Journal of Agricultural and Applied Economics, 37,3(December 2005):537–548

Experimental Evidence on Willingness to Pay for Red Meat Traceability in the United States, Canada, the United Kingdom, and Japan

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We employed Vickrey auctions to generate willingness-to-pay (WTP) data for red meat traceability and related product characteristics with comparable experimental auctions in the United States, Canada, the U.K., and Japan. The results show that subjects are willing to pay a nontrivial premium for traceability, but the same subjects show even higher WTP for traceability-provided characteristics like additional meat safety and humane animal treatment guarantees. The implication is that producers might be able to implement traceable meat systems profitably by tailoring the verifiable characteristics of the product to consumer preferences.

Key Words: auction experiments, information, red meat, traceability

JEL Classifications: C90, D44, D80

Although traceable food systems in U.S. competitor and customer markets are becoming the standard (Farm Foundation; Liddell and Bailey), and although the United States is actively working toward implementing a farm-to-slaughter traceability system for livestock called the National Animal Identification System (NAIS), some producers and others have been resistant to this movement. Currently, implementation of the NAIS is voluntary and is well behind the initial schedule outlined in the forerunner of the NAIS, the U.S. Animal Identification Plan (USAIP). A few notable single supply chain efforts in the United States have made great strides toward developing traceability systems for meat, including Harris Beef Ranches, Premium Standard Farms, and Creekstone Farms. According to Smith, these systems are being developed to address customer demands and to capture higher anticipated prices for traceable meat products.

This paper is an extension of research completed by Dickinson and Bailey but provides

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This research was supported by USDA, CSREES grant 2001-01714. Partial support was also provided by the Utah Department of Agriculture and Food and the Utah Agricultural Experiment Station. Approved as UAES journal paper 7644. This project would not have been possible without the efforts of numerous individuals. We especially thank Richard Baines from the Royal Agricultural College; Jill Hobbs at the University of Saskatchewan, Canada; Kouzo Kasahara and Shoichi Ito from Tottori University, Japan; and Von Mendenhall, Daren Cornforth, and Dale ZoBell from Utah State University. Valuable comments were provided by Jason Shogren and seminar participants at the University of Saskatchewan. We thank Hisako Kure for translation of the Japanese experimental instructions and paperwork. Valuable research assistance was also provided by Li Wan, Francisco Gonzalez-Diaz, and Nitesh Saha.

a unique case study in consumer willingness to pay (WTP) for "farm-to-fork" traceable meat products in four industrialized countries. At the time of the experiments (fall 2001 in the United States and United Kingdom and spring 2002 in Japan and Canada), these countries varied in their experiences with bovine spongiform encephalopathy (BSE or "mad cow" disease)[1] and other industry setbacks that might have affected consumer WTP for traceability and other characteristics that can be certified with traceability. The objective of this paper is to determine the WTP for traceability and traceability-provided characteristics for ham and beef in the United States and major competitor markets.

Past studies have focused on the value of characteristic information that could either be placed on labels or communicated to consumers in other ways. For example, a substantial body of research has recently focused on consumer acceptance of and government policy toward genetically modified (GM) food products (e.g., Caswell; Huffman et al. 2003a,b; Lusk and Fox; Lusk, Roosen, and Fox; Lusk et al.; Rousu et al.). Other research has examined the value to consumers of providing information on a myriad of different single or bundled characteristics, including certifying enhanced food safety, the processes used to produce food, the location in which food was produced, or the certifying agency (e.g., Dickinson and Bailey; Loureiro; Loureiro and Umberger). A few studies have addressed the issue of traceability directly and have found traceability to be a valuable characteristic in food products (e.g., Buhr; Dickinson and Bailey; Hobbs 1996a,b). The contribution of this paper is its examination of consumer attitudes about traceability and the characteristics it can verify, not only in the United States, but also in major U.S. red meat competitor and customer nations. Results show that U.S., Canadian, and overseas consumers alike are willing to pay nontrivial amounts for meat traceability and other meat characteristics that can be verified through traceable systems. There are, however, notable differences across countries. Although the final U.S. direction on traceability in meat systems could be a government mandate, our results show that profitable market opportunities likely exist both domestically and abroad for U.S. producers who can successfully convey this valued information to consumers.

[1] The debate about traceability has been heightened by the highly publicized incidents of BSE in the United Kingdom and Japan and more recently in the United States and Canada. These events have brought to the forefront the food traceability issue because BSE is believed to originate from the use of contaminated feeds fed to cattle. Traceability is a critical element for dealing with BSE. Although traceability cannot prevent the disease, once BSE is detected, traceability is essential for tracking the source of the disease. Traditional inspection systems focus on eliminating pathogens such as *Escherichia coli* O157:H7 or *Salmonella* in the food marketing chain, mostly at the processor and food preparation levels of the chain. Because BSE originates with farm-level inputs, identification of the farms in which an infected animal has been, together with other animals on those farms and feed sources, is essential.

