra ecolabeling costs, so the price premium ($P_{x'}$-$P_{x°}$) increases.

Producers may also increase consumer demand by developing and offering *proof* about their environmental claim (e.g., third-party certification). Increasing the amount of proof would increase both π and the price premium (($P_{x'}$-$P_{x°}$).

To determine whether ecolabeling increases demand for a good, we compare demand with and without ecolabeling. Without ecolabeling, the individual demand function for *regular apples* is:

(1) $X = X(P_x, P_y, \partial E/\partial X, \partial R/\partial X, M)$

where P_y is the price of close substitutes and M is income. With ecolabeling, the individual demand functions for *labeled* and *unlabeled* apples reflect the price premiums, the environmental benefit, the food safety benefit, and trust in the benefit claims or:

(2) $X' = X'(P_{x'}, P_{x°}, P_y, (\partial E/\partial X' - \partial E/\partial X°), (\partial R/\partial X' - \partial R/\partial X°), \pi, M)$ and

(3) $X° = X(P_{x°}, P_{x'}, P_y, (\partial E/\partial X° - \partial E/\partial X'), (\partial R/\partial X°, \partial R/\partial X'), \pi, M)$.

Methods

There are no markets in which all variables in the demand functions (1-3) can be measured, so we use a modified market method (MMM) adapted from research by van Ravenswaay and Wohl (1995). The MMM presents a description of an existing market to a representative sample of consumers. Own-price and other market conditions are varied across respondents and quantities of the existing good that would likely be purchased are elicited. One or more modified versions of the existing good are then hypothetically introduced into the existing market and quantities of the existing and modified goods that would likely be purchased are elicited. Average individual demand for the existing and modified goods is estimated from the responses of the sample.

Conditions in the existing retail apple market were described to a random sample of U.S. households in telephone interviews. A hypothetical introduction of ecolabeled apples was also presented. Respondents were given market scenarios *with* and *without* ecolabeling and asked whether and how much X, X', and $X°$ they would buy on a single shopping occasion. The survey instrument is in Blend and van Ravenswaay (1998).

Four different ecolabels were developed to examine the effect of *claim comprehensiveness* $(\partial E'/\partial X' - \partial E'/\partial X°)$ and amount of *proof* (π) on the demand for regular and ecolabeled apples. There were two levels of claim comprehensiveness: (1) a more comprehensive claim called ECO which promised more efficient water and energy use, application of naturally occurring fertilizers, use of natural insect controls, and reduced pesticide use and (2) a less comprehensive claim called IPM which promised natural insect controls and reduced pesticide use. There were two amounts of proof: (1) certification by USDA and (2) no proof. The four ecolabel descriptions were randomly assigned to respondents with each respondent receiving only one description.

Several versions of the survey instrument were developed in order to randomly vary apple prices (P_x, $P_{x'}$, and P_{x°) and the ecolabel price premium ($P_{x'}$ - P_{x°) across respondents. The prices of X and X° were identical in each survey, so P_x=P_{x°. The setting in which the apples were sold was described as the place where the respondent normally buys fresh apples. Since the setting could vary, respondents were asked a closed-ended question about where they normally buy fresh apples (e.g., grocery store, farmer's market, organic food store, etc.). Since IPM has been used in agriculture for many years, respondents receiving the IPM label descriptions (i.e., half the sample) were asked if they were familiar with IPM. The price of substitutes (P_Y) was held constant, but the type substitute could vary (e.g., organic apples versus other fruits). The time of purchase was recorded as the month in which the interview took place.

Open-ended questions were used to elicit the quantities of *regular* (X), *labeled* (X′), and *unlabeled* (X°) apples. In the ecolabeling scenario, respondents could buy a mix of labeled and unlabeled apples. Open-ended questions asked if the primary reason for buying ecolabeled apples was environmental or food safety concerns. Household income and other demographic variables expected to explain variation in apple purchases were recorded using a mix of open- and closed-ended questions (e.g., education, age, gender, household size). Table 1 presents operational definitions of all variables.

The phone interviews were conducted by trained interviewers at the Institute for Public Policy and Social Research (IPPSR), Michigan State University between November 3, 1997 and February 11, 1998. IPPSR purchased phone numbers from Gensys Sampling Inc. who generated a proportional sample of random numbers from the lower 48 states. Of 1,453 eligible phone numbers that were contacted, 972 interviews were completed resulting in a participation rate of 66.9 %.

Only respondents who buy apples (92%) were asked the purchasing questions (i.e., n=893). Just over three-quarters of respondents were female. Compared to census data, higher income households were somewhat over-represented as were larger households and householders with more education (U.S. Bureau of Census 1996).

Demand was estimated using both a Cragg (1971) Double-Hurdle model and a Tobit model (Tobin, 1959). The Cragg allows for different variables to affect the decision to purchase and the quantity purchased while the Tobit imposes the restriction that the same variables affect both decisions similarly. We hypothesized the Cragg would be more appropriate for the single shopping trip scenario because the shopper would likely determine the quantity in advance, but would decide whether to buy after observing price and quality. Thus, different factors would affect each decision. In the longer term purchasing decision, the decision to buy and the amount purchased are more likely to be correlated with one another over numerous trips.

