Traceability in the Canadian Red Meat Sector: Do Consumers Care?

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ABSTRACT

Increased traceability of food and food ingredients through the agri-food chain has featured in recent industry initiatives in the Canadian livestock sector and is an important facet of the new Canadian Agricultural Policy Framework (APF). While traceability is usually implicitly associated with ensuring food safety and delivering quality assurances, there has been very little economic analysis of the functions of traceability systems and the value that consumers place on traceability assurances. This paper examines the economic incentives for implementing traceability systems in the meat and livestock sector. Experimental auctions are used to assess the willingness to pay of Canadian consumers for a traceability assurance, a food safety assurance, and an on-farm production method assurance for beef and pork products. Results from these laboratory market experiments provide insights into the relative value for Canadian consumers of traceability and quality assurances. Traceability, in the absence of quality verification, is of limited value to individual consumers. Bundling traceability with quality assurances has the potential to deliver more value.

INTRODUCTION

Food safety and food quality have increasingly come to the forefront of consumer concerns, industry strategies, and government policy initiatives. A variety of private sector and public policy traceability initiatives have emerged in various countries, ostensibly with the objective of reducing consumer information asymmetry with respect to food safety and food quality attributes. In Canada, traceability of food and food ingredients through different levels of the agri-food chain has featured prominently in recent industry initiatives and in policy discussions within the Agricultural Policy Framework (APF). The discovery of BSE in a Canadian beef animal in 2003, and the U.S. BSE case later the same year that was traced back to a Canadian cow, has intensified the interest in traceability.

Given the private sector and public policy interest in traceability, it is timely to ask what is really meant by "traceability" and what are the expected benefits from traceability? There is no international agreement on the definition of traceability. At its simplest, it is defined as the ability to follow the movement of food through specified stages of production, processing, and distribution, however, other definitions are also used (Souza-Monteiro and Caswell 2004). Traceability sometimes refers to simple traceback systems but the term has also been applied to programs that provide identity preservation and quality assurances throughout the supply chain. Traceability can be part of a strategy to reduce the risks or minimize the impact of a foodborne disease problem. It can also be part of a larger quality assurance strategy, facilitating the verification of specific quality attributes.

This paper examines the economic incentives for implementing traceability systems in the meat and livestock sector, distinguishing between ex post traceback systems and ex ante quality verification systems. Examples of voluntary private sector and public sector traceability programs are discussed. Experimental auctions are used to assess the willingness of Canadian consumers to pay for a traceability assurance, a food safety assurance, and an on-farm production method assurance for meat products. Results from these laboratory-based market experiments provide insights into the relative value of traceability and quality verification assurances to Canadian consumers.

THE DEVELOPMENT OF TRACEABILITY SYSTEMS

Various livestock identification and meat traceability systems have emerged in different countries in recent years. Most of these are private sector systems, although there are examples of public sector regulatory initiatives to mandate livestock traceability. Some systems have partial traceability capabilities facilitating traceability between specific stages of the supply chain (e.g., point of slaughter back to farm of origin), whereas others offer traceability from the retail counter back to the farm.

Private sector traceability initiatives in the livestock sector include individual supply chain initiatives and industry-wide programs. Voluntary labeling by firms, sometimes supplemented by third-party certification, can identify credence attributes [1]. If there is a market premium for

"safer" food, there is an incentive for firms achieving enhanced levels of food safety to identify this attribute in a label. A credible monitoring and enforcement mechanism is necessary to reduce the risk of cheating through mislabeling. While labeling at the retail level may be used to convey traceability information to consumers, other mechanisms such as certification, contracts, and third-party audits are more commonly used to convey traceability information along the supply chain.

Food retailers may be a catalyst for improved traceability if this reduces their risk exposure, improves product recall effectiveness, or reduces the transaction costs arising from the monitoring of product quality including the production methods of suppliers. The motivation for these traceability systems is improved supply chain management from the retail sector back down the food chain. However, traceability information may not necessarily be provided to consumers on retail packages. The primary motivation for retailers is usually to reduce the transaction costs of supply chain management rather than to provide information to consumers on credence attributes. For example, U.K. supermarkets require their beef suppliers to be members of accredited quality assurance programs but do not always identify this requirement on the retail label (Fearne 1998).

The Canadian Cattle Identification Agency (CCIA), established in 2001, is an example of an industry-wide traceability system. The national cattle identification system became mandatory in July 2002. Its objective is to facilitate the traceback of cattle in the event of a food safety problem. Cattle leaving the herd of origin are issued a unique identification (ID) number that remains with the animal to the point of carcass inspection in the packing plant. In the event of a food safety problem, information on the last location of the animal and the herd of origin is used to track cattle movements both backward and forward in the supply chain. The CCIA was introduced to protect markets for Canadian beef in the event of a herd health or safety issue by facilitating traceback of cattle. The system had only been mandatory for 10 months when a case of BSE was discovered in May 2003. Although it facilitated a rapid trace of the recent offspring from the affected cow, the system could not assist in tracing back the history of the cow itself due to her age.