The WTP Experiments

The experimental design is motivated by the design in Shogren et al. (1994) and is described in more detail in our previous work (Dickinson and Bailey). Groups of 11–14 subjects participated in an hour-long experiment designed to elicit valuations for food traceability and other food characteristics. At the beginning of the experiment, the subjects were endowed with some cash ($15 U.S. or roughly the foreign equivalent in other countries) and a lunch consisting of, among other things, pork (ham) or beef. In all countries, except Japan, the meat was included in a sandwich that was part of the subject's lunch. In the Japanese lunch, sliced ham was used as an addition to a ramen bowl for cultural appropriateness of the lunch. The experiment consisted of several rounds of subjects bidding in a theoretically demand-revealing (second-price) auction format. When subjects place bids, they bid on what they would be willing to pay to exchange their endowed sandwich (or ham for Japan) for an auction sandwich (ham) that differed only in terms of the information that could be verified about the meat in the sand-

wich (ham).[2] Each subject in each group placed bids on four different auction sandwiches. The meat in Sandwich 1 had verifiable extra measures taken to ensure high quality or humane animal treatment. Sandwich 2 had extra verifiable safety in its meat. The meat in Sandwich 3 was verifiably traceable to the farm level, whereas in Sandwich 4, it was verifiable on all three of these dimensions.

Although the subject pools consisted of individuals affiliated with the universities involved in this study, the variety of our experimental groups included student groups, faculty groups, professional staff groups (e.g., accountants and secretaries) and maintenance staff groups (e.g., buildings and grounds workers and maintenance workers). As such, there is still a considerable variation within the subject pools. About 54 subjects participated in each of the experiments in the United Kingdom and Japan, and about twice as many participated from both the United States and Canada to generate data in both ham and beef experiments.[3]

Subjects were also informed that the purpose of having the winning bidder pay the second highest price was to remove the incentive to misrepresent their true WTP for the auction meat. Although such information on the theoretical incentives of the auction is not appropriate for a theory-testing experiment, the purpose of these experiments was not to test second-price auction theory, but rather to have subjects comprehend the auction process. It was made clear to subjects that one random round and one random auction sandwich from that round would be chosen at the end of the experiment and the auction would then be completed. As such, a bid for any auction sandwich in any round stood an equally likely chance of being the binding bid at the end of the experiment, thus preserving the demand-revealing properties of the auction. At the end of the auction, a random round and sandwich were chosen, the auction was concluded, and all subjects then consumed their sandwiches while completing a brief questionnaire.[4]

Experiment Results

Figures 1–6 and Table 1 present the summary data from the experiments. Figures 1–6 show the bid distributions from the experiments—the value of the baseline sandwich in local nominal currency is also given for reference in Table 1. Each individual's average percent bid in the final five auction rounds for each individual sandwich is the unit of observation to generate the bid distributions. Percent bid is calculated as the subject's actual bid divided by the value of the baseline sandwich as given by the collaborators who were native to each of the countries. As such, the percent bid calculation is sensitive to the baseline value used for the calculation. Nevertheless, such percent bids provide for some comparability across experimental sites, although caution is advised in interpreting the absolute level of overall percent bids. The final five rounds are arbitrarily chosen as a more stable measure of subject bids than the initial five rounds (see, e.g., Shogren et al. 1994).

In Table 1, we see that in every case, bids

[2] Efforts were made to avoid deception in the information presented to the subjects in these experiments. Depending on the location, either domestic or imported meat was used to ensure verifiable characteristics, although meat used in any one location was either all domestic or all imported (in order to avoid WTP differences for domestic vs imported meat infiltrating our data generation process). Traceable U.S. beef was obtained from an individual animal grown on a university farm that was slaughtered in facilities at the university.

[3] The authors controlled the experiment process in each location. In Japan, the authors were present and conducted the experiments through a bilingual (native Japanese-speaking) assistant to ensure as much similarity in protocol as possible with the English language experiments. All subject materials (e.g., instructions, auction ham descriptions, etc.) were in Japanese and had been translated by a native Japanese speaker and then reviewed by the assistant who also conducted the oral translation of the experiments.

[4] It is considered somewhat standard in food auction experiments to use practice auctions when subjects bid on a small item such as a candy bar. We did not conduct such practice auctions for these experiments. However, we did conduct such additional experiments as sensitivity tests in our previous research (see Dickinson and Bailey 2002), and the data indicate that our results are not sensitive to our slightly different protocol in these experiments.

