Consumer Willingness-to-Pay for Pork Produced Under an Integrated Meat Safety System

By

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Abstract

The objective is to estimate consumer willingness-to-pay (WTP) for pork chops produced under an integrated program which is designed to reduce the incidence of *Salmonella*. A double-bounded model is estimated to determine Kansas and Indiana consumers WTP for these pork chops. The median WTP is $4.92 per pound.

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Introduction

The HACCP Final Rule (U.S. Department of Agriculture) indicates that food safety is best accomplished through a program that uses an integrated systems approach, linking on-farm production to consumption. A pre-harvest program focuses on live animal testing on farms whereas post-harvest inspection occurs after slaughter when the carcass is hanging on the rail. Officials at the Center for Disease Control and Prevention report that most pathogens enter the food chain at the farm level and are broadly distributed during slaughter and meat processing (Baltzer et al.). However, prevention at the production level is nearly impossible because the pathogens of concern occur naturally in dirt and manure.

The pork industry has been proactive in addressing meat safety issues related to pork production. For example, the National Pork Producers Council initiated the highly successful Pork Quality Assurance program which has three levels that require producers to voluntarily implement pork safety guidelines. Levels I and II correspond to various management practices such as recordkeeping and well water testing. In Level III, producers assure the slaughter plant that pork is free of chemical residues. Dryden suggests that a future level (i.e., Level IV) might include information on pathogens.

Salmonella is the pathogen most likely to be monitored in a pre-harvest program and integrated into a slaughter plant's HACCP program.[1] For example, the Danish *Salmonella* Control Program monitors and tests for *Salmonella* in live animals and post-harvest carcasses. However, it is unclear whether eradication of all pathogens at the farm

level is practical or necessary due to the potential for co-mingling during transport to the plant or at the plant's stockyards prior to entering the plant. Dryden notes that coordination of the pork marketing chain may facilitate information sharing and consequently reduce possible health hazards before animals arrive at a plant. However, Ragan indicates that the U.S. Department of Agriculture has no plans to regulate live animals.

In order to evaluate the feasibility of an integrated program linking production systems with slaughter and processing plants, producers and managers require information on benefits and costs to evaluate the feasibility of an on-farm system. Previous research by Mark has shown that the costs associated with on-farm testing for *Salmonella* vary by the type of test (hide swipe test, fecal test, and blood test), and range from approximately $2.00 to $5.00 per animal. If the costs of food safety are passed along to consumers, then information on their willingness-to-pay (WTP) is needed to analyze the benefits and costs of such an integrated program.

Estimating a consumer's WTP is a common method for providing information to policy makers regarding the potential benefits and costs associated with a particular policy. Typically, this involves eliciting a consumer's WTP for a particular policy. Three methods are typically used to obtain bids: personal interviews, written surveys, or experimental auctions. Consumers are asked to respond "yes" or "no" to a question regarding alternative bids for a particular policy.

Hanneman and Carson first proposed a double-bounded model which asks a consumer to answer "yes" or "no" to an initial bid, followed by a second question which again asks a consumer to answer "yes" or "no" to a particular bid. Hanneman, Loomis,

and Kanninen compared single- and double-bounded logit models and reported that the double-bounded model yields tighter confidence intervals. Herriges and Shogren report similar results. Hanneman and Kanninen (page 70) "...recommend using the double-bounded format when collected CV (i.e., contingent valuation) data because of the extra information it provides."

The objective of this research is to estimate consumer willingness-to-pay for pork produced under an integrated program which is designed to reduce the incidence of meat pathogens. The food pathogen chosen in this research is *Salmonella*. Following Hanneman and Kanninen's recommendations, a double-bounded model is estimated to determine consumer WTP for pork which has been produced under an integrated meat safety system.

Theory and Methodology

To motivate the double-bounded model, the single-bounded model is introduced. Let B denote the value of the bid and π is the probability associated with a "yes" or "no" response (Hanneman, Loomis, and Kanninen). For the single response scenario with only one bid (single-bounded model), the probability of obtaining a "yes" response to that bid is

(1) $$\pi^{y}(B) = 1 - G(B;\theta)$$

and the probability of receiving a "no" response bid is

(2) $$\pi^{n}(B) = G(B;\theta).$$

$G(B;\theta)$ represents a cumulative density function such as the logistic function and θ is a set of unknown parameters (a, b) which are hypothesized to determine a person's response to a bid. This can be expressed as

(3) $$G(B) = \left[1 + e^{\alpha - \beta(B)}\right]^{-1}.$$

The scenario where an individual responds to one bid which is then followed up with an alternative bid (double-bounded model) has four possible responses (yes-yes, no-no, yes-no, no-yes). The probability of receiving a "yes" response to the first bid followed by a "yes" response to the second bid is