National livestock identification systems are also being used as a springboard for more extensive quality assurance programs. Australia introduced a voluntary National Livestock Identification System (NLIS) that combines animal identification with the storage of information on the disease and residue status of the animal, market eligibility, and other commercial information (Meat and Livestock Australia 2001). A quality assurance system including DNA sampling for traceback piggybacks on the Australian NLIS through a series of quality management protocols that can be linked to the producer through the cattle ID number. Traceability back from the point of consumption is possible through DNA samples of carcasses and meat cuts (Lawrence 2002).

Mandatory traceability and labeling initiatives have been introduced in some jurisdictions. In 1997, the European Union (EU) introduced a regulation establishing rules for beef labeling systems in Member States [2]. The regulation required that Member States develop national cattle identification and registration systems and that beef products be labeled with a traceability

number identifying origin, including where the animals from which the meat was derived were born, reared, slaughtered, and processed. The regulation also introduced rules for voluntary labeling with additional information (e.g., production information, animal welfare information, etc.). The EU beef labeling and traceability regulation represents a more extensive regulatory involvement in meat traceability than is evident in many other countries.

As these examples illustrate, there are many approaches to enhancing traceability in livestock and meat sectors, including industry-wide private sector initiatives, individual supply chain initiatives, and public sector regulation. Some of these systems provide for complete traceability from the retail package purchased by consumers back to the farm production unit, while others facilitate only limited traceability between specific stages, such as packer to producer. There are systems that provide simple traceback capability, while others provide more extensive information, including quality or food safety assurances coupled with traceability. It is therefore timely to ask: what do we really mean by "traceability"? To help answer that question, it is first necessary to examine the economic incentives for traceability.

ECONOMIC MOTIVATIONS FOR TRACEABILITY

As the preceding discussion illustrates, a wide variety of traceability systems are emerging, driven both by private sector management motivations and public policy initiatives. A number of authors have explored the scope and functions of livestock traceability systems. Liddell and Bailey (2001) distinguish between traceability, transparency, and quality assurances (TTA) and compare TTA across six major pork exporting and importing countries. Traceability is defined as the ability to track the inputs back to their source at different levels of the marketing chain; transparency refers to the public availability of information on production practices, while quality assurances relate to measures to ensure food safety and enhance quality measurements (Liddell and Bailey 2001). Golan et al (2003a, 2003b) identify three motivations for food suppliers to establish (private sector) product tracing systems: to capture efficiency gains through improved supply-side management; to improve food safety and quality control by facilitating firms in identifying and resolving food safety or quality problems; and to differentiate foods with credence attributes. Souza-Monteiro and Caswell (2004) focus on the human and animal health effects, liability impacts, trade, and supply chain effects of traceability systems. Human and animal health concerns are identified as key motivations for adopting traceability systems. Increased liability from more accurate traceability is a primary concern of opponents to mandatory traceability, however, increased liability creates incentives to use safer production and processing methods.

The complexity and variety of traceability systems suggest that traceability is not simply a binary variable (i.e., either in place or not). Instead, there are degrees of traceability. Golan et al (2003b) identify three characteristics by which traceability systems can differ: breadth, depth, and precision. Breadth refers to the amount of information recorded, for example, feed ingredients, production methods, processing methods, etc. Depth indicates how far back or forward through the supply chain the system tracks. Precision is the degree of assurance with which the system can pinpoint the movement of a specific product, for example, tracing to a

specific animal, a lot of animals, or a farm. The greater the precision or accuracy, the higher the cost. Souza-Monteiro and Caswell (2004) use the metric of breadth, depth, and precision to provide a comparison of beef traceability systems across six countries, plus the EU. They note considerable differences between the systems, including governance (mandatory, combination of mandatory and voluntary, voluntary) as the countries respond to internal motivations for traceability systems with either a primarily policy-driven approach or with industry-led initiatives.

Mandatory traceability systems may be introduced to correct perceived market failures when firms fail to supply the socially optimal level of traceability. Market failure can occur in two ways. First, the credence nature of food safety and quality attributes may lead to markets being dominated by low-quality products if producers of high-quality (or "safer") food are unable to offer credible assurances to consumers (Golan et al 2003a; Hobbs 2004). Traceability systems certified by third-party verifiers can facilitate credible quality assurances and protect consumers from fraudulent quality claims. Second, traceability systems facilitate the traceback of products in the event of a food safety problem, reducing the impact on public health and protecting the reputation of other firms in the same industry (Hobbs 2003; Golan et al 2003a). The net social benefits of a traceback system may outweigh the net private benefits, leading to underinvestment in traceability. Golan et al (2003a), however, warn that mandatory traceability may be an inefficient policy response compared to other measures of enhancing food safety. They call for flexibility in the design of mandatory systems that target performance goals for traceability systems, rather than proscribing a process of traceability.

Identifying the economic incentives for introducing traceability systems is useful in understanding the extent to which traceability is likely to deliver net economic benefits. Three separate functions of a livestock and meat traceability system are apparent. The first is ex post cost reduction. This is a reactive function, which allows the traceback of products or animals through the supply chain in the event of a food safety problem. This describes the livestock traceability systems in place in most countries, including Member States of the EU and Canada. They enable ex post cost reduction after a problem has arisen.