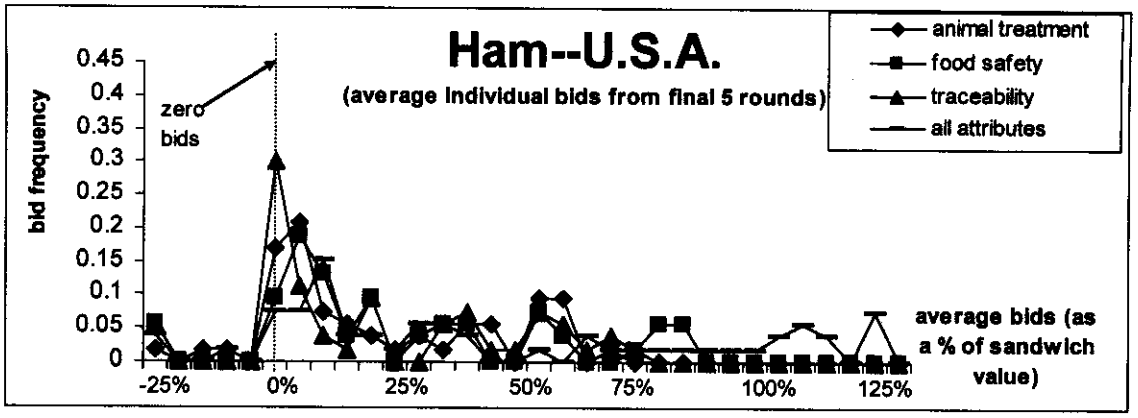

Figure 1. Average Bid Frequencies for Ham—United States

were on the average statistically higher for meat with all three characteristics than for meat with only one verifiable characteristic (bottom three rows of Table 1).[5] This might seem obvious, but it is still significant because traceable systems can be used to verify and trace information on multiple characteristics, including those tested. In fact, it is interesting to note that in the United States and Canada, average bids are significantly higher for the combined characteristics than for traceability alone, even though traceability is a necessary condition to verify farm-level food safety measures and animal assurances. The average subject is likely not aware of this (though we did not inquire), which highlights the importance of consumer education in creating profitable markets for products with these characteristics.

Among individual characteristics, traceability alone was significantly less valued than either food safety or animal assurances in the United States and Canada (although not significantly less so for beef in Canada). In contrast, there are no significant differences in average bids for the individual characteristics in the United Kingdom and Japan, although per-

[5] Comments in this section on statistical significance are based on results of the Friedman (1937) nonparametric test, which is used to compare an experimental group's WTP rankings. This test is appropriate when data can be arranged in independent blocks (i.e., each of our experimental groups) but when treatments within a block (i.e., the auction sandwiches) can be ranked according to some criterion, which in our case is WTP. As such, it yields slightly different results than simply comparing average percent bids from Table 1. When any significance is noted, significance is at the $\alpha = .10$ level or better.

