Meat Traceability: Are U.S. consumers willing to pay for it?

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ABSTRACT

This article reports the results from a series of laboratory auction markets in which consumers bid on meat characteristics. The characteristics examined include meat traceability (i.e., the ability to trace the retail meat back to the farm or animal or origin), transparency (e.g., knowing that the meat was produced without growth hormones, or knowing the animal was humanely treated), and extra assurances (e.g., extra meat safety assurances). This laboratory study provides non-hypothetical bid data on U. S. consumer preferences for traceability, transparency, and assurances (TTA) in red meat at a time when the U.S. currently lags other countries in development of TTA meat systems. Our results suggest that U.S. consumers would be willing to pay for such TTA meat characteristics, and the magnitude of the consumer bids suggest a likely profitable market for development of U.S. TTA systems.

Keywords: Auctions, experiments, red meat, traceability, willingness-to-pay

Introduction

Recent research suggests the U.S. red meat system is falling behind many of its major competitors and trading partners in terms of traceability, transparency, and other quality assurances (TTA) (Liddell and Bailey). In fact, the U.S. pork system ranks last, according to Liddell and Bailey, when compared against the United Kingdom (UK), Denmark, Canada, Japan, and Australia/New Zealand[1] for TTA. For example, Liddell and Bailey indicate that the United States red-meat inspection system is designed principally to control pathogens while the inspection systems in some other competitors is designed not only to control pathogens but also to trace back meat to its origin and also to provide information on other "extrinsic"[2] characteristics.

Traceability is sometimes called identity preservation and is defined in Liddell and Bailey as the ability to track the inputs used to make food products backward to their source at different levels of the marketing chain. Transparency refers to the public availability of information on all of the rules, procedures, and practices used to produce a food product at each level of the marketing chain (Baines and Davies (1998); Early).[3]

Quality assurance has three key elements including managing hygiene to ensure food safety, ensuring quality through grading and other measurements, and providing mechanisms for product recalls (Early; Baines). For example, the processes for ensuring hygiene in the European

[1] We refer to Australia and New Zealand together since the two countries are coordinating their TTA programs.
[2] Extrinsic characteristics refer to meat characteristics that neither affect food safety nor traditional government grading but which are still valued by some consumers. One example would be assurances about animal welfare. Additional information on intrinsic and extrinsic qualities is given later in the text.
[3] Transparency as defined in Liddell and Bailey requires published procedures that are publicly available and can be influenced by input from stakeholder groups.

Union (EU) red-meat system has focused on Hazard Analysis Critical Control Point (HACCP) systems[4] at each point in the pork value chain beginning at the farm level.

Ensuring quality in red-meat system includes measurements of the intrinsic quality of a carcass or product (tenderness, back fat, curing, etc.). Intrinsic quality measurements are common to most government grading systems including the United States, its trading partners, and competitors. However, the EU system also provides measures of the extrinsic qualities of red meat. Extrinsic qualities do not affect either food safety or the intrinsic qualities of the meat product but may still affect the value of the product. Extrinsic qualities could include assurances about animal welfare, environmental preservation, or other inputs or absence of inputs used to produce the meat product[5] (Liddell and Bailey; Baines).

TTA evolved initially in response to the perceived regulatory failure of European Union (EU) governments to provide adequate information to consumers during the EU *BSE* (*bovine spongiform encephalopathy*)[6] crisis (Baines and Davies (1998)). As a result the EU has developed systems that enhance the credence nature of attributes such as animal welfare and even food safety issues such as *BSE* by filling the perceived information void inherent in standard government grading practices with TTA.

TTA systems, especially in the EU have been implemented primarily in response to the *BSE* crisis and not directly as a value-adding marketing strategy. Consequently, willingness-to-pay (WTP) for characteristics like traceability was not a primary consideration when

[4] Codex standards emphasize hygiene and fit well into the HACCP approach for ensuring food safety. ISO 9000 standards are private labeling schemes that certify practices and procedures for a wide range of products. Capmany et al. indicate that the United States is also lagging other countries in the adopting ISO 9000 standards.

[5] An example would be the assuring the absence of genetically modified organisms (GMOs) in a product. TTA is different than typical quality assurances and standardization in its scope (tracing throughout the market chain) and it focus (certifies more than just food safety). For example, Codex standards emphasize hygiene. ISO 9000 standards are private labeling schemes that certify practices and procedures for a wide range of products. TTA could serve as a basis for ISO certification if private companies decided these types of certifications were desirable.

[6] Also known as "mad-cow" disease.

requirements for providing traceability were imposed on market participants but rather became an issue of access to markets. However, discussions in the United States about TTA have focused on consumers' WTP. For example, a recent conference discussing genetically modified crops sponsored by the Pew Initiative on Food and Biotechnology and the USDA, Economic Research Service identified WTP as one of the primary issues involved in identity preservation. Dr. John Wiemers, the chairman of the U. S. Department of Agriculture's, Food Safety and Inspection Service Interagency Committee on Animal Identification, has stated that red-meat traceability systems will only be implemented in the United States if consumers are found to be willing to pay for the additional costs to produce traceable products. This suggests that evidence of consumer willingness to pay for TTA products is essential if TTA systems are to be developed in the United States.

