Consumers' Willingness to Pay for Food Safety: A Pathogen Specific Analysis

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Abstract

Estimates of the economic benefits of intervention strategies to make food safer from specific pathogens for different durations of protection are not available. We estimated consumers' willingness to pay for a hypothetical vaccine that would deliver a 1-year, 5-years, 10-years, or lifetime protection against *Salmonella*, *E. coli*, or *Listeria*. We used logit and Tobit models to estimate the economic benefits of food safety measures against these major foodborne pathogens. Based on FoodNet 2002 population survey data, consumers were willing to pay for protection against foodborne pathogens. They were willing to pay more for longer protection and for protection against *E. coli* compared to *Salmonella* or *Listeria*. However, they were less willing to pay if the protection was costly.

Key words: Contingent valuation, Food Safety, Economic benefits, population survey

Introduction

"*We have built a solid foundation for the health of America's families. But clearly we must do more. No parent should have to think twice about the juice they pour their children at breakfast, or a hamburger ordered during dinner out.*"

– *President Bill Clinton, Radio Address, January 25, 1997*

Safety from foodborne illnesses has become one of the main concerns of American families over the past decade. National Food Safety Initiative (NFSI) was conceived during Clinton administration in 1997 to address those concerns. NFSI funded research and intervention strategies that estimate burden of illness caused by food and water borne pathogens and implement regulations to improve the safety of the US food supply. The most common method used to estimate the economic burden of illness is the cost-of-illness approach which may well underestimate the cost because of its inability to measure society's pain and sufferings. Several studies have estimated the cost of illness caused by foodborne pathogens like *Salmonella*, *Listeria* and *E. coli* (see Buzby and Roberts, 1995, Buzby et al., 1996, Frenzen et al., 1999).

Estimates of the economic benefits of intervention strategies to make food safer from specific pathogens are not available. Classical economics tells us that benefits and costs should be similar for marketable goods. Food safety is a non-market good, which means the benefits from food safety are not directly observed in the marketplace. Nonetheless, the estimates of these benefits are needed to calculate the social benefits from specific measures to improve the level of food safety. A common way of estimating the benefits of food safety is to use the contingent valuation method. In this study contingent valuation method is used to estimate the willingness to pay (WTP) for a vaccine that would protect a person against major foodborne pathogens for different durations. FoodNet conducted a survey in which subjects were asked whether they would be willing to pay a specified amount of money to purchase an intervention that would protect them against foodborne pathogens. The individual would respond with a 'yes' if his or her level of satisfaction from consuming safer food at the reduced income level is not less than their level of satisfaction from consuming food considered to be less safe at the original income. The National Oceanic and Atmospheric Agency (NOAA 1993) recommended that contingent valuation studies be done using yes-or-no referendum format questions. The yes or no responses are then translated into mean or median WTP numbers following the formulas provided by Hanemann (1984, 1989).

Another objective of this study is to undertake an empirical analysis to evaluate the factors that impact the WTP responses elicited in the FoodNet survey. We used regression analysis to determine the factors associated with consumers' expected WTP for protection against foodborne pathogens. We conducted a series of regressions to examine how the participants' WTP vary across the respondents according to a type of pathogen, duration of protection, gender, and race. Regression analysis allowed us to undertake this analysis while correcting for the effects of a variety of other variables including age, education, household income, home setting and the respondent's current health condition.

We used 2002 Foodborne Diseases Active Surveillance Network (FoodNet) population survey data that were collected over a 12-month period. In the survey, respondents were selected randomly for telephone interviews and asked whether they would be willing to pay a bid amount of: $25, $50, $75, or $100 for a hypothetical vaccine that would deliver a: 1-year, 5-years, 10-years, or lifetime of protection against *Salmonella*, *E. coli*, or *Listeria*. Only those who responded with a 'no' were asked a follow up question about how much they would be willing to pay, resulting in a censored dataset. Data on socioeconomic and demographic characteristics, health status, and food safety awareness were obtained from the FoodNet 2002 population survey.

Some of the questions we want to answer include: 'are WTP responses for protection against foodborne illnesses sensitive to the type of pathogen?'; 'does the time frame of protection affect elicited values?'; and 'do values differ whether the person is self-protecting or providing protection for children?' We used a logit model to estimate the probability that a respondent will accept a given bid amount and analyzed the factors that determine this probability. We used a Tobit model to estimate dollar amounts that consumers will be willing to pay given a specific pathogen and duration of protection.