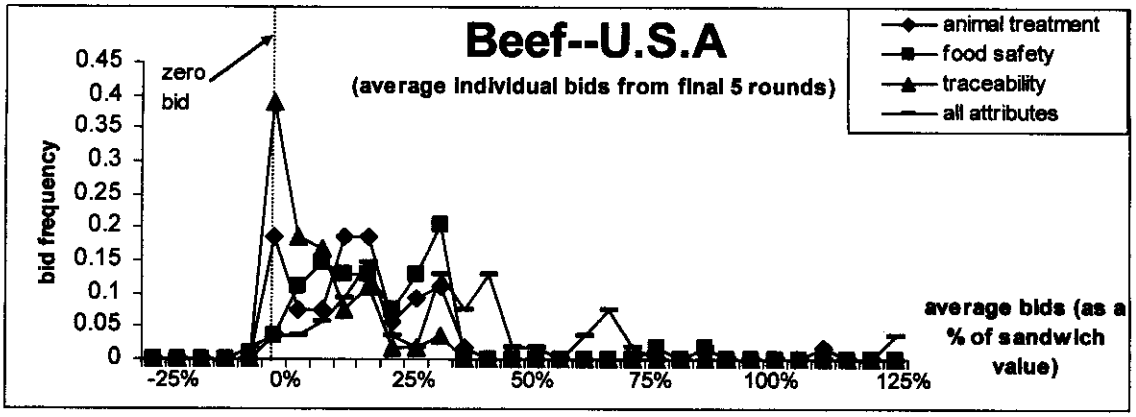

Figure 2. Average Bid Frequencies for Beef—United States

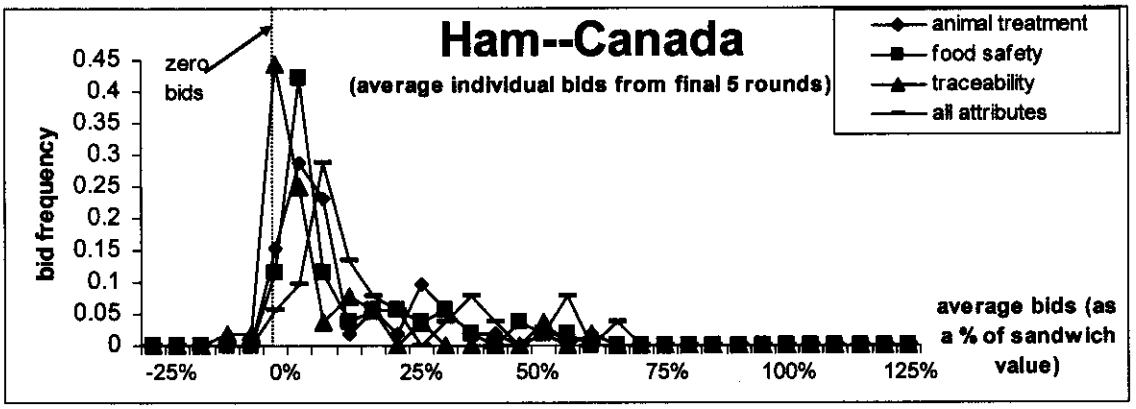

Figure 3. Average Bid Frequencies for Ham—Canada

cent bids for characteristics are uniformly higher in Japan. Both the United Kingdom and Japan had experienced verified incidents of BSE, and the United States and Canada had not, at the time of our experiments, which might explain why British and Japanese participants valued traceability (statistically) equally with animal treatment or meat safety. This result suggests that consumers in the United Kingdom and Japan had learned the "hard way" about the value of traceability. The same could be true in the United States after the BSE incident of December 2003, although this would need to be tested in a separate study. Another implication is that profitable U.S. export markets for traceable meat more likely exist in countries that have already experienced an industry setback like BSE. However, evidence from more controlled multivariate analysis will shed additional light on this.

Table 2 presents parametric analysis of average bid behavior with controls for age, income, education, and knowledge of foodborne diseases. The dependent variable is the subject's average bid from the final five rounds of the experiment for each of the auction meat products. In our protocol, before bidding in rounds 2–10, we announce the second highest bid, or market price, for that sandwich in the previous round as a form of market information for the subjects. Because subjects can experience some affiliation of value given such feedback information, a market price variable is included in our specification. *MARKET PRICE* measures the average market price for each sandwich from the first five rounds of the auction—market price as defined for the