This article presents initial evidence on U.S. consumers' WTP for TTA characteristics in beef and pork. We report the results from a series of controlled laboratory experiments in which consumers bid in a (theoretically) demand-revealing auction on meat sandwich upgrades. These WTP auctions, utilized first in Shogren et al (1994b), generate non-hypothetical data on consumer valuation of TTA attributes in meat and are a first step towards identifying the potential U.S. market(s) for meat produced through a TTA system. Since no existing willing-to-pay data for red meat with TTA characteristics are available, these results can help lower the risk of retail trials of TTA meat products. We find that consumers are willing to pay significant amounts of money to upgrade a sandwich to an otherwise identical sandwich containing TTA attribute(s) meat. Furthermore, our results suggest that the market for TTA beef may be broader than the market for TTA pork, as auction market valuation of the latter is more sensitive to the specific demographic characteristics of the consumers. Part of the focus of our analysis is on

what consumers are willing to pay for extrinsic quality assurances because extrinsic characteristics are beyond the typical assurances (food safety and intrinsic qualities) provided by public sector inspection and grading in the United States (Baines and Davies (2000)).

Background on TTA

TTA is obtained through a system of records and certifications that allow a product to be traced and certified back to different points in the food chain. Currently most U. S. red meat is traceable from retail back to the distributor or processor but not to the farm or animal level. Establishing TTA prior to processing would require a system that is currently not generally in place in the United States. While the U. S. has been slow to adopt TTA standards and certifications, some countries in the European Union (EU) and elsewhere have been developing TTA systems (Early; Baines and Davies (2000); Liddell and Bailey; Abbatemarico).

Red meat producers and processors in the United States should be concerned that the U. S. system is lagging other countries in terms of TTA for at least three reasons. First, consumers have become increasingly concerned about the processes (inputs and methods) used to produce food (e.g. Dorey; Nakamoto). Second, if competitors are able to differentiate their red meat products as being superior to U. S. red meat products in terms of TTA, the United States may lose market share in its red meat export markets. For example, recent food safety concerns in Japan, including the recent discovery of *BSE*, could potentially lead to heightened import restrictions and regulations (Nakamoto). Japan is the United State's principal export market for red meat and such concerns could eventually lead to a loss of U. S. market share if competitors such as Canada, Australia/New Zealand, and Denmark are successful in convincing Japanese buyers that their products are "safer" than U. S. products because their system provides more TTA than the U. S. system. Finally, consumers may simply be willing to pay for red-meat

products with TTA characteristics and a market opportunity may be lost to U. S. producers if such products are not produced in the United States.

While TTA has not been a central issue in red meat markets in the United States, it has been in the EU and other countries during the past six years (e.g. Early (1998); Baines and Davies (1997, 1998, and 2000) Liddell and Bailey). As a result, the EU systems have evolved at a faster rate than the U. S. system. The consequences in the U. S. may not be felt immediately, but the potential of the United States losing market share in red meat markets in the future exists if competitors can successfully differentiate their products based on real or perceived food safety and quality assurance characteristics that can be certified and traced (Bailey and Hayes).

An examination of differences in worldwide consumer attitudes about TTA and the market value they place on TTA certifiable characteristics will eventually be essential to identifying the optimal approach to improving TTA in the U. S. red meat system since U. S. red meat is traded not only domestically but also internationally. However, in this study we focus on the United States to ascertain if domestic consumers are willing to pay for TTA and other meat characteristics that could be certifiable through TTA. If significant changes are made in the U. S. red meat system to address TTA concerns, large investments will be needed to do so.[7] Recapturing these investments will require capturing a significant market share of the red meat market for products featuring TTA characteristics. This will probably require a significant penetration of domestic red meat markets as well as foreign ones. The controlled experiments we use in this study generate non-hypothetical bid data on consumer WTP for TTA, and this information is vital towards assessing whether the U.S. red meat system should consider implementing TTA. A large-scale field experiment would be an effective but prohibitively

costly way of conducting such research. As an alternative, the small-scale controlled laboratory experiments described in the next section offer a cost effective way of generate initial data on domestic consumer attitudes about WTP for TTA.

Experiments

Economic research on issues relating to TTA is quite limited since these systems have been evolving only within the past five years. The economic literature that exists dealing with TTA focuses primarily on the aftermath of the *BSE* crisis in the United Kingdom. For example, Palmer and Loader and Hobbs document the economic devastation to the British beef industry resulting from the *BSE* scare.

