An Experimental Approach to Valuing New Differentiated Products

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Abstract
An experimental store was created to evaluate initial demand for locally-produced and guaranteed tender steak products as a more realistic alternative to contingent valuation (CV) and dichotomous-choice experimental methods. Strengths of the approach are incentive compatibility, a realistic consumption set, and a familiar choice environment. Consumers selected among USDA Choice, premium quality, lean, guaranteed tender, and locally-produced strip steaks. A double-hurdle count data model indicated initial willingness-to-pay for locally-produced steak comparable to prior CV results, but demand was highly elastic. Demand for premium quality steak crowded out demand for the guaranteed tender product, contrasting with prior dichotomous-choice experimental results.

One of the most striking trends in the U.S. food system is the increasing emphasis on differentiation at the farm level. Coinciding with a strategic shift from emphasis on the "value chain" to emphasis on what The Food Industry Center (2002) termed the "benefits based value chain," producers now show heightened interest in identifying consumer willingness-to-pay (WTP) for prospective new products. The Land Grant research system is an appropriate supplier of publicly-accessible market research serving producers and agribusinesses that lack the resources to privately commission new product development studies.

Beef steak is a lightly-processed food for which product differentiation often originates at the farm level. Within a given cut of steak, consumers can typically choose among two or three quality grades, differentiated primarily by marbling. Higher quality products are often branded (e.g., Certified Angus Beef). In some markets, lean and hormone-free attributes are bundled and sold at a premium (e.g., Laura's Lean Beef).

Two differentiated products of particular interest to the industry that are rarely available on supermarket shelves are certified locally-produced beef (i.e., produced within the state) and "guaranteed tender" steak. The hypothesized value-added attributes of locally-produced beef are source verification (food safety, accountability, environmental stewardship) and support of local, independent, small-scale producers. Tenderness and uniformity are important steak quality attributes that, when bundled under the guaranteed tender label, are hypothesized to command premiums.

The goal of this study was to provide producers and potential investors with valid initial consumer demand assessments for locally-produced steak and guaranteed tender steak. Consumers provided with a $20 budget shopped in an experimental meat store offering five types of strip steak: USDA Choice, premium quality, lean, locally-produced, and guaranteed tender. Sensory evaluations, a prominent and useful feature of prior studies (Lusk et al., 1999; Boleman et al., 1997), were avoided in this case to isolate consumers' preconceptions about the value of the locally-produced attribute. In the absence of a viable existing market for locally-produced steak, quality attributes of currently-available, grass-fed local products may not be representative of future local offerings. As Melton et al. (1996) demonstrated, direct sensory experience is such an important source of consumer information that the threat of confounding value for the local attribute with values for accompanying attributes was expected to be greater if sensory evaluation were used in addition to visual inspection.

The experiment illustrates a methodology that may be applied to many new products. The approach is useful because (1) it introduces a highly controlled, non-hypothetical market that is incentive compatible, (2) it places the purchase decision in a

more realistic context of multiple, familiar substitutes than dichotomous-choice experimental approaches, and (3) it returns data on both participation decisions (whether to purchase product j) and consumption decisions (how much of product j to purchase).

The methods used in this study may be contrasted with popular alternatives such as choice-based conjoint (CBC) analysis. CBC may also be applied in a non-hypothetical setting, and multiple attributes may be evaluated (see, e.g., Lusk and Schroeder, 2002). Although CBC is also occasionally used to to evaluate consumption decisions in addition to participation decisions (see, e.g., Pilon, 1998), the methods used in the present study contribute the ability to distinguish between participation price elasticities and consumption price elasticities. Particularly in the case of new products, distinguishing between the consumer's decision to try a product at all, versus the decision about how much to buy, can impact marketing strategies.

This study emphasized initial demand conditioned on preconceptions of attribute value, but the approach can be extended through iterations to assess persistent demand after consumers gain experience with the product offerings. In this case, timely iterations were precluded because we exhausted the available supply of locally-produced strip loins in the initial experiment, and subsequent iterations would have threatened local suppliers' ability to service their regular accounts.

Background

Burdine, Meyer, and Maynard (2002) estimated WTP for locally-produced steak using the CV method, by which 20 percent of respondents reported willingness to pay a 40 percent premium. An additional 32 percent of respondents reported willingness to pay

a 20 percent premium for locally-produced steak. The CV method involves presenting a hypothetical scenario in which participants can articulate WTP to obtain a good or to avoid a "bad" (Mitchell and Carson, 1989, p. 4). The method is most often used to value public goods, but it is equally useful for eliciting WTP for prospective private goods or attributes (see, e.g., Buzby, Ready, and Skees, 1995; Buzby et al., 1998; Halbrendt et al., 1995; Maynard and Franklin, 2003; van Ravenswaay and Hoehn, 1991; van Ravenswaay and Wohl, 1995).

The hypothetical nature of the WTP scenario potentially introduces a number of biases in CV estimates. Specifically, a portion of the added value in locally-produced meat may be attributable to public goods, such as support of local producers. Free rider incentives suggest that WTP elicited via hypothetical surveys may exceed WTP revealed in the marketplace.