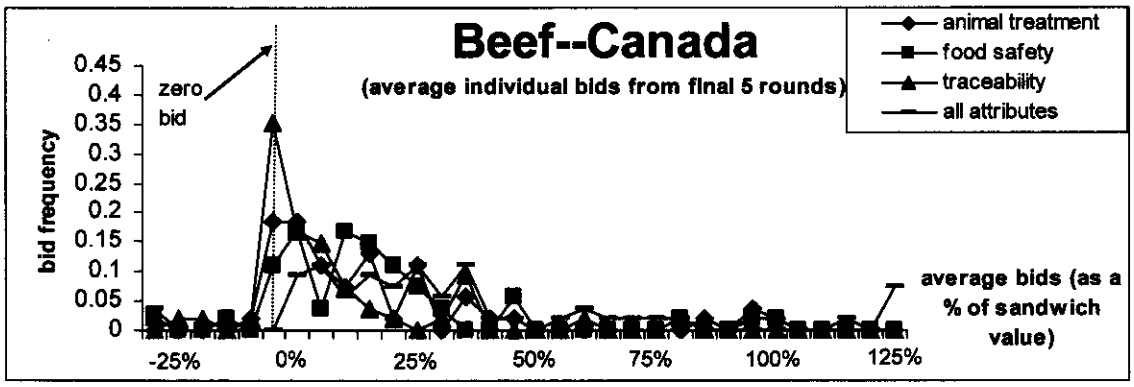

Figure 4. Average Bid Frequencies for Beef—Canada

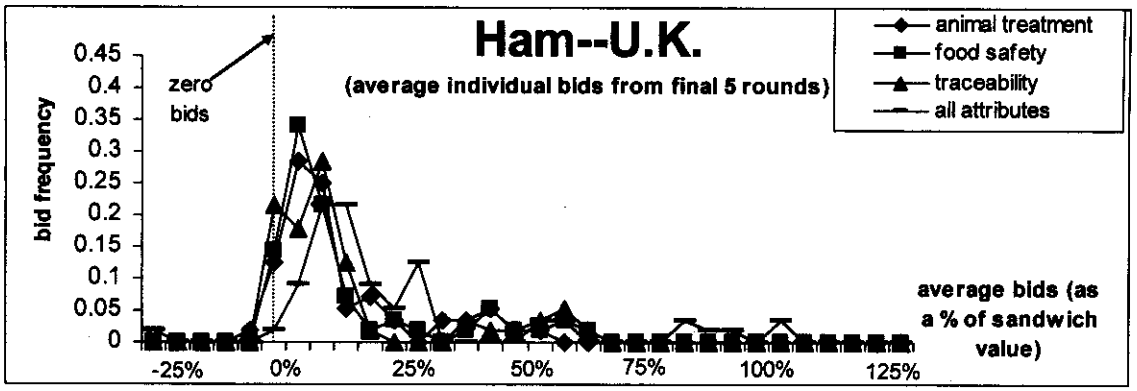

Figure 5. Average Bid Frequencies for Ham—United Kingdom

econometric analysis is therefore exogenous. We also include experiment group controls (suppressed in Table 2 for space considerations) and a random effects component that captures the potential lack of independence of an individual's bid across different sandwiches.

That is, these data are viewed as panel data in which individuals are the cross-sectional units and the "time series" are the bids across sandwiches for that individual. A Lagrange multiplier test on each of the models in Table 2 indicates that individual-specific effects, in addition to those captured in our demographic variables, are present in the data. This suggests either a random effects or fixed effects specification. Unfortunately, we cannot estimate a fixed effects model for a specification that includes individual-specific demographic variables because of a perfect collinearity problem. As such, we are unable to perform the standard Hausman test to compare the appropriateness of fixed versus random effects in our Table 2 specifications. We therefore proceed with the random effects modeling as the best alternative for estimating the bid functions.[6]

Perhaps not surprisingly, results reported in Table 2 show that subjects' WTP across coun-

[6] In the event that the individual random effects were correlated with the other regressors, the coefficient estimates in Table 2 would be inconsistent. We would note, however, that the treatment effects estimated in Table 2 are highly consistent with those from the summary data in Table 1. The only exception is the U.K. pork results: the Table 2 estimates indicate a slightly higher WTP for animal treatment than traceability. This is in minor contrast to the comparative group bid percentages in Table 1. Given this, we doubt that our principal results are the result of a misspecification of the individual-specific error term.

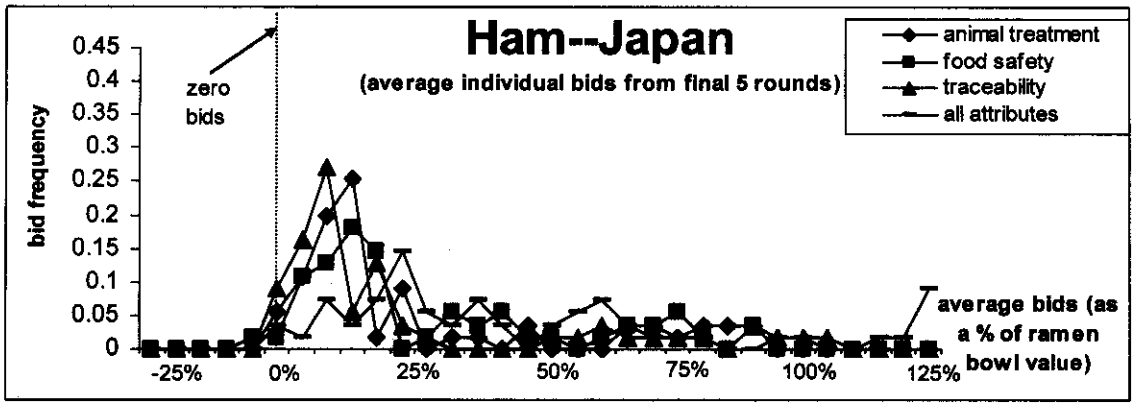

Figure 6. Average Bid Frequencies for Ham—Japan

Table 1. Average Bid Premiums (Percent Bids) for Exchanging Characteristic Verifiable Product for the Baseline Product Base on Final Five Rounds of Bidding Averaged Across Individuals and Groups