A Fin-Schmidt test (1984) supported using the Cragg model. Effects of explanatory variables on purchase probability were estimated using Probit. Effects on the quantity purchased were estimated using a truncated regression.

Results

Means and standard deviations of explanatory variables are in Table 1. Marginal effects on purchase probability and quantity purchased are in Table 2. To illustrate, the marginal effect of an additional year of education (educ.) raises the probability of buying labeled apples .026, and decreases pounds purchased by .023.

Purchase probability for *regular* apples is significantly affected by own-price, income, age and education. Different variables are significant for quantity, thus supporting use of a two-stage model.

Purchase probability for *labeled* apples is significantly affected by own-price, unlabeled price, familiarity with IPM, month of purchase, gender, and education. The sum of the marginal effects of labeled and unlabeled prices is negative, so a price premium reduces purchase probability. However, a $.10 price increase reduces purchase probability by only .09. Since 72% of respondents bought labeled apples at a zero price premium, a $.10 cent price increase reduces the percentage to about 63%. At a $.40 premium, over a third would still buy. Different variables are significant for quantity, thus supporting the two stage model. Comprehensiveness of the environmental claim and amount of proof are insignificant for probability of purchase and quantity purchased. Environmental concern significantly affects quantity purchased. Familiarity with IPM is significant, but changes sign in the quantity decision.

Results for *unlabeled* apples mirror those for labeled apples. Unexpectedly, proof has a significantly positive effect on quantity, though not on the probability of purchase. Unlabeled apples are more price elastic than regular apples. Own price elasticity of regular apples was -.14 compared to -1.7 for unlabeled. Average total pounds of any kind of apples was slightly lower with ecolabeling (2.8) than without (2.9 lbs.).

Conclusions

There is substantial consumer demand for ecolabeled apples. Purchase probability decreases as the price premium increases, but even with a premium of $.40, over a third would still buy. Comprehensiveness of environmental claims and the amount of proof do not affect purchase probability or the quantity purchased. Environmental concern significantly affects quantity purchased, but food safety concerns do not. Familiarity with IPM reduces purchase probability and quantity. Education level increases purchase probability. Males are less likely to purchase ecolabeled than females.

Table 1-Operational Definitions, Means, and Standard Deviations of Variables

Variable	Definition	Mean	Std. Dev.
X	Pounds of *regular* apples without ecolabeling	2.8996	6.1662
X′	Pounds of *labeled* apples with ecolabeling	1.4981	14.8275
X°	Pounds of *unlabeled* apples with ecolabeling	1.2983	3.0481
$P_x = P_{x°}$	Price $/lb. regular and unlabeled apples	.8823	4.9425
$P_{x'}$	Price $/lb. labeled apples	1.0794	.2940
compreh.	1=ECO label, 0=IPM label	.5006	.5003
proof	1=USDA certification, 0=no certification	.5050	.5003
environ.	Buy to 1=improve environment, 0=other	.2722	.4455
safety	Buy to 1=improve health/safety, 0=other	.3689	.4830
IPM	1=familiar with IPM, 0=unfamiliar	.0659	.2546
grocery	Shops at 1=grocery or supermarket, 0=other	.8959	.3056
organic	Buys organic apples 1=often/always, 0=rarely	.0291	.1682
month	Interviewed 1=Nov., 0=Dec.- Feb.	.3359	.4726
income	Household income in thousands of dollars	53.0028	36.09
size	Number of occupants in household	2.9287	1.6094
age	Respondent's age in years	46.1596	16.1943
male	Respondent is 1=male, 0=female	.2318	.4222
educ.	Respondent's years of completed education	14.0331	2.7065

Table 2-Estimated Marginal Effects of Explanatory Variables

Variable	Probability of Purchase (Probit)			Quantity Purchased (Truncated Regression)		
	regular	*labeled*	*unlabeled*	*regular*	*labeled*	*unlabeled*
$P_x = P_{x^\circ}$	-.1505***	.7513***	-.8452***	-.5216	.8784	-1.0056
$P_{x'}$		-.8894***	.7552***		-1.0746*	.2975
compreh.		.0506	-.0098		.0807	-.1544
proof		-.0133	.0305		-.1416	.5060**
environ.		-----[a]	-----[a]		.5473**	-----[a]
safety		-----[a]	-----[a]		.3841	-----[a]
IPM[b]		-.1973*			.7132*	
grocery	.0278	-.0536	-.0446	-1.1218***	-.8379**	-.7037**
organic	.0180	.1653	-.3142***	-.5300	.1255	.1449
month	.0158	.0624*	-.0528	.0954	-.2770	.1218
income	.0006*	.0002	.0003	.0011	.0004	-.0009
size	.0063	.0142	.0080	.2183***	.1238**	.2086***
age	-.0015**	-.0014	.0000	.0201***	.0143**	.0205***
male	-.0145	-.1112***	.0918**	.3346*	.4952**	.1953
educ.	.0141***	.0255***	-.0042	.0123	-.0229	-.0171

*10% significance level,**5% significance level,***1% significance level

[a]Variable measured only for those who bought ecolabeled, so not included in probit model of the decision whether to buy or in the decision of how much unlabeled to buy.

[b]Variable measured only for those presented with the IPM label.

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