Lusk et al. (1999) and Boleman et al. (1997) used experimental methods to elicit WTP for guaranteed tender steak. Lusk et al. (1999) found that, when provided with tenderness information, about half of the participants were willing to pay an average premium of $1.84 per pound (approximately 20 percent above a typical USDA Choice strip steak price) to obtain a guaranteed tender steak rather than keep a "probably tough" steak. In a small sample, Boleman et al. (1997) found that virtually all participants chose tender steak over tough steak at a $1.00 per pound premium. The experimental approach is potentially more reliable than contingent valuation because it uses non-hypothetical means of eliciting WTP. The elicitation method used by Lusk et al. (1999) was a variation on the Becker-DeGroot-Marschak mechanism, which, like the Vickery second-

price auction, is incentive compatible (see, e.g., Fox, 1995; Fox et al., 1995; Melton et al., 1996; Hayes et al., 1995; Shogren et al., 1994).

Experimental Methods

Following Lancaster (1966), assume consumers rationally purchase goods that deliver a utility-maximizing bundle of attributes, subject to a budget constraint. A demand function for each differentiated product therefore exists, reflecting the expected quantity purchased given prices, income, and tastes and preferences. An experimental setting allows one to control the number of goods and consumers' budget. Unlike market-level demand studies, endogeneity bias from simultaneously-determined prices and quantities is precluded. The consumption set included frozen hamburger patties (used in lieu of change to ensure binding budget constraints) and five differentiated strip steak products: USDA choice, premium quality, lean, locally-produced, and guaranteed tender.

Boxed strip loins were purchased from the wholesale distributor SYSCO (except for locally-produced product), trimmed, sliced into approximately six-ounce steaks, vacuum-packed, and labeled in the university's meat science laboratory. Display samples of each product were packaged on styrofoam trays with clear plastic film to simulate a typical supermarket presentation. The USDA Choice product effectively refers to beef from the bottom third of the Choice quality grade, defined by a "small" degree of marbling (intramuscular fat). The premium quality product was Certified Angus Beef, defined by a quality grade in the top two-thirds of the Choice category (i.e., "modest" or "moderate" marbling). The lean product was defined by beef in the Select quality grade

(i.e., "slight" marbling). The locally-produced product was purchased from both a local producer and the university's farm. Guaranteed tender steaks were selected on a steak-by-steak basis by experienced meat cutters as they sliced the meat. The Warner-Bratzler shear force test is a more objective alternative, reported to be 90 percent accurate (Lusk et al.), in which results from a cooked sample are extrapolated to the remainder of the loin from which it originated.

Each consumer (one per household) received a short demographic and preference survey, a $20 voucher (respondents were compensated in kind rather than in cash due to university administrative constraints), and a unique price schedule. The price of frozen hamburger patties was fixed at $0.50 each, and USDA Choice strip steak was offered at a fixed price of $9.10 per pound, based on prevailing retail prices. Thus, real household "income" in terms of these two products was equal across all consumers. Prices for the other four steak products were randomly drawn from bounded uniform distributions and rounded to the nearest 10 cents.

Premium quality strip steak was priced within a range of $10.00 - $12.00 per pound, based on prevailing retail prices. The $12.00 upper bound was used for each of the variable-price products because it represented the lowest observed retail price for filet mignon, an easily recognized beef cut perceived by many as superior to strip steak. Lean steak and guaranteed tender steak were priced between $9.10 and $12.00 per pound, consistent with WTP ranges suggested in prior studies (Smith, 2001; Lusk et al., 1999). Locally-produced steak was priced between $8.00 and $12.00 per pound, which was deemed an appropriate range based on the premiums suggested in Loureiro and McCluskey (2000) and Burdine, Meyer, and Maynard (2002). The potential discount

below the USDA Choice price allowed the possibility that local origin might be a negative attribute to some consumers.

Consumers were recruited from a variety of sources to approximate a representative sample of area food shoppers; details follow in the "Results" section. University staff (not faculty or students) and physical plant division employees made up the majority of the 227-consumer sample. A substantial portion of the sample was not affiliated with the university, and was recruited from area neighborhoods, a visit to a large community association meeting, and flyers distributed at a bakery and a liquor store. Consumers were scheduled in half-hour time slots over three days (a Wednesday, Friday, and Saturday), so that fewer than 12 were participating at any given time.

The experiment was held in a well-marked university location with convenient parking and access to walk-in coolers and freeezers. Upon entering the experiment, consumers were asked to complete a short questionnaire that inquired about steak shopping habits and preferences, number and ages of household members, household income, length of residence in the state, education, and gender. Next, consumers read a definition of marbling and its role in determining quality grades, recognizing the dominant perception that marbling and overall eating satisfaction are positively associated, and recognizing that higher degrees of marbling imply higher fat content. The USDA Choice product was described as a high-quality, "typical" product sold in area stores, premium quality steak was described as being selected from the top two-thirds of the Choice quality grade, and lean steak was described in terms of lower fat content (not lower quality grade). Locally-produced steak was described as produced entirely within the state, and quality grade was assigned as Choice. The guaranteed tender description

emphasized that an extra selection process had been used to identify steaks known to be tender. Given the low correlation between tenderness and quality grade (Lusk et al., 1999), a single quality grade was not assigned to the guaranteed tender product. Consumers then viewed two fresh samples of each product displayed in a commercial meat case, and completed an order form contained in the questionnaire, on which was listed the fixed budget and randomly-generated price schedule. Calculators and scratch paper were provided to facilitate rational decision making. To gain information about relative strength of preferences, consumers were asked two questions after completing the order form: "If you could keep only one of the products you selected, which one would you keep?" and "If you had to give up one of the products you selected, which one would you give up?" Consumers' orders were filled upon turning in the questionnaire.