The Data

FoodNet data set were collected over a 12-month period in the year 2002. Respondents were selected randomly for telephone interviews from nine Emerging Infections Program (EIP) sites which includes nine states (in 2002): California (CA), Colorado (CO), Connecticut (CT), Georgia (GA), New York (NY), Maryland (MD), Minnesota (MN), Oregon (OR) and Tennessee (TN). Although the chosen states may not be representative of the whole country, we hope that our study might yield interesting and useful insights about the geographical distribution of WTP across the USA.

FoodNet 2002 data set contains information on a randomly selected individual residing in his or her private residence located at one of the EIP states derived from random telephone interview surveys. This information includes data on individual characteristics like gender, race, ethnic associations, age and education; socio-economic characteristics like household income, medical insurance and home setting; health status, food safety awareness and expected risk and severity assessments. If the selected individual is below 12 years of age the child's parent or guardian provided proxy answers for the child. Children between 12 and 15 years of age are considered non-working and did not answer work related questions. In order to obtain information on the distribution of WTP responses we confine ourselves to examining data with valid (yes or no) responses to the following question[1]:

"*Imagine there were a safe vaccine against* {*random pathogen*} *that* {*you or your child*} *could swallow*. *This vaccine would have no side effects and would last for* {*random time period*}. *Would you be willing to pay* {*random dollar bid*} *for this vaccine* (*assume that this is not covered by your insurance*)?"

Only those who responded with a 'no' were asked a follow up question:

"*If no*, *how much would you be willing to pay*?"

Responders were given a choice of only one random pathogen out of *Salmonella*, *E. coli* and *Listeria*, one random time period out of one year, five years, ten years, and lifetime periods, and one random dollar bid out of $25, $50, $75 and $100 bids before providing their yes or no response. Yes or no response to willingness to pay a random bid amount is the primary variable examined in this study. The mean of this variable represents the proportion of respondents who accepted the random bid amount. Further

[1] Some outliers are omitted from the analysis so as to prevent our regression analysis from being dominated by a few, possibly spurious, observations. For example, some responded with a 'no' to the dollar bid amount but offered a bigger payment. Those observations were left out from censored regression to avoid confusion between censored and uncensored observations.

analysis were conducted with a censored variable that takes the dollar value of the random bid amount if the respondent were willing to pay the bid and takes the dollar response to the follow up question if he or she rejected the bid.

Table 1: Percent of respondents willing to pay the bid amount for a vaccine against food-borne pathogens (*Salmonella* or *E. coli* or *Listeria*) by duration of prevention.

Bid ($)	$25	$50	$75	$100
All durations	68 (1949)	56 (1893)	50 (1812)	45 (1854)
Duration of protection: 1 year	58 (508)	45 (493)	36 (411)	31 (447)
Duration of protection: 5 years	67 (466)	54 (470)	46 (448)	42 (483)
Duration of protection: 10 years	70 (483)	61 (466)	53 (457)	47 (438)
Duration of protection: lifetime	76 (492)	64 (464)	63 (496)	58 (486)

Table 1 reports the percentage of respondents accepting the bid separated by the years of protection irrespective of the pathogen. On average, 68%, 56%, 50%, and 45% of respondents were willing to pay $25, $50, $75, and $100, respectively, for a hypothetical vaccine to protect them against one of the foodborne pathogens. The percentage of respondents willing to pay for the vaccine increased with the duration of protection for each bid level. The response shows that the law of consumer demand holds because number of respondents willing to pay higher dollar amount decreases as the bid amount increases.

The results are not so clear when the same percentages are computed for pathogen specific protection. Especially, the bid levels and/or timeframe of protection do not fully explain the variations in the WTP responses from protection against *Listeria* (see Figure 1). The sources of these variations among examined groups are not always clear.