Hobbs used transaction costs economics to examine the perceived value of tracing beef cattle from the farm to the packer level (1996a) and between beef suppliers and retail outlets in the UK (1996b). Her findings indicate that traceability is the most important characteristic desired by large beef processors when purchasing cattle from farmers (1996a). Hobbs (1996b) also found that the ease of traceability ranked ahead of prices paid to processors as an important characteristic to consider when supermarkets purchased meat.[8] Latouch, Rainelli, and Vermersch reported that consumers in the Rennes area of France were willing to pay for traceability. However, their study focused entirely on one issue, *BSE*, and did not deal with more general issues relating to TTA. Verbeke et al. examined the attitudes of Belgian meat consumers about pork and argued they argued that traceability systems would work best when coupled with efforts to improve intrinsic qualities such as leanness, taste, and tenderness and the extrinsic

[7] Direct measures of the required investment are not currently publicly available. However, initial estimates suggest that the investment at a single meat packing plant to implement TTA would be into the millions of dollars depending on the desired level of TTA to be achieved (Coe).

[8] However, Hobbs (1996b) found supermarkets' most important consideration to be consistent quality of products.

quality of healthiness. None of these studies provide information or data for U. S. consumers and all are narrowly focused typically dealing with only one issue such as *BSE*.

Since data on TTA systems in the United States is not publicly available,[9] we use the laboratory market approach for eliciting individuals' WTP for food traceability and related characteristics. Our experiments follow the basic design utilized in Shogren et al (1994b) for eliciting bids to "upgrade" a meat sandwich. Subjects in the experiments are given a free lunch, which includes a meat sandwich, along with $15 cash at the beginning of the one-hour experiment. Subjects in the experiment are allowed to bid on what they would be willing to pay to exchange or upgrade their existing sandwich for a sandwich with the meat described as having one or more extra verifiable attributes. Subjects are aware that their baseline sandwich meets current standards enforced by the USDA but does not have the extra verifiable attributes in the upgrade sandwiches.

The upgrades we consider are based on each of the elements of TTA. They are 1) transparency, which in our experiments is given by extra assurance or information relating to the processes used to produce meat including animal treatment (humane treatment procedures and lack of growth hormones used in production of the meat), 2) assurance, which in our experiments is given by extra assurance of food safety (extra tests for *e coli* or *salmonella* for beef or pork, respectively),[10] 3) traceability, which in our experiments is stated as the ability to trace the meat

[9] Some TTA products have been developed by private companies in the United States. For example, Farmland Industries has developed TTA products. The fact that a large firm like Farmland is developing TTA products provides additional evidence that TTA systems and products are becoming more important in the United States and should be studied.

[10] This relates to the assurance part of TTA since *actual* tests and guarantees are made. Participants were told that testing beyond that required by normal USDA inspection for the particular pathogen (*e. coli* in the case of beef and *salmonella* in the case of ham) were made for the meat contained in Sandwich 2.

back to the farm of origin,[11] and 4) all three upgrades combined. The respective auction sandwiches are numbered as Sandwich 1, Sandwich 2, Sandwich 3, and Sandwich 4.

While it is apparent that much of the value of a TTA system is likely to be in the attributes of the product that can be verified, and not just the fact that the product can be traced back to the farm or origin, our use of an auction sandwich verifying only traceability is useful for two purposes. First, in valuing traceability by itself we gain initial insights on consumer willingness to pay just for this information *net* of the attributes that can verified because of the traceability system. Secondly, the comparison of traceability bids to bids on other sandwiches will then help us gain insights into the perceived value-added to assuring certain characteristics along with the traceability information.

Subjects were recruited from four different demographic cohorts for the experiments. The subjects were informed at recruitment that either beef or pork would be consumed as part of the free lunch. Each experimental group consisted of 13-14 individuals on average. Eight total experiments were conducted, four experiments using ham sandwiches and four using roast beef sandwiches. Experimental groups were recruited for the ham and beef experiments such that students were one experimental group, faculty were a group, professional staff (e.g., accountants, administrative personnel, etc) another group, and classified staff (e.g., maintenance workers, buildings and grounds keepers, etc.) as the fourth distinct demographic group. We chose to conduct experiments in groups of similar individuals for two reasons. First, it is often the case that individuals of similar socio-demographic populations shop in similar locations, and so this

[11] Even though the beef used in the experiment was traceable to the animal level and the ham to the farm level, for consistency the participants were simply told for both ham and beef that Sandwich 3 contained meat traceable to the farm level.

approach may help engage subjects in the auction process to the largest extent possible.[12] Secondly, *ex poste* controls for the experimental group can help uncover the potential importance of consumer demographics in estimating the market potential for traceable food products.

We recruited an overall subject pool as diverse as possible from within our university population. Nonetheless, our sample still consists of individuals all affiliated with the university. Some sample statistics from our overall subject pool will help ensure the reader that our sample is still reasonably representative. Our overall sample, which is 49% female, has average annual *household* income of $43,369 (ranging from reported household income levels of less than $10,000 to greater than $100,000 annually) and mean weekly earnings for the experimental subjects of $588. Data from the Bureau of Labor Statistics reports median weekly earnings for males to be $672 and for females to be $511. Though our subjects were all at least 18 years of age, the BLS data includes all individuals 16 years of age and older (see ftp://ftp.bls.gov/pub/special.requests/lf/aat37.txt). The level of education completed for our sample ranged from high school to post graduate degrees (though most had at least some college education completed). Finally, 67% of our sample reports making most of the food purchase decisions for his/her household.