Meat Characteristic	U.S. Pork	Canadian Pork	Japanese Pork	U.K. Pork	U.S. Beef	Canadian Beef
Baseline Value[a]	2.90	5.00	5.50	1.80	2.90	5.00
ANIMAL TREATMENT	20%	13%	27%	17%	16%	19%
MEAT SAFETY	23%	13%	29%	18%	20%	18%
TRACEABILITY	18%	7%	25%	19%	7%	9%
COMBINED ATTRIBUTES	43%	21%	49%	34%	35%	37%

[a] Quoted in local currencies with value determined by domestic food preparation collaborators.

tries is uniformly higher for the combined meat attributes.[7] Subjects in the United Kingdom do not value meat safety as an individual characteristic any higher than traceability alone, although they are willing to pay a significant additional premium for assurances of humane animal treatment (Table 2). Japanese subjects are willing to pay a significantly higher premium for meat safety and animal treatment than for traceability alone. Overall, the treatment variable results from Table 2 show that animal treatment and meat safety are generally valued more highly than traceability alone, and WTP for the combined attributes is highest. However, raw bid data show that WTP for the combined attributes is less than the sum of the three individual characteristics, indicating a diminishing marginal utility for traceability and other extrinsic meat characteristics that can be provided by traceable systems.

We also examine age, income, education, and knowledge of foodborne diseases as key demographic variables that might influence a subject's WTP for the extrinsic meat characteristics. Our Table 2 results show that older subjects are willing to pay more for the traceable pork product in Japan and in Canada. Higher income Japanese subjects are willing to pay less, and education is an insignificant determinant of subjects' WTP across all samples. The level of subject knowledge about foodborne illnesses, as proxied by the number of articles read on such subjects (*ARTICLES*) shows a curiously opposite effect in the United States compared with Canada. Additional information, as proxied by *ARTICLES,* increases WTP in the United States but decreases WTP in Canada. Because beef traceability had been mandated in Canada but not in the United States at the time of these experiments, one would expect that Canadian consumers had been exposed to more investigative, popular press articles about traceability. At the time of these experiments, many Canadian consumers might not have perceived an immediate need for meat traceability because no BSE crisis had yet developed there. The result might have been more awareness about traceability in Canada but, perhaps, less awareness of its potential benefits. One other way of interpreting this result is in terms of diminishing marginal benefits. It is logical to expect diminishing marginal benefits of additional information (i.e., articles) at some point, and a negative coefficient on *ARTICLES* in Canada is consistent with the average Canadian subject being at a point of negative marginal benefit of additional information on foodborne illnesses.

Overall, across all countries examined, the demographic variables are usually insignificant determinants of subjects' WTP. This is an important finding because it indicates that the market potential for traceable meat products is broad and cannot be defined well by demographic characteristics. Dickinson and Bailey report that demographic characteristics are likely an important determinant of WTP, but their result is only inferred from the use of

[7] The only case in which we fail to reject the null hypothesis (at the $\alpha = .10$ level) of equal coefficients by the Wald test is in comparing the coefficient on animal treatment and the combined attributes in the U.S. pork sample ($p = .18$).

Table 2. Determinant of Subjects' Bids Based on Random Effect Estimates—Dependent Variable Was a Subject's Average Bid in the Final Five Auction Rounds as a Percentage of the Baseline Sandwich Value

Variable	U.S. Pork[a]	Canadian Pork	Japanese Pork	U.K. Pork	U.S. Beef	Canadian Beef
MARKET PRICE	.130	.081	.001	.224	−.0001	.090
	(.00)***	(.00)***	(.00)***	(.00)***	(.79)	(.00)***
ANIMAL TREATMENT	.050	.039	.025	.014	.091	.082
	(.01)***	(.00)***	(.02)**	(.09)*	(.00)***	(.02)**
MEAT SAFETY	.044	.024	.046	−.003	.132	.076
	(.01)***	(.01)***	(.00)***	(.67)	(.00)***	(.03)**
COMBINED ATTRIBUTES	.90	.064	.116	.047	.277	.177
	(.00)***	(.00)***	(.00)***	(.00)***	(.00)***	(.00)***
AGE	−.006	.005	.005	.003	.002	−.001
	(.15)	(.02)**	(.05)**	(.38)	(.40)	(.79)
INCOME	.0000003	−.000001	−.00000002	−.0000004	−.000001	−.00000006
	(.88)	(.22)	(.01)***	(.83)	(.47)	(.76)
EDUCATION	.030	.022	−.007	−.002	−.043	.047
	(.57)	(.42)	(.90)	(.94)	(.26)	(.39)
ARTICLES	.001	−.000	−.002	—	.001	−.003
	(.81)	(.92)	(.13)	—	(.04)**	(.06)*
CONSTANT	.124	−.120	.36	−.092	.072	.105
	(.44)	(.39)	(.84)	(.57)	(.58)	(.64)
R^2	.51	.52	.86	.48	.31	.28

Note: Data are significant at the * $p < .10$, ** $p < .05$, and *** $p < .01$ level for the two-tailed test. Group dummy variables were included in each case. *ARTICLES* could not be included in the U.K. beef model because of negative estimates of the variance component for the random effects model. Sensitivity analysis of remaining coefficients with distinct combinations of demographic variables indicates that the results above are not sensitive to the omission of the *ARTICLES* variable for the U.K. pork sample.