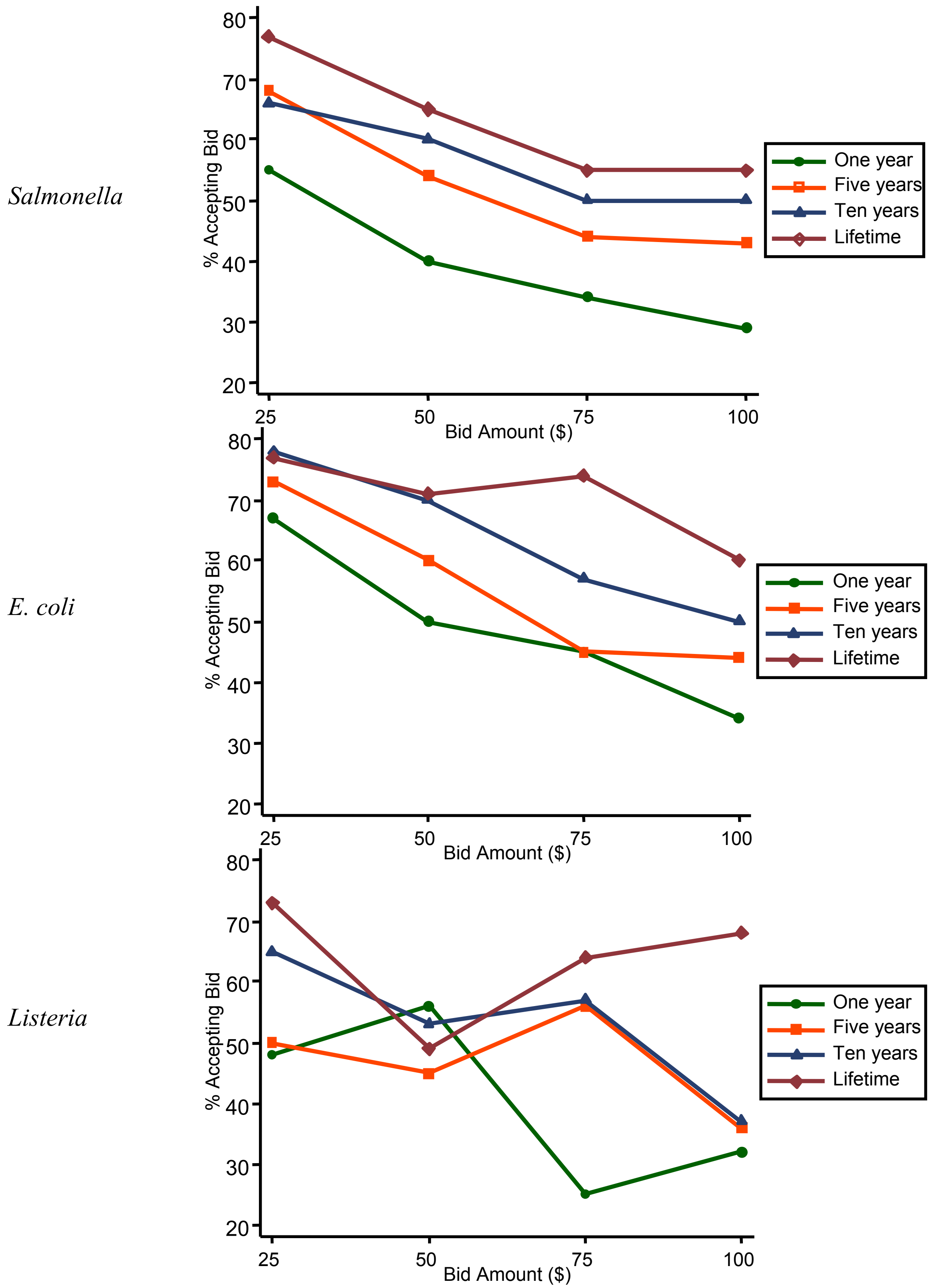

Figure 1. Percent of respondents willing to pay the bid against *Salmonella*, *E. coli*, and *Listeria* by duration of prevention

There must be other factors or groups that impact the WTP responses other than type of pathogen or duration of prevention or the bid levels. It will be interesting to see how much of the variations in WTP responses remain after correcting for individual and socio-economic characteristics through regression later in this study.