Empirical Methods

The primary data obtained from the experiment were the quantities of five products purchased by 227 consumers, and the prices faced by each consumer. The quantities were count data left-censored at zero, i.e., integer values between zero and six. The Poisson distribution is potentially an appropriate tool in explaining the quantity of the jth product purchased by the ith consumer, denoted q_{ij} (Maddala, 1983, p. 51):

$$\Pr(q_{ij} = q) = \exp(-\lambda_{ij})\frac{(\lambda_{ij})^q}{q!} \tag{1}$$

Assume that $\ln\lambda_{ij} = x_{ij}\hat{a}_j$, where x_{ij} denotes a row vector of K explanatory variables and $\hat{a}_j$ is a conformable parameter vector. The resulting Poisson likelihood function is:

$$L_j = \prod_{i=1}^{n}\left(\exp(-\exp(x_{ij}b_j))\frac{\exp(q_{ij}x_{ij}b_j)}{q_{ij}!}\right) \tag{2}$$

One potential weakness of the Poisson specification is that explanatory variables and/or parameter magnitudes that describe the participation decision (to purchase product j or not) may differ from those that describe the consumption decision (how much of product j to purchase). Zero expenditures are common in cross-sectional demand data with little temporal aggregation, and may reflect corner solutions resulting from high relative prices, aversion to the product regardless of relative price, or short-run inventory management. As a solution, Cragg (1971) proposed modeling the participation decision as a probit model, and the consumption decision as a truncated tobit model. Drammeh et al. (2002) is a recent application of a Cragg "double-hurdle" model. Dong, Chung, and Kaiser (1999) extended Cragg's model to a panel data framework, Dong and Gould (1999) extended it to endogenize product quality, and Yen and Huang (1996) generalized it to correct violations of econometric assumptions. Particularly relevant to this study are Mullahy (1986), and Yen (1999), who considered count data double-hurdle models.

A count data double-hurdle model was developed for this study in which a probit model described the participation decision, and a Poisson regression truncated at zero described the consumption decision. As economic theory provided no justification for assuming different explanatory variables for the participation and consumption decisions, the vector of variables x_{ij} was applied in both the probit and Poisson components.

The probit model assumes that consumer i's latent continuous demand for the jth product, q^*_{ij}, is described by explanatory variables x_{ij} and a conformable parameter vector $á_j$, where purchases are observed (denoted $y_{ij} = 1$) when latent demand is positive, and $y_{ij} = 0$ otherwise:

$$q^*_{ij} = x_{ij}á_j + u_{ij}, \tag{3}$$

where $y_{ij} = 1$ if $q^*_{ij} > 0$

$y_{ij} = 0$ otherwise.

The residual u_{ij} is assumed to be independently and identically distributed with a standard normal distribution. The probability that $y_{ij} = 1$ equals the probability that $u_{ij} > -x_{ij}á_j$, which equals $[1 - Ö(-x_{ij}á_j)]$, where $Ö(-x_{ij}á_j)$ denotes the standard normal cumulative density function evaluated at $-x_{ij}á_j$. Symmetry of the normal distribution implies that $Pr(y_{ij} = 1)$ equals $Ö(x_{ij}á_j)$, and thus the probability that $y_{ij} = 0$ equals $[1 - Ö(x_{ij}á_j)]$. The resulting probit likelihood function is:

$$L_j = \prod_{y_i=0}\left[1 - \Phi(x_{ij}\mathbf{a}_j)\right]\prod_{y_i=1}\Phi(x_{ij}\mathbf{a}_j) \tag{4}$$

The likelihood function of the count data double-hurdle model combines the probit likelihood specification for zero-expenditures with the Poisson likelihood specification conditional on positive expenditures. As detailed in Mullahy (1986), the conditional data generating process for the truncated Poisson specification is:

$$Pr(q_{ij}|q_{ij} > 0) = \exp(1 - \mathbf{l}_{ij})\frac{(\mathbf{l}_{ij})^{q_{ij}}}{q_{ij}!} . \tag{5}$$

The general likelihood function for the double-hurdle model is

$$L_j = \prod_{q_{ij}=0} Pr(q_{ij} = 0) \prod_{q_{ij}>0} [Pr(q_{ij} > 0) Pr(q_{ij}|q_{ij} > 0)] . \tag{6}$$

Assuming $\ln ë_{ij} = x_{ij}â_j$, and substituting expressions from (4) and (5) into (6), yields the specific likelihood function for the count data double-hurdle model used in this application:

$$L_j = \prod_{q_{ij}=0}\left[1 - \Phi(x_{ij}\mathbf{a}_j)\right]\prod_{q_{ij}>0}\left\{\Phi(x_{ij}\mathbf{a}_j)\exp[1 - \exp(x_{ij}\mathbf{b}_j)]\frac{\exp(q_{ij}x_{ij}\mathbf{b}_j)}{q_{ij}!}\right\} \tag{7}$$