(4) $$\pi^{yy} = 1 - G(B_i^u;\theta)$$

where B_i^u is the second bid for the *i*th respondent ($B < B_i^u$), *y* denotes "yes". The probability of receiving a "no" response to the first bid followed by a "no" response to the second bid is

(5) $$\pi^{nn}(B_i, B_i^d) = G(B_i^d, \theta)$$

where B_i^d is the second bid for the ith respondent ($B < B_i^d$) and *n* denotes "no". For the other two outcomes, the probability of receiving a "yes" response and then a "no" response ($B > B_i^u$) is

(6) $$\pi^{yn}(B_i, B_i^u) = G(B_i^u;\theta) - G(B_i;\theta)$$

and the probability of receiving a "no" response followed by a "yes" response ($B > B_i^d$) is

(7) $$\pi^{ny}(B_i; B_i^d) = G(B_i;\theta) - G(B_i^d;\theta).$$

The log-likelihood function for the double-bounded model is

(8) $$\ln L^D(\theta) = \sum_{i=1}^{n} d_i^{yy} \ln \pi^{yy}(B_i, B_i^u) + d_i^{nn} \ln \pi^{nn}(B_i, B_i^d) + d_i^{yn} \ln \pi^{yn}(B_i, B_i^u) + d_i^{ny} \ln \pi^{ny}(B_i, B_i^d).$$

where *ln* is the natural log operator and L^D is the value of the double-bounded log likelihood. The equations for the binary variables $(d_i^{yy}, d_i^{nn}, d_i^{yn}, di^{ny})$ are shown in equations (4) through (7).

Data

A survey was formed to measure consumer attitudes towards a pork product that was labeled as having been produced under an integrated program which included on-farm testing by producers for the pathogen *Salmonella*. Consumers in two metropolitan areas (250 consumers from Indianapolis and 250 consumers from Kansas City) were the survey sample for these data. These geographic regions were chosen because a producer-owned pork marketing cooperative was interested in marketing pork products with this label in these markets. Their producers were interested in the economic incentives that might be present for implementing such an integrated program.

The consumers were identified from transaction-level data ("scanner data") provided by a collaborating retail supermarket chain in each region. Two types of consumers were surveyed: 1) the top 250 (125 in each city) purchasers (as measured by sales volume) of unfrozen or "fresh" pork products and 2) the top 250 (125 in each city) purchasers of unfrozen pork products (as measured by sales volume over the 1998 calendar year) who also simultaneously purchased products which were labeled 'organic', such as hydroponic tomatoes. The largest purchasers of pork products were chosen because they represented the largest sales and were hypothesized to have a preference for pork (due to their large consumption) which have been labeled for safety. Those consumers who also purchased organic products were chosen because they were hypothesized to have a preference for safety-enhanced products.

The surveys asked that the person most responsible for food purchases for the household complete the survey and provide information about their: 1) attitudes towards various types of meat (beef, pork, chicken), 2) knowledge and attitudes towards food

safety, and 3) socio-demographic information.[2]

The survey described a Pork Quality Assurance program that would allow pork producers to be certified with regard to animal and food safety by completing a continuing education course every two years, having their farm inspected, and testing for *Salmonella* (similar to Dryden's proposed program). This program is similar to the existing PQA program administered by the National Pork Producers Council but includes a final step of on-farm pathogen testing.

After describing the PQA program, consumer WTP bids were elicited using a double-bounded model in which consumers were asked to choose between regular pork chops and pork chops produced under the PQA program. The first bid asked consumers to choose a bid for regular pork chops and the pork chops produced under the PQA program. A second bid was contained in a follow-up question to this first bid.

Four versions of the survey were used which differed only in the amount of the bid. The bid for the pork chops produced under the PQA program was higher in every instance. For example, in Version 1, consumers were asked to choose between a regular pork chop for \$3.00 per pound (i.e., B) and a Quality Assured pork chop for \$4.00 per pound. The consumers that selected the regular pork chops were then asked to chose between a regular pork chop at \$3.00 per pound and a Quality Assured pork chop for \$3.50 per pound ($B^{d.}$). Consumers that selected Quality Assured pork chops in the first question were asked to chose between a regular pork chop at \$3.00 per pound and a Quality Assured pork chop at \$4.60 per pound (B^{u}). The four versions (125 each) of these 500 surveys describing the PQA program varied the prices at which consumers could purchase the regular and PQA pork chops. The initial \$3.00 price corresponded to

the per pound average price for pork chops that was reported for the 1998 calendar year transaction data. These prices are summarized in Table 1.