Methods

The willingness to pay (WTP) is defined by the equality of indirect utility functions: $u(I - WTP, s^1; D) = u(I, s^0; D)$, where u represents indirect utility function, I denotes income level, D represents a set of demographic and socio-economic characteristics, and s^0 and s^1 indicates unsafe and safe food correspondingly (Vaughan et al. 1999). In case of dichotomous (yes or no) response question, WTP is not observable. Let v be the observable part of the indirect utility function u. An individual will respond with a 'yes' to the random bid if

$$v(I - Bid, s^1; D) + \varepsilon^1 \geq v(I, s^0; D) + \varepsilon^0,$$

where ε^1 and ε^0 are i.i.d. random variables with zero means. Suppose the above equation can be rewritten by specifying v as the functional form of a statistical model,

$$\alpha_1 + \beta(I - Bid) + \varepsilon^1 \geq \alpha_0 + \beta I + \varepsilon^0,$$

where α_0, α_1, and β are functions of D and hence suppressed. Therefore,

$$\begin{aligned} Pr(\text{'yes'}) &= Pr(\alpha_1 + \beta(I - Bid) + \varepsilon^1 \geq \alpha_0 + \beta I + \varepsilon^0) \\ &= Pr(\varepsilon^0 - \varepsilon^1 \leq \alpha_1 - \alpha_0 - \beta Bid) \\ &= Pr(\varepsilon \leq \alpha_1 - \alpha_0 - \beta Bid) \text{ where } \varepsilon = \varepsilon^0 - \varepsilon^1 \text{ is the error term.} \end{aligned}$$

In the logit model, errors are assumed to have a standard logistic distribution with mean 0 and variance $\pi^2/3$. The cumulative distribution function can be written as

$$\Lambda(\varepsilon) = \exp(\varepsilon)/[1 - \exp(\varepsilon)].$$

The logit specification in our study becomes,

$$\Pr(\text{'yes'}) = \Lambda(\alpha_1 - \alpha_0 - \beta \text{Bid}) = \Lambda(\alpha - \beta \text{Bid} + \gamma D),$$

where $\alpha_1 - \alpha_0 = \alpha + \gamma D$, D = vector of demographic and socio-economic variables. The logit model can be written as the log-linear model:

$$\ln \Pr(\text{'yes'})/\Pr(\text{'no'}) = \ln \Pr(\text{'yes'})/[\ 1 - \Pr(\text{'yes'})] = \alpha - \beta \text{Bid} + \gamma D.$$

Since this model is linear, the parameters can be interpreted in terms of odds ratios.

The Tobit formulation in our study is as follows:

$$\begin{aligned} \text{WTP}_i &= \text{WTP}_i^* \quad \text{if } \text{WTP}_i^* < \text{Bid}_i \\ &= \text{Bid}_i \qquad \text{if } \text{WTP}_i^* \geq \text{Bid}_i\,, \end{aligned}$$

where WTP_i is the stated WTP of respondent *i* and WTP_i^* is the corresponding latent variable that is observed for values less than Bid_i and is censored for values greater than or equal to Bid_i. The estimation of the Tobit model requires the maximum likelihood procedure, which assumes that the errors are normal and homoscedastic (Long 1997). If these assumptions are violated the estimates remain consistent, but not efficient. The maximum likelihood estimation assumes that both the uncensored and censored responses were generated from the same process.

Some explanation of the variables used in this study is necessary before we begin examining the results of our analysis. A number of variables are “dummy variables” which are one if the respondent indicated that he or she was a member of a certain group, and zero otherwise. The “Female,” “Black” and “Hispanic or Latino” variables are dummy variables that are set equal to one if the respondent or respondent’s child was a member of those groups, and zero otherwise. In general, gender should not affect WTP.

However, eating behavior of males and females can be different. Furthermore, females are more involved in buying and handling food. Therefore, female perception of risk of foodborne diseases can be different from male. Food safety practices and eating behavior can also be closely associated with race, ethnicity, and culture of respondents.

The age variables were computed similarly, based on the participant's response to a question regarding his or her or child's (in case of a proxy) age. Respondents were divided into five categories, "Infant or Toddler" (less than five years old), "Young" (five or more but less than 12 years old), "Youth" (12 or more but less than 18 years old), "Intermediate age" (18 or more but less than 65 years old) and "Elderly" (more than or equal 65 years old), according to current age of the respondent or respondent's child. In fact, the parent or guardian of the selected child provided responses for those in the "Infant or Toddler" and "Young" category. They are expected to pay more to protect their offspring. Elderly respondents are willing to pay more or less depending on their life experiences with foodborne illnesses.