From the probit specification, the probability of observing a positive quantity of the jth good equals $\Phi(x_{ij}\acute{a}_j)$. From the Poisson specification, the unconditional expected value of the jth good's quantity is $\ddot{e}_{ij} = \exp(x_{ij}\hat{a}_j)$ (Greene, 2000, p. 880). The relation $E(q_{ij}) = \Pr(q_{ij} > 0)\, E(q_{ij} \mid q_{ij} > 0)$ therefore implies that the conditional expected value of the jth good's quantity is

$$E(q_{ij} \mid q_{ij} > 0) = \frac{\exp(x_{ij}\boldsymbol{b}_j)}{\Phi(x_{ij}\boldsymbol{a}_j)} \tag{8}$$

The marginal effect of the kth explanatory variable x_{jk} on participation is the derivative of the probability of purchasing a positive quantity of good j with respect to x_{jk}, and the marginal effect on quantity purchased is the derivative of the expected value with respect to x_{jk}. Thus, marginal effects on participation, unconditional quantity purchased, and conditional quantity purchased are, respectively:

$$ME(x_{jk} \text{ on probability of participation}) = \boldsymbol{f}(\overline{x}_j\boldsymbol{a}_j)\boldsymbol{a}_{jk} \tag{9}$$

$$ME(x_{jk}) = \boldsymbol{b}_{jk} \exp(\overline{x}_j\boldsymbol{b}_j) \tag{10}$$

$$ME(x_{jk} \mid q_j > 0) = \frac{\exp(\overline{x}_j\boldsymbol{b}_j)}{\Phi(\overline{x}_j\boldsymbol{a}_j)^2}\left[\boldsymbol{b}_{jk}\Phi(\overline{x}_j\boldsymbol{a}_j) - \boldsymbol{a}_{jk}\boldsymbol{f}(\overline{x}_j\boldsymbol{a}_j)\right] \;, \tag{11}$$

where overbars denote sample means and $\ddot{o}(.)$ denotes the standard normal pdf. Elasticities of unconditional and conditional purchases equal the respective marginal effects multiplied by the appropriate sample mean of x_{jk}/q_j.

Alternative model specifications that might have been more appropriate than the double-hurdle probit/Poisson framework were tested. The Poisson distribution imposes equality of the mean and variance (Maddala, 1983, p. 51), which may be inappropriate if the data are overdispersed, and it imposes a strong independence assumption (i.e., the

probability of an event is not conditional on prior events). Compound Poisson

distributions, which nest the Poisson as a parametric restriction, are a class of more

flexible alternatives that allow overdispersion and heterogeneity (Cameron and Trivedi,

1986). The negative binomial distribution is a commonly-used member of this class.

Following Cameron and Trivedi's (1986) suggestion of sequential testing and model

revision, three specification tests were used in this study to identify an appropriate model

structure.

Overdispersion was tested in the Poisson model (not truncated) using a

conditional moment test of the null hypothesis that the variance is entirely explained by

the mean of the dependent variable (Greene, 2000, p. 885). The test statistic is

distributed Chi-square with degrees of freedom equal to the number of regressors,

including the intercept. Rejection of mean-variance equality suggests the data are poorly

fit by the Poisson distribution, suggesting that a double-hurdle model and/or a compound

Poisson specification may be more appropriate. The Poisson distribution was next

compared to the negative binomial distribution using a Lagrange Multiplier (LM) test

(Greene, 2000, p. 886). The LM statistic is distributed Chi-square with one degree of

freedom.

If the data appear to be overdispersed, but are also poorly explained by the

negative binomial distribution (which allows overdispersion), then a double-hurdle model

may better characterize the data generating process. This hypothesis was tested using the

following likelihood-ratio test (Drammeh et al., 2002):

$$\Lambda = -2(LLF_{Poisson} - LLF_{\Pr obit} - LLF_{Truncated Poisson}) \qquad , \qquad\qquad (12)$$

where *LLF* denotes maximized log-likelihood function values. The statistic Ë is

distributed Chi-square with degrees of freedom equal to the number of regressors,

including the intercept. Rejection of the null supports the use of a double-hurdle model.

Goodness-of-fit in the participation model was evaluated by a likelihood ratio test

of the joint significance of regressors other than the intercept, and the likelihood ratio

index (LRI) measured as one minus the ratio of the unconstrained and intercept-only log-

likelihood function values. Goodness of fit in the consumption model was evaluated by

the likelihood ratio test of joint significance of regressors, and the R^2_p statistic for the

Poisson model (Greene, 2000, p. 882):

$$R^2{}_p = 1 - \frac{\sum_{i=1}^{n}\left(\frac{q_{ij} - \hat{\boldsymbol{l}}_{ij}}{\sqrt{\hat{\boldsymbol{l}}_{ij}}}\right)^2}{\sum_{i=1}^{n}\left(\frac{q_{ij} - \overline{q}_j}{\sqrt{\overline{q}_j}}\right)^2}. \tag{13}$$

Results

Figure 1 is a frequency histogram of the quantities purchased by steak type.