Once the experimental subjects arrived, they were seated with the free lunch in front of them, given the $15 cash up front, and told to await instruction before unwrapping the lunch sandwich. Subjects had hardcopy instructions of the experiment, the instructions were also explained orally, and all clarification questions were answered prior to commencement of the experiment. The auction format was such that subjects would place a bid to upgrade their existing sandwich to one of the four auction sandwiches, and the auction rules were those of a

[12] Subject engagement in the auction was one reason behind the use of the random n^{th}-price auction in Shogren et al. (forthcoming).

(theoretically demand-revealing) second-price sealed-bid auction.[13] There were no differences in appearance of any of the sandwiches, which were visually inspected by each subject prior to bidding. The instructions clearly explained the different verifiable meat attributes in each auction sandwich.[14] Unlike the auctions in Shogren et al (1994b), subject bids are not truncated at zero, although we expect that individuals would place positive value on the attributes we study in this article.[15]

Bids from each subject were taken in turn for each auction sandwich, and this constituted one round of the auction. Ten total rounds were conducted to allow for bid stabilization (see Hayes et al., and Shogren et al (1994b)), and market price information (i.e., the second highest bid) for each sandwich was presented prior to eliciting the next round's bid for that sandwich. Subjects were aware that a random draw at the end of the 10^{th} round would determine which of the four simultaneous auctions would be binding—no subject would end up consuming more than one sandwich in the experiment.[16] A second random draw determined which of the 10 rounds would be binding. Subjects were therefore fully aware prior to starting the first auction round that there was a uniform chance that any round for any auction sandwich might be the binding auction, and the subjects reported no confusion over the understanding of these procedures. After this second random draw, the appropriate auction was consummated by the

[13] Shogren et al (1994a) examine second-price, random n^{th} price, and combinatorial auction rules and find that average bids in such food auction experiments are insensitive to the auction format.

[14] The experiments involved no deceit as the auction sandwiches were truly and verifiably different in the meat they contained. Imported ham from Denmark was used for the traceable (and related characteristics) ham, and one of the Utah State University farms was used to trace the roast beef (as well as to conduct extra safety tests and verify humane animal treatment).

[15] While it is highly unlikely that negative bid possibilities would significantly affect the average willingness-to-pay data for items generally viewed as upgrades from a baseline product, this is not to say that negative bids might be much more likely for other food attributes that are not necessarily considered "goods" (e.g., radiated meat). In our experiments, only a small minority of the subjects every submitted negative bids, and these subjects often did this only in the early auction rounds—these rounds are not included in the Table 1 analysis of the data.

[16] While some may find elicitation of bids on four products at once cumbersome and/or confusing for the subjects, Melton et al. elicit simultaneous bids on eight different pork chops after noting that consumers regularly evaluate from six to eight packages of a particular cut of meat on display at once.

winning subject paying the second highest bid amount to exchange his/her original sandwich for the auction sandwich. Note that only one auction winner per experimental group consumes an auction sandwich. All subjects were then allowed/required to consume their sandwiches prior to leaving the experiment with their experiment cash.

Results

The main results of average bid behavior for beef and pork are highlighted in Figures 1 and 2, respectively. While the magnitudes of the average bids are important, our main discussion will involve comparisons of bids for different attributes of the same type of meat and for the same attribute for different types of meat. As do Hayes et al., we consider the magnitudes of the average bids more as an upper bound on bids due to the nature of the one-day experiment. Nonetheless, it is apparent that the average subject is willing to pay nontrivial amounts of money to upgrade the meat in a sandwich valued at approximately $3.00. Average willingness to pay (averaged across all subjects and all rounds) to upgrade the roast beef sandwich is $0.23 to add basic traceability, $0.50 to add assurances on animal treatment, $0.63 to add extra assurances of food safety, and $1.06 to upgrade the sandwich to one in which the roast beef contains all three upgrades. For pork, the same respective upgrades were valued on average at $0.50, $0.53, $0.59, and $1.14.[17]

From Figure 1 we see that, while traceability for beef products itself is valued to some extent, consumers place an even larger value on specific attributes that might be verifiable within a traceable meat system. Bids for beef traceability are statistically significantly lower than bids for animal treatment assurances and bids for increased food safety ($p<.01$ for the two-tailed

[17] Minor differences in the verifiable food safety characteristic—e.g., *salmonella* (ham) versus *e coli* (beef) safety—imply that the beef/ham results may not be entirely comparable and therefore should be considered separately. These differences are, however, consistent with how extra safety assurances are implemented in existing TTA systems of other countries.

nonparametric Mann-Whitney U-test of means using average bids in each round as the observation of interest).[18] Similarly, among the specific attributes of food safety and animal treatment, bids for food safety are higher than those for animal treatment ($p<.05$). Subjects are also willing to pay significantly more for beef that combines all three of these meat attributes in a single product ($p<.01$ for each comparison), although the average bid for the "everything" sandwich is less than the sum of the bids for individual meat attributes. That is, subjects display a decreasing marginal willingness-to-pay for additional attributes. Similar results are to be found by analyzing market price data, which is descriptive of the subjects' highest willingness-to-pay for comparative valuations of the food attributes.