The education level variable records the respondent's education level on a nine point scale starting from less that first grade to doctorate degree.[2] Respondents were divided into three categories, "Less than high school" education (up to 12th grade with no diploma), "High school graduate" education (high school diploma, some college without degree or college with associate degree) and "College graduate" (bachelor's, master's, or doctorate degree). More educated people are expected to pay more because they are familiar with potential risks from foodborne pathogens.

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[2] We exclude respondents with technical and other degrees so as to allow examination of our regression equations with a continuous education level variable. Education level variable may include responses that proxy responders answered for themselves.

The “Household income” variable represents each respondent’s or proxy respondent’s self-reported household income (before taxes) category levels in 2000. The variable was recoded from seven category levels to three category levels of income, “Household income less than or equal $15K per year,” “Household income greater than $15K but less than or equal $40K per year” and “Household income more than $40K per year” with additional assumption that grouping won’t change when household income numbers are expressed in 2002 dollars. The respondents with higher household income are expected to pay more.

Home setting variables are dummy variables that are assigned the value one according to whether the respondent indicates that he or she lives in a “Rural,” “Suburban,” or “Urban” areas. State dummies are included in the analysis to find if there are any state specific effects. Respondents living in rural and suburban areas are more likely to have experience with working in farms, have contact with farm animals and exposed to lesser hygienic conditions than their urban counterparts. Therefore, rural people are more vulnerable to foodborne illnesses. Respondents who perceive this risk are willing to pay for protecting themselves from foodborne illnesses.

Health status variables are based on the participant’s response to a series of questions regarding his or her health condition. These are dummy variables that are assigned the value one if the respondent had “Recent (past month) case of diarrhea or vomiting”. “Groups at high risk for diarrheal illnesses” dummy variable includes individuals who has been told to have diabetes or heart disease or high blood pressure or kidney disease, or had organ transplant or liver disease or cancer or spleen removed or HIV/AIDS or other illnesses, or was pregnant during previous month. Although infants or toddlers (less than five years old) and elderly (more than or equal 65 years old) are considered to be at high risk for food-borne illnesses, this group does not separate them as such.

Selected activities like “Attend daycare” and “Drink untreated tap water at home” are two more dummy variables that measure respondent’s preference towards sending less than five years old infant or toddler in the household to daycare and respondent’s habit of drinking untreated water at home. “Eat out-of-home” variable is based on the participant’s response to a series of questions regarding his out-of-home eating habits. The dummy variable takes a value one if in the past seven days he or she ate in a regular sit-down restaurant or deli shop or sandwich shop or fast-food chain or buffet restaurant or ready-to-eat food in a supermarket or street vended food or ready-to eat food in a convenience store. Other than food safety awareness dummy the data includes expected severity of illness variables that record the respondent’s rating of his or her severity of sickness on a three point scale from “mild” sickness to “severe” sickness if ate food with a specific pathogen. We have converted these variables to a negative one to one scale in order to express mild sickness level as a negative number.

The dependent variable in the logit model is yes or no responses to willingness to pay a given bid amount. A series of dummy variables for the type of pathogen, duration of prevention that the imaginary vaccine provides, and the bid level offered to the respondent are included as independent variables. We also included dummy variables for gender, race, ethnicity, age, education, household income, residency, state where the respondent lives, health status of the respondent, respondent’s subjective severity of illness assessment, selected type of activity in which the respondent engages and the respondent's knowledge about food safety. The dummy variables that are used in the model are set up so that the "reference level" for the equation (when all of the dummy variables take a value of zero) is a male respondent, not Black or Hispanic or Latino, between 18 and 65 years of age, with high school graduate degree, household income between $15K to $40K per year, who lives in urban areas, had no case of diarrhea or vomiting in the past month, does not belong to the high risk group for diarrheal illness, has no infant or toddler at home who attend daycare, does not drink untreated tap water at home, ate out-of-home in past seven days, has not heard the Fight-bac food safety message, gets moderately sick if eats food containing *Salmonella* and were asked to pay $100 for lifetime protection. As a result, all of the odds ratios for the dummy variables in the equations can be interpreted as the factor changes associated with changing a factor from the reference level, holding all other variables constant. The results for the logit regression reported in Table 2.