[a] *P*-values are in parentheses.

group control dummies for each of the different experimental cohorts, with no individual demographic controls. Because subjects in their study were also grouped by type (e.g., all students or all faculty) for the experiments, it was reasonable to consider that group differences in WTP reflected the demographic differences of the groups. Our current results show that a more detailed analysis of key demographic variables finds less significance overall than anticipated.[8]

Although our results suggest that the variation in WTP across characteristics is largely not affected by the demographics of the subjects, it is still of interest to examine the magnitude of the WTP effects for distinct meat types. Given that we examined both beef and pork in the United States and Canada, we conduct Chow tests for structural differences to determine whether the coefficients on the three treatment variables (*ANIMAL TREATMENT, MEAT SAFETY, COMBINED ATTRIBUTES*) are significantly different in the beef equation compared with the pork equation for each country. The results indicate that the coefficients on the treatment variables in beef differ significantly from those for pork in both the United States and Canada ($F[3, 408] = 21.6$ for the United States and $F[3, 416] = 3.67$ for Canada) at least at the 5% level. Such results are sensitive to our choice of baseline sandwich value because bids are expressed as a percentage of baseline sandwich value; however, recall that all details of the subject lunch and sandwich in each country are identical except for the roast beef or ham in the sandwich. These results are most likely not an artifact of the baseline auction product value, which would be more a concern in comparing the percent WTP magnitudes of the U.K. sandwich and Japanese ramen bowl experiments, for example. It is for this reason that we caution making any direct comparisons of WTP magnitudes across countries.

The key result from the Chow tests on U.S. and Canadian results from Table 2 is that subjects seem willing to pay higher premiums for the beef with guarantees of additional animal treatment, meat safety, or combined traceability attributes than for pork with similar additional guarantees. In Table 2, the range of price premiums individual subjects are willing to pay for attributes other than traceability alone in the United States is estimated from 4%–9% for pork and 9%–28% for beef. In Canada, it is 2%–6% for pork and 8%–18% for beef (see treatment variable coefficients in Table 2). As such, profitable markets for food attributes that can be guaranteed through traceable systems might be more likely for beef than for pork—this is true even if one considers the magnitude of bids as an upper bound on subjects' true WTP (see Shogren, List, and Hayes; Shogren et al. 1999). This is likely a result of more publicized and serious meat safety scares for beef products than for pork (e.g., the 2002 ConAgra beef recall, the 1996 BSE cases in the United Kingdom, the 1993 *Jack in the Box* food poisoning incident), but it is nevertheless ironic given that more resistance to implementation of traceable systems in the United States has come from the beef industry than the pork industry.

Another item worth noting is that, although consumers' WTP is significantly positive on average, a significant number of our subjects were not willing to pay any positive amount for certain attributes. Across countries, anywhere from 9% (Japan) to 48% (Canada, pork) of subjects were not willing to pay a positive amount for traceability alone, whereas for the combined attributes it ranges from 4% (Canada, beef; Japan, United Kingdom) to 13% (United States, pork). This result can be seen in Figure 1 by summing all bid frequencies for all bids less than or equal to the 0% bid for a given country and meat characteristic. To the extent that a higher percentage of a market is willing to buy a product at a price premium is a measure of the potential overall market, the promotion of traceability alone would capture the smallest market. Among the individual characteristics, food safety would interest the largest number of individuals at some price premium because only from 4% (Japan, United States, beef) to 15% (Canada, beef; United

[8] Recall that we do include group dummies in the current analysis so that the results in Table 2 control for possible group effects.

States, pork) of subjects would not pay a positive amount for additional food safety assurances. These more aggregate results are similar to estimated treatment effects on individual WTP, which is further evidence that the treatment effects in Table 2 are not driven by a few aberrant subjects—this would be the case if WTP values were highest for additional meat safety, for example, and yet for additional meat safety the largest percentage of consumers had WTP equal to 0.