Figure 2 shows the comparable aggregate bidding data for the ham sandwich upgrade. The bid data for each auction sandwich are not as neatly ordered for ham as they are for beef, but subjects are still willing to pay significantly more for food safety than for animal treatment assurances ($p<.10$ for the two-tailed test) or traceability alone ($p<.05$). We find no significant difference, however, in the average willingness-to-pay for animal treatment assurances and traceability for ham ($p>.10$). As before, subjects are willing to pay significantly more for all attributes together in the sandwich meat ($p<.01$ for each comparison), but the average bid for the "everything" sandwich upgrade is less than the sum of the individual meat attributes. Interestingly, similar analysis of the market price data for the ham experiments show that the market price for the animal treatment upgrade is significantly higher than the market price for traceability ($p<.01$). These results are due to some outlier subjects' high willingness to pay for

[18] The Mann-Whitney nonparametric test of means places no distribution assumptions on the subject bids, although it does assume that average subject bids are independent across rounds for each sandwich auction. The basic results are, however, consistent with the parametric regression results shown in Table 1 in which we use each subject's average bid *across* the final five auction rounds as the dependent variable.

traceability in ham, which generates high market prices but is tempered more in the overall average bid data.[19]

In comparing average willingness to pay for a meat attribute in beef and pork, there is no significant difference in subjects' average bids for animal treatment in beef versus pork ($p>.10$ for the two-tailed Mann-Whitney test) and food safety in beef versus pork ($p>.10$). The latter is true though the pathogen being tested is different in beef (*e coli*) than in ham (*salmonella*). However, subjects are willing to pay significantly more for traceability in pork than in beef ($p<.01$), which leads to a higher average bid for a ham sandwich with all three attributes than for a roast beef sandwich with all three attributes ($p<.10$).

Figures 3 and 4 show the average bid frequencies for beef and ham, respectively. While the average subject is willing to pay significant amounts of money for meat with these attributes, Figures 3 and 4 highlight that a significant number of subjects—anywhere from 15% (food safety) to 55% (traceability) in beef and from 21% (food safety) to 40% (traceability) in pork—place a zero value on some of the individual food attributes. As such, the conditional mean willingness-to-pay for these quality attributes in meat is even higher for the relevant segment of the market that positively values these attributes. The parametric regression results reported next will help highlight whether the positive willingness-to-pay of certain consumers is general across the demographic groups we used as experiment subjects or specific to one or more demographic group.

Table 1 reports the results of a basic treatment effects regression on average bids for ham and beef attributes. The regression results include group-specific controls, and each group

[19] We have yet to find a satisfactory explanation for the apparent initial upward trend in ham bidding data versus the initial downward trend in the beef bidding data. The parametric regression results in table 1 avoid this issue by focusing on the average bid in the *final* 5 rounds of the experiment as the dependant variable. Recall also that the purpose of a 10 round auction is to allow for bids to stabilize, which they apparently do in both cases.

represents a different demographic market type. The independent variable in the Table 1 results is the average of the *final* 5 rounds of bids for each subject's bid an a particular auction sandwich (i.e., average subject bids after bid stabilization in the auction trials). Differences in bidding behavior are separated into those resulting from demographic effects of the subject group and those resulting from the particular meat attribute of the auction sandwich.

Students and faculty made significantly lower bids for ham than professional staff while classified employees bid higher for ham than professional staff. For beef, each of the other three demographic groups placed higher average bids than the professional staff group (Table 1). These results, which are attributed to differences in meat preferences, could be a function of educational differences present in our cohort groups. Education levels are likely to affect the level of awareness of issues related to TTA such as a *BSE* or *salmonella* outbreak. It is interesting to note that the classified staff cohort in our experiments—possessing the lowest average education level in our sample—was willing to pay the highest premium for meat attributes in both the ham and beef regressions. This result is not attributable to income levels, since the student cohort is the lowest average income level cohort in our sample.

Table 1 also shows that students and faculty bid the lowest premiums on meat attributes for ham but not so for beef, suggesting that some demographic groups respond differently across meat types.[20] Also, the range of demographic group effects on average bid prices is narrower for beef than for pork in Table 1, implying that consumer demographics are a more important determinant of willingness-to-pay differences for TTA pork than beef. In either case, these results suggest that significant demographic effects exist and are larger in magnitude for pork,

[20] While the average bids of students, faculty, and classified staff were statistically above those of professional staff for beef, the premium above bids of the professional staff cohort is statistically equal for the three groups (i.e., a test of the restriction for the parameter estimates for students=faculty=classified employees could not be rejected (p>10%)).

which implies that marketing strategies for TTA characteristics should perhaps not be uniform across meat types.