FoodNet data also provides a censored willingness to pay variable measured through an open-ended contingent valuation method survey. Empirical analyses were performed using the dollar values for the willingness to pay as the dependent variable. All the independent variables used in the logit regression described above, except the dollar bid, were included as the independent variables. The dependent variable is censored since the respondents who were willing to pay the bid were not asked a follow up question: how much more are you willing to pay over the specified bid amount? Also, the censoring limits differ by an individual. A Tobit regression model was estimated to take into account this censoring and to avoid getting biased and inconsistent estimates of the parameters in the model. Table 2 reports the consistent estimates of the effects of the independent variables on the latent variable WTP_i*. The reference level was set the same way as in the logit model except that the bid dummies were left out.

Results

The logit model of consumers' WTP for the hypothetical vaccine yielded the following predictions. Holding all other variables fixed, the odds of accepting a bid were 1.4 times greater ($p<0.000$) for *E. coli* than *Salmonella* or *Listeria*; 3.3 times higher ($p<0.000$) for a bid amount of $25 compared to $100; lower by a factor of 0.3 ($p<0.000$) for one-year prevention compared to a lifetime protection. As expected, odds ratios were higher for more durable vaccine and lower bid amount. The odds ratios for the female and Black dummy variables were not statistically significant. For a Hispanic/Latino individual the odds of saying 'yes' to the bid were 1.9 ($p<0.000$) times greater than for a non-Hispanic or non-Latino. The odds ratio associated with various age groups decreased as we move from younger age group to older age group. The odds were 0.8 ($p<0.002$) times smaller for a college graduate than for a non-college graduate, a surprising result. Odds of responding with a 'yes' to the bid were higher for respondents having household income more than $40K per year compared to respondents from middle-income households. Respondents living in rural areas were less willing to pay for the vaccine than those living in urban areas. Respondents, who were at high risk for diarrheal illnesses or those who had a recent case of diarrhea or vomiting, were more likely to pay than those who were healthier. Also, the likelihood of saying 'yes' increased with respondent's higher expected severity of illness if ate food, containing pathogen. Sending kids to daycare or drinking untreated tap water at home were significant factors affecting WTP.

Table 2: Logit and Censored (Tobit) Regression Results.

Regression Model	Logit		Censored – Tobit	
	Odds Ratio	Z	Coeff.	Z
Protection from *E. coli*	1.37**	4.59	10.45**	4.06
Protection from *Listeria*	0.96	–0.50	0.22	0.07
Duration of prevention: 1 year	0.30**	–14.00	–41.21**	–13.44
Duration of prevention: 5 years	0.53**	–7.47	–23.91**	–7.35
Duration of prevention: 10 years	0.71**	–3.96	–14.77**	–4.40
Random bid amount: $25	3.31**	13.85	–	–
Random bid amount: $50	1.71**	6.41	–	–
Random bid amount: $75	1.24**	2.56	–	–
Gender: female	0.94	–1.03	0.40	0.18
Race: Black	0.99	–0.10	–1.08	–0.26
Ethnicity: Hispanic/Latino	1.88**	4.11	21.64**	3.68
Infant/Toddler (< 5 years)	2.69**	5.66	31.97**	4.80
Young (≥ 5 years but < 12 years)	1.77**	4.00	20.39**	3.70
Youth (≥ 12 years but < 18 years)	1.84**	2.60	19.57**	2.14
Elderly (≥ 65 years)	0.56**	–5.51	–15.50**	–4.41
Less than high school education	1.13	0.95	7.32	1.54
College graduate	0.82**	–3.10	–7.52**	–3.16
Household income (≤ $15K / year)	0.90	–0.94	–6.74*	–1.65
Household income (> $40K / year)	1.25**	3.02	4.10	1.57
Rural home setting	0.81**	–2.61	–8.16**	–2.80
Suburban home setting	0.95	–0.73	–0.19	–0.07
Recent (past month) diarrhea or vomiting	1.24**	2.55	6.30**	1.99
Groups at high risk for diarrheal illnesses	1.19**	2.69	4.60*	1.90
Expected severity of illness: mild	0.77**	–2.87	–8.99**	–2.83
Expected severity of illness: severe	1.28**	3.78	10.90**	4.50
Attend daycare	1.35**	2.32	9.80**	2.03
Drink untreated tap water at home	0.87**	–2.31	–5.01**	–2.26
Not eating out-of-home (past seven days)	0.87	–1.57	–6.39*	–1.95
Heard Fight-bac food safety message	1.34**	2.13	4.82	0.97
Reference level	–	–	103.53**	18.30
Pseudo R-square	0.10		–	
Log pseudo-likelihood	–3242		–10798	
Number of observations	5293		1667 – uncensored 3065 – right-censored	