Consumers' budgets allowed them to buy an average of 4.6 steaks. Locally-produced

steak was purchased by 55 percent of consumers, and comprised 29 percent of all steaks

sold. As shown by descriptive statistics in Table 1, locally-produced steak was the

second-lowest-priced product, on average. Premium-quality steak, the highest-priced

product, was purchased by 45 percent of the consumers, and accounted for 22 percent of

all steaks sold, as did the low-priced USDA Choice steak. Guaranteed tender steak and

lean steak were the least popular, comprising 16 percent and 11 percent of units sold,

respectively. Approximately 40 percent of those who purchased either lean, locally-produced, or guaranteed tender steak spent their entire budget on a single type of steak, 62 percent of those purchasing USDA Choice steak acted as quantity maximizers and only purchased that variety, and 24 percent of those purchasing premium-quality steak only purchased that variety. A large majority of consumers appeared to have well-defined preferences for steak attributes; only seven percent of consumers were "experimenters" who purchased more than three varieties, and 73 percent of consumers purchased no more than two varieties.

Given that the locally-produced and guaranteed tender steak varieties were not available in supermarkets, we were interested in the anticipated consumer surplus that consumers attached to the new, value-added products. A survey question asked, "If you could only keep one of the products you selected, which one would you keep?" The most frequently-cited variety was premium-quality steak (66 consumers), followed by locally-produced steak (59 consumers), USDA Choice steak (37 consumers), guaranteed tender steak (35 consumers), and lean steak (22 consumers).

Table 1 contains descriptive statistics on price levels, relative prices, and other variables used to explain demand for steaks with varying attributes. Women comprised 53 percent of the sample. Relative to the 2000 U.S. Census profile of general demographic characteristics (http://www.census.gov/census2000/states/us.html), the sample appeared representative in terms of gender, average household size (2.7 sample vs. 2.6 Census), household members age 55 and over (23 percent sample vs. 21 percent Census), and households with annual income over $70,000 (22 percent sample vs. 26 percent Census). Relative to the U.S. population, the sample under-represented

households with children under 18 (16 percent sample vs. 29 percent Census), over-represented households with members aged 35-54 (40 percent sample vs. 29 percent Census), under-represented households with annual income under $20,000 (7 percent sample vs. 22.2 percent Census), and over-represented consumers with a four-year college degree (51 percent sample vs. 24 percent Census). Information on how well the self-selected sample corresponded to the target audience of nationwide steak consumers was unavailable.

The average participant had lived in the state more than 20 years, expected the quality and taste of locally-produced steak to be between "no difference" and "slightly better" relative to undifferentiated steak, and tended to believe that the difference in quality between high-priced and low-priced steak is "usually worth the extra cost." The average consumer expected lean steak, and steak produced with no added hormones, to be slightly healthier than "regular" steak. Consumers did not, on average, expect lean steak to taste better or worse than "regular" steak.

Poisson, negative binomial, and double-hurdle count data models were estimated to determine the extent to which one can explain consumers' choice of differentiated steak products in terms of relative prices, household demographic variables, and reported expectations about price-quality tradeoffs, quality of locally-produced steak, and healthfulness of steak. The regressions served two purposes: to examine response to price signals in a highly-controlled setting, and to offer guidance to potential marketers of value-added, differentiated steak products regarding product, price, and promotion decisions.

Table 2 provides details on model selection. Conditional moment tests strongly rejected the maintained assumption of the Poisson distribution that mean equals variance. Casual observation of frequent zero observations in each of the five steak varieties suggested overdispersion, and the conditional moment test was a formal confirmation. Lagrange Multiplier tests, however, suggested that the negative binomial distribution (which parameterizes overdispersion) failed to fit the data better than the Poisson distribution. The third hypothesis was that the untruncated Poisson model explained the data as well as a double-hurdle model separating the participation decision from the consumption decision. This hypothesis was strongly rejected by the likelihood ratio test (12). Thus, estimation results from the double-hurdle model consisting of a binomial probit model (participation) and a truncated Poisson model (consumption) are reported in Table 3.

Despite the significance of several variables in most of the participation models, explanatory power was low, with likelihood ratio index values virtually identical to those found in trout steak participation models estimated by Dasgupta, Foltz, and Jacobsen (2000). The percentage of correct predictions ranged from 63 percent (locally-produced) to 79 percent (lean). One often observes lower explanatory power in cross-sectional studies, but more importantly, the experimental setting already controlled for the budget constraint (each consumer faced a $20 budget), consumer acceptance of the product category (consumers would not have volunteered if they did not value steak), and preferences correlated with residential location (to the authors' knowledge, all consumers lived within 30 miles of the experiment). Drammeh et al. (2002) estimated a probit model with 88 percent prediction accuracy as part of a double-hurdle catfish consumption

model, in which 12 of 16 significant variables were either consumer acceptance or regional variables. In contrast, Lusk et al. (1999) estimated a logit model of consumers' decision to pay to exchange a "probably tough" steak for a guaranteed tender steak, in which no regressors were statistically significant. Like the present study, Lusk et al.'s (1999) sample already controlled for consumer acceptance and preferences correlated with residential location.

The own price coefficient was negative and significant in the locally-produced, lean, and premium quality participation models; it was negative but not significant in the guaranteed tender participation model. Regarding cross price terms, premium quality prices displayed the largest coefficient magnitudes. Premium quality price was significantly positive in the locally-produced participation equation (i.e., substitution effects dominated income effects), and significantly negative in the guaranteed tender participation equations (i.e., income effects dominated substitution effects). Locally-produced price was significantly positive in the USDA Choice equation, and significantly negative in the lean equation. Guaranteed tender price was significantly negative in the lean equation.