Subjects in the ham sandwich experiment would pay the same additional amount for the three sandwiches with individual characteristics (Sandwich 1, 2, or 3) but would pay significantly more for a sandwich with the combined characteristics (Sandwich 4) than they would for a sandwich with only traceability (see Table 1 and Figure 2). Conversely, subjects in the roast beef sandwich experiment would pay more for animal welfare (Sandwich 1), food safety (Sandwich 2), and the combined characteristics (Sandwich 4) than for traceability alone (Sandwich 3) (Table 1 and Figure 1). This suggests perhaps a higher degree of concern about the procedures used to produce and process beef than ham. One could surmise this result from more highly publicized food scares in recent years being related to beef than to pork.

Discussion

Our results suggest that many consumers would be willing to pay for TTA characteristics in red meat products. Average bids for each individual TTA characteristic as well as the combined characteristics were found to be positive. The potential market segments for TTA red meat products appear to be large when one considers that *all* cohort groups, on average, were willing to pay a premium for red meat with TTA characteristics. This suggests that a significant marketing opportunity might be exploited if red meat producers developed TTA products. These results imply that U. S. consumers would be willing to pay for TTA characteristics in red meat products meeting the specific criterion suggested by Wiemers for considering the implementation of these systems.

The implementation of some sort of TTA system for red meat in the United State seems inevitable as our trading partners and competitors move rapidly to develop such systems. While

possible TTA systems in the U.S. are being examined, and in some cases implemented, the USDA and producer groups in the U.S. have sought evidence that TTA systems would produce a net benefit to the industry.

We elicited consumer willingness-to-pay data for TTA characteristics in pork and beef products in a non-hypothetical setting. Our summarized results indicate that U.S. consumers would be willing to pay for TTA characteristics in red meat. Consumers seem to value specific TTA attributes or combinations of attributes more than just traceability or identity preservation in beef and pork. This implies that system of meat traceability alone may not be valued enough by private consumers to justify its creation, although traceability itself could be a valuable public good in terms of limiting contamination outbreaks or even potential terrorism strikes at our nation's food system. Systems that provide traceability can, however, provide additional information on TTA characteristic(s) that consumers value even more. The characteristic most valued by consumers in our experiments was food safety, and so safety guarantees are likely an important component of any profitable TTA system.

We also find some distinct results for beef and pork. Specifically, consumers seems more willing to pay *additional* money for knowledge about animal treatment and additional food safety assurances in beef than in pork—this is in addition to what consumers are willing to pay for meat traceability information alone. Therefore, markets for specific and distinct TTA guarantees may be worth exploring in beef. Consumers are still willing to pay for TTA characteristics in pork, but we find less evidence for a difference in WTP for food safety and animal treatment guarantees versus traceability than in beef. There is also evidence that a consumer's demographics are less a determinant of WTP for TTA beef than TTA pork. This has important implications for any marketing strategy for TTA meat products since TTA pork may

have to be targeted to more specific consumer demographic groups than TTA beef, which may be a broader potential market.

The results reported in this paper are meant to be an initial step towards identifying the willingness-to-pay of U.S. consumers in retail markets for red meat. In the absence of such initial insights there is a higher risk of proceeding towards retail field trials of TTA meat products, and so this study will hopefully provide valuable information for such field trials. Our results not only need to be confirmed by field trials but they also do not answer the question of how TTA systems would affect the cost structure for producing and processing red meat—the other important ingredient in determining market viability of TTA products. Nonetheless, our findings offer enough evidence to justify continued examination and determination of the most effective ways for implementing TTA in the U.S. red meat system.

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Table 1. Regression Results.[a]

(dependent variable in ham and beef regression is average subject bid in final 5 rounds of auction)

Item/Independent Variable	Ham	Beef
Observations	212	220
Adjusted R^2	0.4603	0.2392
Intercept	0.943	-0.017
	(0.140)**	(0.097)
Demographic Type:[b]		
Students	-1.084	0.296
	(0.154)**	(0.105)**
Faculty	-1.074	0.230
	(0.148)**	(0.103)*
Classified Employees	0.485	0.345
	(0.150)**	(0.103)**
Meat Characteristic(s):[c]		
Sandwich 1 (Animal Treatment)	0.038	0.265
	((0.152)	(0.104)*
Sandwich 2 (Food Safety)	0.127	0.375
	(0.152)	(0.104)**
Sandwich 4 (Combined Characteristics)	0.676	0.802
	(0.152)**	(0.104)**

[a] Standard errors are in parentheses.
[b] Base is professional staff.
[c] Base is Sandwich 3 (traceability).
* Significantly different than zero at the 5% level.
** Significantly different than zero at the 1% level.