* Statistically significant at 10% level. ** Statistically significant at 5% level. Note: Yes or no response to willingness to pay a random bid amount is the dependent variable in the logit model. Willingness to pay ($) is the dependent variable in the censored (Tobit) regression model. The state specific dummies were also included but not reported in the table. In logit regression chi-squared statistic (≈ 606) is significant at >1% level. In the censored regression chi-squared statistic (≈ 500) is significant at >1% level. Z-statistics are reported for all regression models. Robust standard errors are used to compute Z statistics in both regressions.

Results from the Tobit model show that compared to the expected WTP for a vaccine with lifetime protection against *Salmonella* for the reference individual (\$104, $p<0.000$), consumers were expected to pay \$10 ($p<0.000$) more for protection against *E. coli*, \$41 ($p<0.000$) less for one-year prevention, \$16 ($p<0.000$) less if aged 65 years and above, \$32 ($p<0.000$) more on behalf of children less than five years of age, holding all other variables constant. The expected WTP increased as the duration of protection increases, which is consistent with our prior expectation. The expected WTP was higher for proxy response dummies (“Infant/Toddler” and “Young”), where the parent or guardian of the selected child provided responses. There is no way to determine if this is a proxy bias or reflects a true higher WTP. Once again, gender and race were not significant factors. However, respondents of Hispanic or Latino origin were expected to pay \$22 ($p<0.000$) more than non-Hispanic or non-Latino respondents. Interaction terms were added in the Tobit specification to find other associated factors that were driving the result. College graduates expected WTP were \$8 lower ($p<0.002$) than high school graduates. Respondents with a household income of \$15K or lower were willing to pay \$7 less ($p<0.099$) than the respondents in the middle-income category. The expected WTP from respondents living in rural areas were significantly less than those live in urban areas. Respondents who had recent case of diarrhea or vomiting showed higher expected WTP. Finally, the expected WTP increased with higher subjective severity of illness assessment for consuming food, containing pathogen.

Table 3: Robustness check.

Regression Model	Logit with Continuous Bid		Logit Variation		Tobit with Interaction Term	
	Coeff.	Z	Coeff.	Z	Coeff.	Z
Protection from *E. coli*	0.32**	4.63	0.32**	4.67	10.71**	4.17
Protection from *Listeria*	–0.04	–0.45	–0.03	–0.30	0.72	0.23
Duration of prevention: 1 year	–1.20**	–14.04	–1.20**	–14.01	–40.93**	–13.41
Duration of prevention: 5 years	–0.64**	–7.48	–0.64**	–7.53	–24.10**	–7.43
Duration of prevention: 10 years	–0.35**	–3.99	–0.33**	–3.86	–14.44**	–4.32
Random bid amount	–0.02**	–14.38	–0.02**	–14.59	–	–
Gender: female	–0.07	–1.09	–0.06	–0.91	0.71	0.32
Race: Black	–0.02	–0.15	–0.03	–0.24	–1.30	–0.32
Ethnicity: Hispanic/Latino	0.61**	3.98	0.57**	3.69	13.17**	2.05
Hispanic with less than high school education	–	–	–	–	32.12**	2.22
Infant/Toddler (< 5 years)	1.00**	5.68	–	–	–	–
Young (≥ 5 years but < 12 years)	0.57**	3.94	–	–	–	–
Youth (≥ 12 years but < 18 years)	0.62**	2.64	–	–	–	–
Elderly (≥ 65 years)	–0.57**	–5.50	–	–	–	–
Age	–	–	–0.02**	–9.78	–0.53**	–8.12
Less than high school education	0.11	0.88	–	–	–	–
College graduate	–0.20**	–3.11	–	–	–	–
Education level	–	–	–0.06**	–3.39	–2.58**	–3.80
Household income ≤ $15K / year	–0.11	–0.99	–	–	–	–
Household income > $40K / year	0.21**	2.96	–	–	–	–
Household income level	–	–	0.07**	3.98	1.94**	2.92
Rural home setting	–0.21**	–2.63	–0.19**	–2.38	–7.37**	–2.54
Suburban home setting	–0.05	–0.69	–0.05	–0.71	–0.29	–0.11
Recent (past month) diarrhea or vomiting	0.22**	2.53	0.18**	2.11	5.39*	1.71
Groups at high risk for diarrheal illnesses	0.18**	2.70	0.27**	3.91	7.07**	2.82
Expected severity of illness: mild	–0.25**	–2.78	–0.23**	–2.52	–8.15**	–2.57
Expected severity of illness: severe	0.26**	4.75	0.29**	4.36	11.85**	4.91
Attend daycare	0.30**	2.29	0.27**	2.09	9.23*	1.95
Drink untreated tap water at home	–0.14**	–2.30	–0.11*	–1.83	–3.98*	–1.79
Not eating out-of-home (past seven days)	–0.15	–1.61	–0.09	–0.96	–4.87	–1.49
Heard Fight-bac food safety message	0.29**	2.14	0.24**	1.76	2.76	0.55
Reference level	1.94**	11.62	2.71**	13.45	128.83**	18.75
Pseudo R-square	0.10		0.10		–	
Log pseudo-likelihood	–3249		–3249		–10797	
Number of observations	5293		5293		1667 – uncensored 3065 – right-censored	