Economists often envision utility maximization as a sequence of product selections in descending order of consumer surplus. Given that the $20 budget allowed the purchase of only four or five steaks, the decision to purchase a given variety implied substantial impacts on one's remaining budget. Cases in which income effects overwhelmed substitution effects to produce negative cross price terms provided clues regarding the sequence of purchases and thus the relative strength of attribute preferences. The results suggested that, on average, the decision to purchase premium

quality preceded the guaranteed tender purchase decision, and decisions to purchase guaranteed tender and locally-produced preceded the decision to purchase lean. Not coincidentally, these findings parallel consumers' aggregate response to the survey question regarding which product they would choose if they could only keep one, discussed above.

Ten non-price coefficients were statistically significant in the participation models. Low-income consumers were less likely, while college-educated consumers were more likely, to purchase locally-produced steak. Women and consumers from childless households were more likely to purchase lean steak, as were those with favorable opinions of lean steak's taste. College-educated consumers and those who did not like the taste of lean steak were more likely to purchase premium quality, and those who believed high-quality steak was worth the cost were more likely to purchase guaranteed tender. Women were more likely to purchase USDA Choice steak.

Explanatory power of the consumption models (as measured by R^2_P detailed in (13)), was considerably higher than that of the participation models, except in the premium quality model. The results were comparable to those of the only identified prior study that reported an R-squared measure (0.40) for a truncated count data model based on survey or experimental data (Creel and Loomis, 1990). Evidence from related applications consists of Lusk et al.'s (1999) 0.26 adjusted R-squared in an OLS regression of willingness-to-pay for guaranteed tender steak.

Own price coefficients were negative, except in the premium quality model, and significant only in the locally-produced model. Only the USDA Choice model contained significant cross price terms (locally-produced price and guaranteed tender price), both of

which were positive. Few non-price coefficients were significant. Those who believed high-quality steak was rarely worth the cost tended to purchase more locally-produced steak, an alarming signal for those hoping to command high premiums for certified locally-produced steak. Those who believed lean steak was healthier than "regular" steak tended, predictably, to purchase more lean steak, and those who felt otherwise tended to purchase more USDA Choice steak.

Table 4 contains uncompensated own price and cross price elasticities for participation and consumption of each product (except USDA Choice, for which own price was held constant). Participation elasticities were calculated from probit marginal effects estimates, and evaluated at mean price levels and participation rates. Consumption elasticities were calculated from truncated Poisson marginal effects estimates, and evaluated at mean price levels and the mean of positive purchase quantities. All own price elasticities were negative, except for the premium quality consumption elasticity. About half of the cross price elasticities were negative, reflecting strong income effects in the experimental setting. The relative magnitudes are of greatest interest. Consumers were particularly price-sensitive when deciding whether or not to purchase lean and premium quality steak, and lean steak purchasers continued to be highly price-sensitive when choosing their consumption level. Premium quality steak purchasers, however, did not appear to let price deter them once they had made the decision to buy premium quality. Locally-produced steak faced the most own-price elastic demand in the consumption model. High premium quality steak prices induced more-than-proportionate increases in locally produced steak participation and

consumption, but consumers also appeared to readily substitute USDA Choice steak in response to higher locally-produced prices.

The survey contained a rudimentary CV question regarding willingness-to-buy locally-produced steak, and responses were qualitatively consistent with the locally-produced own-price elasticity estimates. The question asked, "How often would you choose locally-produced steak in the following situations?" The possible responses were "often" and "rarely." When locally-produced steak was assumed to be available "at the supermarket," 94 percent of consumers responded that they would buy it often if it cost less than steak produced elsewhere, and 88 percent said they would buy it often if it cost the same as steak produced elsewhere. However, if locally-produced steak cost $1 per pound or $2 per pound more than steak produced elsewhere, only 20 percent and 4 percent of consumers, respectively, said they would buy locally-produced steak often. When locally-produced steak cost the same or less than steak produced elsewhere, but was assumed to be available only at a specialty meat store, 50 percent of consumers changed their answer from "often" to "rarely."

Implications

The key elements of the experimental shopping framework are (1) a realistic consumption set and budget constraint, (2) a familiar product selection mechanism (i.e., food shopping) allowing realistic expression of the axioms of choice on which consumers' utility and demand functions are founded, and (3) internalization of the cost of diverging from one's true preferences.

The locally-produced product elicited curiosity and "willingness-to-try" in consumers. Locally-produced steak had the highest participation rate of any product, and consumers expected its taste to be slightly better than "regular" steak, on average. It was not uncommon to hear comments supportive of local farmers while we filled consumers' orders. Burdine, Meyer, and Maynard (2002) elicited similar sentiments in a contingent valuation survey of willingness-to-pay for locally-produced meats. The benefits from a viable local farming sector have public good aspects, making contingent valuation results vulnerable to strategic bias. The experimental framework used in the present study internalized the cost of consumers' responses, thus increasing the validity of the research results for marketing decisions.

Burdine, Meyer, and Maynard (2002) found that 52 percent of participants expressed willingness to pay at least a 20 percent premium for locally-produced steak, relative to a "typical" steak available in the grocery store. The locally-produced participation model estimated in the present study predicted that 51 percent of consumers would purchase at least one locally-produced steak at a 20 percent premium over the price of USDA Choice steak, holding all other variables at their mean levels. The similarity of the findings suggests that strategic and hypothetical bias were not severe in the prior CV estimates of WTP for locally-produced steak.