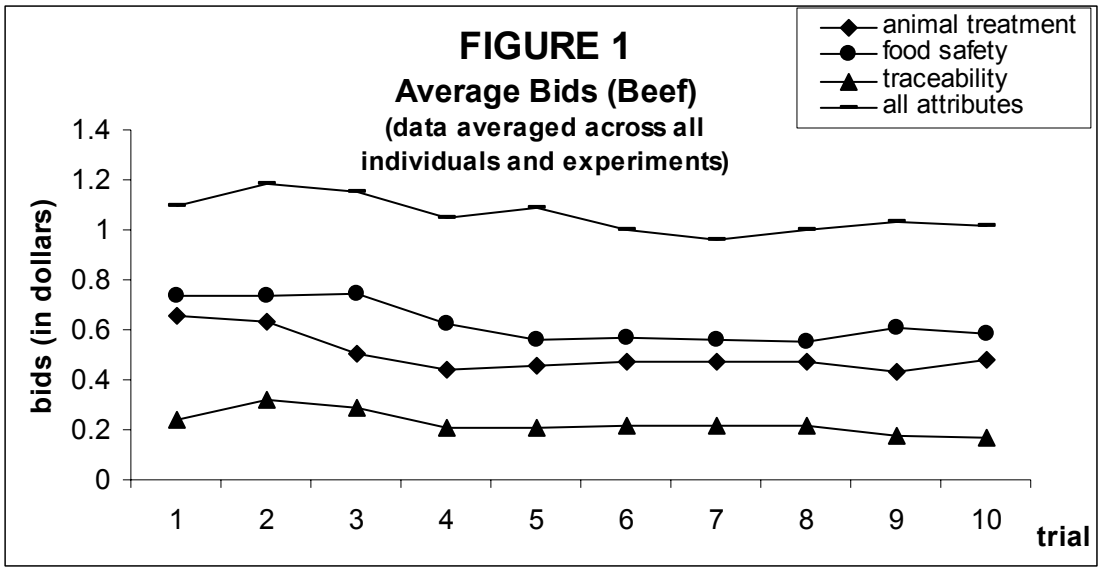
FIGURE 1
Average Bids (Beef)
(data averaged across all individuals and experiments)
animal treatment
food safety
traceability
all attributes
bids (in dollars)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
trial

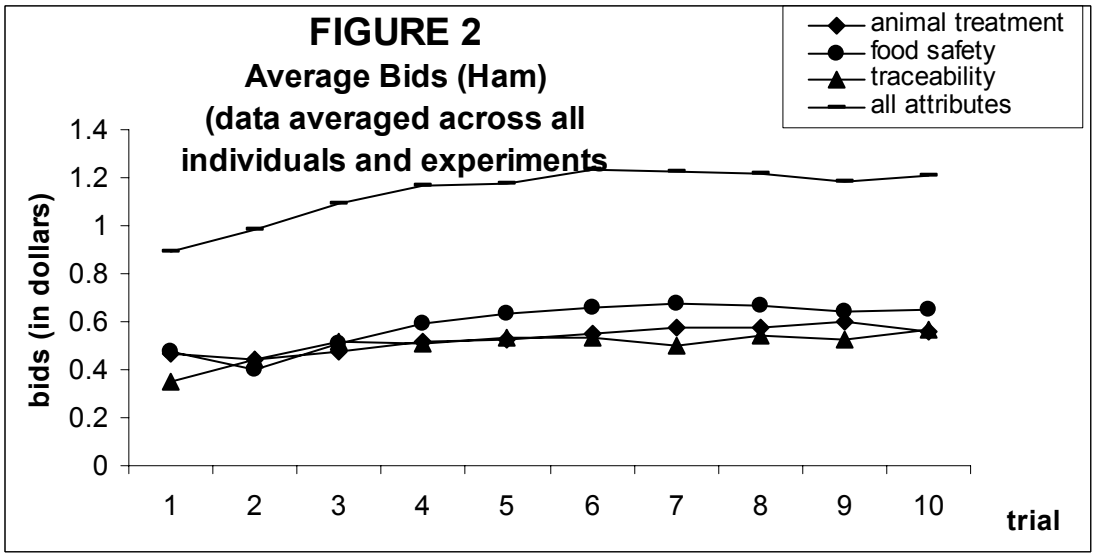
FIGURE 2
Average Bids (Ham)
(data averaged across all individuals and experiments
animal treatment
food safety
traceability
all attributes
bids (in dollars)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
trial