With respect to our methodology, we first calculate the means and standard deviations for selected attitudinal variables. Then the log-likelihood function in equation (9) is formulated in GAMS 2.25 (Brooke, Kendrick, and Meeraus) and solved by maximizing the log-likelihood function in GAMS/MINOS 5.3 (Murtagh and Saunders). Goodness of fit is measured by using McFadden's pseudo R^2 as adapted by Herriges. The variance-covariance matrix is calculated and used for hypothesis testing.[3]

Results

No significant differences (using equality of mean t tests) were found between geographic regions in the attitudinal questions so the results are presented in aggregate form. In addition, we found no significant differences between the two groups in our sample and these results are also presented in aggregated form. Thus, consumers who had the highest sales volume and those consumers who also purchased organic products appear to have similar preferences in our data. Both groups in each city had similar response rates and the overall average response rate was 34.6 percent (173 respondents).

The mean and standard deviation for selected attitudinal questions are presented in table 2. The majority of respondents were women. The mean highest level of education in our sample was between "some college, no degree" and "B.A. or B.S. degree." The mean level of income was approximately $70,000. Respondents were most concerned over tenderness, followed by color, presence of external fat, and leanness which were ranked above 4.4 on a scale of 1 (not important) to 5 (great importance). Artificial

ingredients, marbling, packaging, and sodium were less important relative to the previously listed questions. Melton, Huffman, and Shogren reported similar results as marbling was found to be less important while color was found to be more important.

Only the bid was used as an independent variable in equation (9).[4] When estimated separately, we found no significant differences between the two groups in each city (P = .012). The estimated parameters and other selected statistics are presented in table 3. The median WTP is calculated as the intercept parameter divided by the bid parameter. For this data, the median WTP equals $4.92. The parameter on the bid was statistically different from zero at the .001 level of significance. The pseudo R^2 is .13. Thus, the results suggest that consumers might be WTP more for pork chops that have been produced under an integrated program that includes *Salmonella* testing at the farm level.

Implications

The results suggest that consumers are concerned about various attributes of pork and might be willing-to-pay more for pork that is produced in an integrated system that includes on-farm testing of *Salmonella* coupled with a slaughter plant's HACCP program. It is not possible to directly compare the costs reported by Mark with the benefits found in this study. Nonetheless, the information suggests that there may be economic incentives for producers who might consider putting together such an integrated program that would include an on-farm pork quality assurance program.

Footnotes

[1]Blaha notes that research is underway to identify critical control points which could be used by producers and slaughter plant managers as part of an integrated program.

[2]A copy of the survey is available upon request from the authors.

[3]We also estimated the log-likelihood function using Herriges and Shogren's proposed method (the "gamma" term was .012 in our study which was not statistically different from zero) and Cameron and Quiggin's proposed method using the probit model. Because we found no evidence of "anchoring", we have not reported those results. This suggests that, for our sample, the initial bids are centered on the true WTP.

[4]We also included other variables such as gender, income, education, etc. but these were all insignificant and contributed little to the value of the log-likelihood function. Similar results were reported by Hanneman, Loomis, and Kanninen.

Table 1 Prices Offered to Consumers in Double-Bounded Model

Version	First Outcome (B)	Second Outcome (if they chose $3.00 as first outcome), B^d	Second Outcome (if they chose the higher price as the first outcome), B^u
1	$3.00 or $4.00[a]	$3.00 or $3.50	$3.00 or $4.60
2	$3.00 or $3.50	$3.00 or $3.20	$3.00 or $4.00
3	$3.00 or $4.60	$3.00 or $4.00	$3.00 or $5.50
4	$3.00 or $5.50	$3.00 or $4.60	$3.00 or $6.50

[a]For example in version 1, if the consumer chose $3.00 ("No") as the first outcome, then their second outcome would be either $3.00 ("No") or $3.50 ("Yes").

Table 2Mean and Standard Deviation for Selected Attitudinal and Socio-Demographic Questions

Question	Mean (Std. Dev.)
Gender (0 = female, 1 = male)	.16 (.39)
Education (1 = high school, ..., 8 = graduate degree)	4.6 (1.6)
Age (years)	41.22 (11.97)
Income (1 = less than $20,000, ...,12 = greater than $120,000)	6.5 (3.6)
Tenderness (1 = less important, ..., 5 = great importance)	4.6 (.6)
Marbling (1 = less important, ..., 5 = great importance)	3.98 (.95)
Color (1 = less important, ..., 5 = great importance)	4.52 (.77)
Packaging (1 = less important, ..., 5 = great importance)	3.7 (1.01)
External Fat (1 = less important, ..., 5 = great importance)	4.5 (.8)
Artificial Ingredients (1 = less important, ..., 5 = great importance)	4 (1.1)
Leanness (1 = less important, ..., 5 = great importance)	4.4 (.8)
Sodium (1 = less important, ..., 5 = great importance)	3.44 (1.3)

Table 3Parameter Estimates and Selected Statistics for the Single-Bounded and Double-Bounded Models

Variable	Double-Bounded
Intercept	5.293
Bid expressed in e^B	1.078 (.0002)
Likelihood Value	-244.638
Pseudo $R^{2, a}$	.13

[a]The pseudo R^2 for the double-bounded is Herriges' modification of McFadden's pseudo R^2.

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