The results illustrated two cautionary findings regarding consumer response to the locally-produced attribute. First, although consumers were prone to try the local product, the –2.07 own-price elasticity estimate of locally-produced consumption suggested limited opportunities to command high premiums on the strength of local origin alone. The finding that only four percent of consumers said they would buy locally-produced

steak "often" at a $2 per pound premium (i.e., 22 percent above USDA Choice) hints that initial WTP, which includes the value of gaining information about the new product, may substantially exceed persistent WTP. Second, consumer interest in locally-produced steak was largely contingent on it being available at supermarkets versus specialty meat stores. Even if marketers could overcome the considerable challenges of gaining access to supermarket space, strategies based on gaining market share through competitive pricing or bundling the local attribute with other value-added attributes appear more promising than a strategy of attaching price premiums to the local attribute alone.

Based on experimental results, Lusk et al. (1999) suggested that the beef industry could increase revenues by marketing products with objective tenderness labels. In the present study, guaranteed tender steak had the second-lowest participation and consumption rates; only lean steak was less popular. Lusk and Schroeder (2002) found a similar result in a non-hypothetical choice experiment: when all steaks were priced equivalently, 7.5 percent chose a guaranteed tender steak, while 52 percent chose a Certified Angus Beef steak. The apparently conflicting results between Lusk et al. (1999) and the other two studies are most likely attributable to differences in consumer information and the consumption set.

Consumers sampled guaranteed tender and "probably tough" steak in the Lusk et al. experiment, and thus were able to define their preferences from immediate experience. When consumers knew which sample was guaranteed tender (as one would in a market setting), 51 percent were willing to pay $1.84 more on average to exchange their "probably tough" steak. In the present experiment, the guaranteed tender participation model predicted that only 20 percent of consumers would purchase at least one

guaranteed tender steak at a $1.84 premium over the USDA Choice price, holding all other variables at their mean levels. Consumers had to define their preferences for the tenderness attribute from prior experience and visual inspection of the samples, and had five alternatives from which to choose. Furthermore, the present study and Lusk and Schroeder (2002) offered five alternatives with diverse attributes, rather than a dichotomous offering emphasizing one attribute.

Synthesizing marketing implications from the three studies, consumer education and providing sensory opportunities (i.e., in-store demos) could play important roles in successfully promoting guaranteed tender beef products. In a market environment, guaranteed tender products would compete with branded products such as Certified Angus Beef that advertise premium quality, rather than products carrying negative labels such as "probably tough." The -2.99 cross price elasticity relating premium quality prices to guaranteed tender participation is consistent with consumer behavior in which initial decisions to purchase premium quality steak crowded out participation in the guaranteed tender product when consumers faced a binding steak budget.

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Table 1. Variable definitions and descriptive statistics

		N	Mean	Std.Dev.	Min	Max
PK	$/package for locally-produced steak	227	3.970	0.444	3.2	4.8
PL	$/package for lean steak	227	4.202	0.345	3.6	4.8
PP	$/package for premium steak, upper 2/3 choice	227	4.425	0.224	4	4.8
PT	$/package for guaranteed tender steak	227	4.218	0.358	3.6	4.8
PC	$/package for USDA choice steak	227	3.600	0.000	3.6	3.6
PLOCAL	price ratio of locally-produced over choice	227	1.103	0.123	0.889	1.333
PLEAN	price ratio of lean over choice	227	1.167	0.096	1	1.333
PPREMIUM	price ratio of premium over choice	227	1.229	0.062	1.111	1.333
PTENDER	price ratio of guaranteed tender over choice	227	1.172	0.100	1	1.333
GENDER	female/male (0/1)	224	0.473	0.500	0	1
PRICE_Q	quality of high- to low-priced steak is worth the cost (0=rarely, 1=usually)	224	0.754	0.431	0	1
ADV_ED	holder of 4-year college degree or higher (0/1)	227	0.507	0.501	0	1
LO_INC	annual income under $20,000 year (0/1)	227	0.070	0.257	0	1
HI_INC	annual income over $70,000 year (0/1)	227	0.216	0.412	0	1
CHILD	percent of children under 18 years of age in household	225	15.548	21.978	0	75
MIDAGE	percent of individuals 35-54 years of age in household	225	39.822	37.374	0	100
OLDER	percent of individuals 55+ years of age in household	225	23.296	39.162	0	100
LOCAL_T	quality and taste of local relative to regular steak (1=much worse, 5=much better)	222	3.396	0.690	2	5
LEAN_H	how much healthier is lean steak (1=much less healthy, 5=much healthier)	227	4.159	0.575	2	5
LEAN_T	taste of lean steak relative to regular steak (1=much worse, 5=much better)	227	3.049	1.140	1	5
NOHORM	how much healthier is steak with no added hormones (1=much less, 5=much healthier)	226	3.916	0.822	2	5
TIME	length of residence in state (1=<3 yrs., 2=3-10 yrs., 3=10-20 yrs., 4=>20 yrs., 5=lifetime)	227	4.044	1.120	1	5

Table 2. Specification tests suggest double-hurdle model more appropriate than Poisson or negative binomial models

	Test statistics, by model				
	Local	Lean	Premium	Tender	Choice
Conditional moment test for overdispersion [a]	1.449E+11	1.295E+12	3.155E+11	3.120E+11	7.420E+10
LM test for Poisson vs. negative binomial [b]	0.051	0.076	0.076	0.076	0.076
LR test for double-hurdle specification [c]	70.179	68.817	62.391	84.654	142.590