Finally, one can ask whether providing traceability and the other traceability-related characteristics examined in this study would be profitable. Little public information is available about the actual costs of providing traceability. The implementation of the NAIS (farm-to-slaughter traceability) is expected to cost over $500 million during its first 6 years (see USAIP). Sparks Companies, Inc., provided estimated costs that were similar to the NAIS estimates for farm-to-slaughter traceability for beef. However, Sparks Companies also provided estimates for a U.S. farm-to-retail traceability system that totaled approximately $1.02 billion per year in variable costs and about $50 million per year in capital investment costs.[9] Annual commercial beef production in the United States is approximately 26 billion pounds, suggesting a cost of approximately $0.04/lb. at the retail level to provide traceability ($1.07 billion/26 billion lb.). Assuming conservatively that retail prices average about $3/lb. for beef, the $0.04 cost of providing traceability equals approximately 1.33% of the retail price.[10] This is considerably less than the 7% and 9% premiums auction participants in the United States and Canada indicated that they would pay for traceability in beef, respectively (Table 1).

Although this does not provide precise measures of expected changes in producer and consumer welfare (demand and supply elasticities), does not provide information on the costs of marketing to selected market segments or countries, and assumes that the WTP estimate is accurate, it does suggest that WTP might exceed the costs of providing traceability. We are careful to note that WTP estimates from such auction experiments are considered upper bounds on consumer retail WTP (see Shogren, List, and Hayes; Shogren et al. 1999). Nevertheless, the evidence in Shogren et al. (1999) indicates that the degree to which auction market estimates are larger than retail WTP estimates is not enough to reverse the conclusion of positive market demand at price premiums.[11] Refined cost estimates would also be needed to make any definitive claims about the profitability of providing traceable meat products. However, these results offer encouragement that profitable markets exist for traceability and traceability-related characteristics in the United States and its trading partners.

Conclusions

This research specifically explores WTP for traceability in food because traceable systems are being developed in the European Union (EU) and elsewhere and will almost certainly be developed in the near future for more food industries in the United States and Canada. For example, Canada has a target of eventually making 80% of its domestic food traceable (Agriculture and Agri-Food Canada), and a limited number of American meat packers already have traceable systems in place. Our results indicate that traceable systems are not merely an extra cost of production without any additional product benefits for which consumers are willing to pay. Furthermore, to the ex-

[9] Industry capital investment costs were estimated by Sparks to be $247 million. It was assumed that this investment would be spread across a 5-year period (the approximate estimated speed of full implementation of the NAIS). Hence, the annual investment cost of $50 million.

[10] Five-year average retail beef prices as reported by the Bureau of Labor Statistics were $3.28/lb. for their choice price series and $2.95/lb. for their all-fresh price series (see USDA-ERS 2005a,b).

[11] Shogren et al. (1999) report frequencies on the percentage of respondents willing to pay discounts, the same or more, for an irradiated chicken product. This does not allow for a direct statistical comparison on WTP for individual consumers, but the implication in Shogren et al. (1999) is that for premiums, little difference exists in WTP for experimental auctions, retail observations, and surveys.

tent that traceable systems might offer positive consumer externalities not reflected in our WTP estimates (e.g., confidence in food system, liability accuracy in the event of negligence), producers might underprovide these systems relative to what is socially optimal. Independent of externality considerations, our data still indicate that profitable markets might exist in which consumer WTP is highest. In addition, we have not considered the potential for such systems to offer efficiency improvement opportunities for producers (e.g., ability to track efficiency of labor in production).[12]

Traceability is a tool that separates the world's largest food systems (Bailey, Jones, and Dickinson; Liddell and Bailey). Although a requirement in EU meat systems, the U.S. meat industry has favored private, rent-seeking activities related to traceability rather than a regulatory solution. As a result, WTP for traceability has been a critical issue in American meat marketing chains. Our results suggest that not only American, but also Canadian, British, and Japanese consumers, on average, are willing to pay nontrivial positive amounts for red meat (beef and pork) traceability. However, other characteristics certifiable with traceability are even more valued than traceability alone (e.g., animal treatment, meat safety). This implies that profitable traceability is probably best bundled along with additional product characteristics that only traceability can verify.

Our results could imply that consumers also value traceability and traceability-verified characteristics in other product markets, not just in food markets, although additional research would be necessary to verify this. Our findings also reflect that a significant proportion of consumers in all four countries would not pay for traceability or characteristics that can be verified through a traceable system. This implies that separate product lines might be warranted for traceable products rather than voluntarily implementing traceability on a general basis. Nevertheless, traceability systems are likely to be mandated in many industries, so these findings indicate that opportunities for producers to remain profitable under a systemwide traceability mandate will likely still exist.

[Received August 2004; Accepted January 2005.]

[12] Although difficult to measure, the added value of such efficiency improvements only increases the opportunity for producers to profitably exploit traceable systems.

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