* Statistically significant at 10% level. ** Statistically significant at 5% level. Note: Yes or no response to willingness to pay a random bid amount is the dependent variable in the logit models. Willingness to pay ($) is the dependent variable in the censored (Tobit) regression model with interaction terms. The state specific dummies were also included but not reported in the table. In logit regression with continuous random bid amount, chi-squared statistic (≈ 600) is significant at >1% level. In a variation of the logit model, chi-squared statistic (≈ 600) is also significant at >1% level. In a variation of the Tobit model, chi-squared statistic 510 is significant at >1% level. Z-statistics are reported for all regression models. Robust standard errors are used to compute Z statistics in all regressions.

Three additional regression models were estimated, and the results are reported in Table 3 as a robustness check. The first regression is the same logit regression reported in Table 2 except that the bid is treated as a continuous variable. The coefficient estimate of –0.02 ($p<0.000$) indicates that the likelihood of saying 'yes' response to the random bid declines with the higher bid amount. The second regression is a variation of the logit model where some of the dummy variables were replaced by continuous or categorical variables. The last regression is a Tobit regression with the same set of regressors as the last logit model, and added interaction terms: Hispanic/Latino dummy variable multiplied by education levels, age categories, household income level, and other independent variables. The interaction term for Hispanic/Latino and less than high school education is the only variable coming significant. This implies that Hispanic/Latino respondents with less than high school education are expected to pay a lot more than a Hispanic/Latino respondent with at least high school education. Overall, the main explanatory variables are found to be significant and robust across different specifications.

Finally, the yes or no responses were translated into estimate of mean or median WTP numbers. For the logit model with continuous bid, Hanemann (1984, 1989) provided the WTP formula[3] for the untruncated mean, median and truncated mean. The untruncated mean is generally less than or equal to the truncated mean which restricts WTP to be positive (Johansson et al. 1989). If protection from foodborne pathogens is desirable one would expect everyone would be willing to pay some positive amount to have it. Therefore truncated mean estimate is closer to reality. The truncated mean

[3] Untruncated mean ($-\infty<WTP<\infty$) = Median, $E(WTP) = (\alpha_1-\alpha_0)/(-\beta)$. Truncated mean ($0<WTP<\infty$) = $\ln(1+\exp(\alpha_1-\alpha_0))/(-\beta)$.

estimate of willingness to pay in our study[4] for the reference individual is \$134 while the untruncated mean or median estimate is \$125. These estimation numbers are higher than Tobit estimate of willingness to pay for the reference individual, \$104.

Conclusions – Consumers were willing to pay for protection against foodborne pathogens, and to pay more for longer protection. They would pay more for protection against *E. coli* compared to *Salmonella* or *Listeria*. They were less willing to pay if the protection was costly. Estimated WTP has been used to evaluate economic benefits of food safety interventions and useful in estimating the total benefit from improved food safety. Finding new or better measures of consumers' valuation for food safety will make it easier for decision makers to set policy that affects both consumers and producers.

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[4] The estimates of willingness to pay are calculated by setting all demographic and socio-economic variables to zero (reference level), that is, $\alpha_1 - \alpha_0 = \alpha$, the original intercept term from the logit regression.

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