[a] All models, rejected null at .05 level of no overdispersion in untruncated data, $\chi^2(.95,16)=26.30$

[b] All models, failed to reject null at .05 level that negative binomial and Poisson are equally adequate, $\chi^2(.95,1)=3.84$

[c] All models, rejected null at .05 level that double-hurdle and untruncated Poisson are equally adequate, $\chi^2(.95,16)=26.30$

Table 3. Double-hurdle estimation results for five steak varieties

Variable	Locally-Produced		Lean		Premium Quality	
	Participation	Consumption	Participation	Consumption	Participation	Consumption
Intercept	-1.8059	0.4668	3.5154	-0.9740	2.1406	-0.6631
PLOCAL	-2.3102**	-2.5770***	-1.5153*	1.3960	0.3066	0.3436
PLEAN	-1.1879	-0.2028	-2.5124**	-2.5423	0.9221	0.2690
PPREMIUM	5.9130**	1.8477	1.3425	-2.2009	-2.6063*	0.6305
PTENDER	-0.7228	0.4704	-1.8797*	2.0078	-0.5552	-0.0071
GENDER	0.1225	-0.0780	-0.4652**	0.3055	0.1559	0.1438
PRICE_Q	0.0970	-0.3032*	-0.0916	0.1880	0.1677	0.2860
LO_INC	-1.7296*	0.4588	-0.2412	0.4932	-0.6455	0.3503
HI_INC	-0.4463	-0.0484	0.3221	-0.3254	-0.0442	0.3264
ADV_ED	0.7394**	-0.1792	-0.0350	-0.2541	0.53612***	-0.1440
CHILD	0.0010	0.0043	-0.0147**	-0.0065	-0.0074	0.0061
MIDAGE	0.0011	-0.0003	-0.0018	0.0048	-0.0039	-0.0008
OLDER	0.0009	0.0026	-0.0022	0.0068	-0.0076**	0.0031
LEAN_H	-0.3855	-0.0139	0.2479	0.8270**	0.0635	0.0384
LEAN_T	0.1186	0.0172	0.3523***	-0.0366	-0.2544***	-0.1412
NOHORM_H	0.1154	-0.0239	-0.1748	-0.2171	0.1706	-0.1076
LOCAL_T	0.1268	0.1309				
TIME	-0.1070	0.0836				
LLF [a]	-133.3845	-172.6234	-100.7441	-63.3390	-125.9129	-139.6053
LRI / R^2_P [b]	0.0999	0.2979	0.1687	0.4358	0.1669	0.1416

Variable	Guaranteed Tender		USDA Choice	
	Participation	Consumption	Participation	Consumption
Intercept	4.9363	3.2886	-1.6421	-2.8825
PLOCAL	-0.5315	-0.2622	1.4122*	2.0317**
PLEAN	-1.3773	-0.3993	1.5711	-0.1250
PPREMIUM	-3.7261*	-1.2048	0.1469	-0.1509
PTENDER	-0.1087	-0.8634	-0.4183	2.1986**
GENDER	-0.0098	0.2224	-0.3114*	0.2557
PRICE_Q	0.5668**	-0.1926	-0.2556	-0.0190
LO_INC	0.5646	0.3562	-0.3705	0.3861
HI_INC	-0.4798	-0.1348	-0.0177	-0.1355
ADV_ED	0.3297	-0.3280	-0.2336	-0.3317
CHILD	0.0044	0.0081	-0.0046	-0.0006
MIDAGE	0.0054	0.0075	-0.0001	-0.0021
OLDER	-0.0169	0.0049	-0.0010	-0.0033
LEAN_H	-0.0205	0.0833	-0.1917	-0.3112*
LEAN_T	-0.0840	0.1781*	-0.0070	0.0014
NOHORM_H	0.2700	-0.2013	-0.1058	0.1668
LLF [a]	-132.3484	-103.1985	-135.4033	-117.4245
LRI / R^2_P [b]	0.0757	0.3336	0.0544	0.3967

***, **, and * denote statistical significance at .01, .05, and .10 levels, respectively
[a] LLF denotes log-likelihood function value. All equations were statistically significant at the .05 level except guaranteed tender and USDA Choice participation equations.
[b] LRI (likelihood ratio index) applies to participation, R^2_P to consumption equations

Table 4. Uncompensated price elasticity estimates

Participation price elasticities, by model					
Price	Local	Lean	Premium	Tender	Choice
PLOCAL	**-0.90**	-1.94	0.35	-0.38	1.54
PLEAN	-0.49	**-3.41**	1.10	-1.05	1.82
PPREMIUM	2.57	1.92	**-3.28**	-2.99	0.18
PTENDER	-0.30	-2.56	-0.67	**-0.08**	-0.49
Consumption price elasticities, by model					
Price	Local	Lean	Premium	Tender	Choice
PLOCAL	**-2.07**	0.83	0.24	-0.19	1.63
PLEAN	-0.17	**-1.60**	0.20	-0.31	-0.11
PPREMIUM	1.65	-1.46	**0.50**	-0.97	-0.13
PTENDER	0.40	1.27	-0.01	**-0.66**	1.87

Figure 1. Strip steak purchases by type