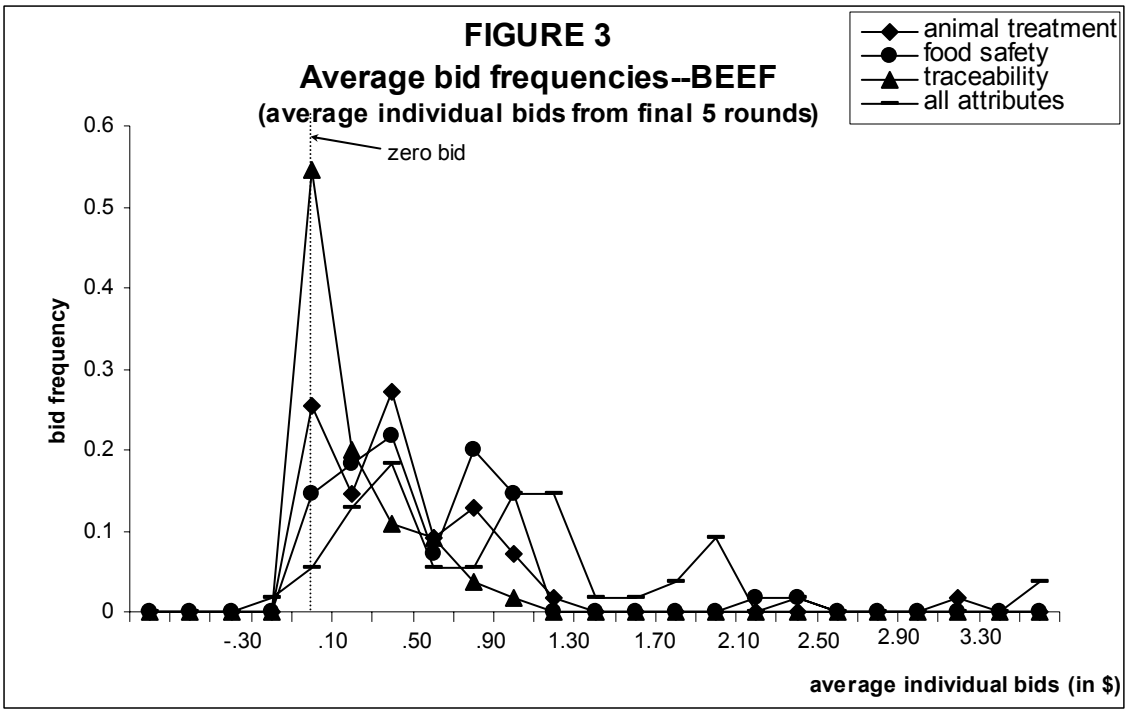
FIGURE 3
Average bid frequencies--BEEF
(average individual bids from final 5 rounds)
animal treatment
food safety
traceability
all attributes
zero bid
bid frequency
0.6
0.5
0.4
0.3
0.2
0.1
0
-.30
.10
.50
.90
1.30
1.70
2.10
2.50
2.90
3.30
average individual bids (in $)

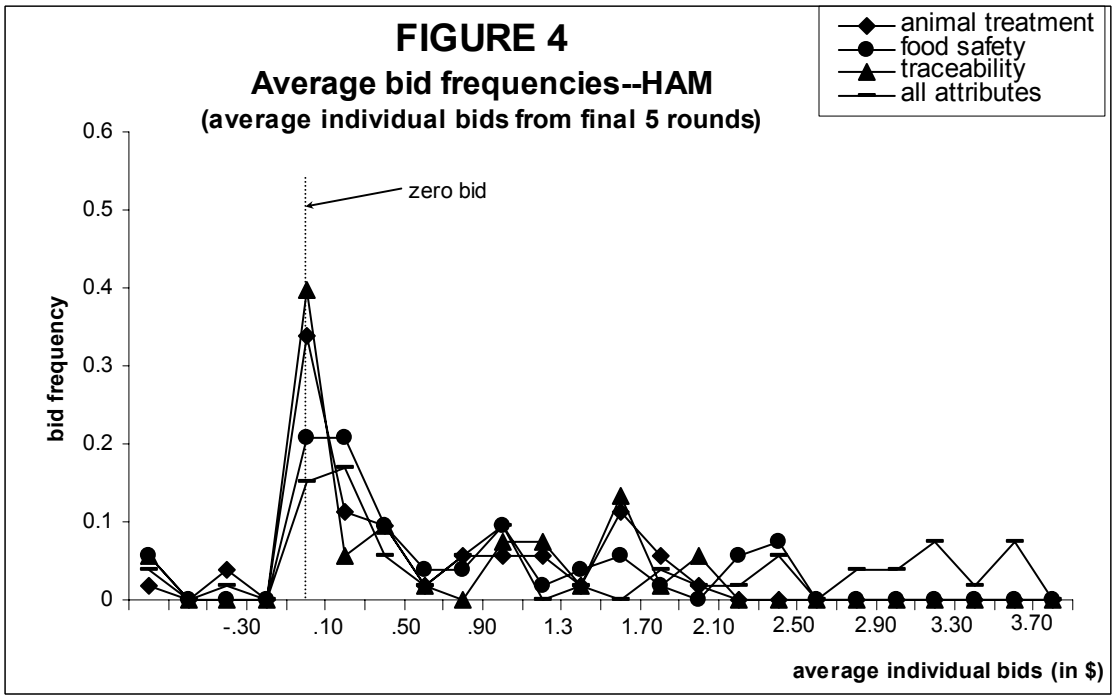
FIGURE 4
Average bid frequencies--HAM
(average individual bids from final 5 rounds)
animal treatment
food safety
traceability
all attributes
zero bid
bid frequency
0.6
0.5
0.4
0.3
0.2
0.1
0
-.30
.10
.50
.90
1.3
1.70
2.10
2.50
2.90
3.30
3.70
average individual bids (in $)