Effective traceback may enable the scope of a foodborne illness to be contained, thereby reducing public costs (e.g., medical costs, lost productivity, etc.) by limiting the number of people exposed to potentially unsafe food. By identifying and isolating a source of contamination, a traceability system can also reduce private costs to the industry by reducing product recall costs through more targeted recalls and protecting firms that practice due diligence from free riders who have failed to invest in good production practices. An effective traceability system may also help to shore up public confidence and maintain access to export markets in the event of a food safety problem if the source can be identified and isolated quickly. Recent analyses of traceability systems identify cost reductions and rapid animal/food traceback as important motivations for establishing mandatory traceability systems and private sector industry-wide systems (Pettitt 2001; Golan et al 2003a, 2003b; Hobbs 2003; Souza-Monteiro and Caswell 2004).

A second function of a traceability system is to enhance the effectiveness of Tort Liability law as an incentive for firms to produce safe food. The threat of civil legal action and the resulting

financial damages and damage to brand name capital provide the incentive. To the extent that industry-wide traceability systems can facilitate the establishment of legal liability, the incentive for firms to adopt measures that enhance food safety is strengthened (Hobbs 2003; Souza-Monteiro and Caswell 2004). In this sense, traceability systems also perform an ex post information function. Traceability also reduces the monitoring and enforcement costs for consumers and downstream food distributors in identifying the party at fault and in seeking legal redress. Traceability systems may also allow governments to operate more efficient monitoring and inspection programs that focus on auditing firms' records, rather than direct monitoring of firms' actions (Souza-Monteiro and Caswell 2004). In this respect, traceability and legal standards may be substitutes [3]. If food safety standards are very high and strictly enforced, the liability incentive for also having traceability is weakened, presumably as is consumer willingness to pay (WTP) for traceability for purely food safety reasons. However, as is discussed below, consumers may value traceability for other reasons.

A third function of traceability is to reduce information costs for consumers by facilitating the labeling of credence attributes, including those related to food safety, animal welfare, environmentally–friendly production practices, etc. (Golan et al 2003a, 2003b; Hobbs 2003). For example, Clemens (2003) discusses a recent strategy by Japanese food retailers to market "story meats," for which information is available on the BSE status and basic production information about the animal, together with traceability information throughout the supply chain back to the farm of origin. This form of traceability performs an ex ante information function, focusing on proactive information provision and quality verification. In the context of Golan et al (2003b), it is a traceability system with more breadth.

If consumers are provided with an assurance about production or processing methods, why should they care that the product could be traced back to the farm of origin? It has been argued that an additional assurance that a product is traceable helps to build consumer trust, particularly when consumer confidence in the government's ability to protect the safety of the food supply has been weakened as in the EU and Japan in the wake of BSE (Clemens 2003). In these cases, retailers have attempted to fill the gap in consumer confidence by offering quality assurances, with traceability integral to that assurance. Indeed, Dickinson and Bailey (2003) find that Japanese and U.K. consumers in general valued traceability more highly than consumers in the United States and Canada, and attribute this to a fallout from the U.K. and Japanese BSE crises. Results from the present study suggest a strong degree of confidence among Canadian consumers in the public food safety inspection system. Thus, a traceability system can be both a vehicle to facilitate ex ante quality assurances and a means to enhance the credibility of those assurances.

Most mandatory livestock identification and traceability systems are reactive ex post information systems that are primarily designed for traceback in the event of a problem. They do not provide information on product attributes to reduce consumers' information asymmetry. For the most part, private sector traceability systems have performed this function. Paradoxically, the frequent justification for public policy intervention to mandate traceability and labeling is the provision of useful information to consumers that the market would otherwise fail to provide. In fact, most of these livestock traceability systems offer only a traceback function. In the

immediate aftermath of the Canadian BSE cases, the media frequently referred to the apparent need for more traceability in the Canadian beef sector but exhibited little understanding of the different economic functions of "traceability."

Advances in information and DNA technology continue to expand the potential scope (breadth, depth, and precision) of traceability systems that are technologically feasible. However, a "Cadillac" traceability system will not be appropriate for some product attributes if the economic benefits fail to offset the costs. A cost-benefit analysis would be an important component of the policy decision-making process for mandatory traceability systems. Ironically, in the case of the EU beef labeling and traceability regulation, there does not appear to have been any formal assessment of the relative costs and benefits [4] (Hobbs 2004).

While the costs of a traceability system should be relatively straightforward to evaluate, the benefits are more nebulous. Valuing the benefits of traceability is therefore important. Of particular interest is whether traceability information per se (as characterized by ex post traceback systems) is useful to consumers or whether quality assurances, delivered through traceability, have more value. This issue is particularly pertinent to the Canadian livestock sector given recent industry initiatives to establish a mandatory cattle traceback system and the proposed target in the 2001 Agricultural Policy Framework that 80% of the domestic food supply should be traceable. An analysis of Canadian consumer responses to traceability and quality verification information informs this debate.

CONSUMER WILLINGNESS TO PAY FOR TRACEABILITY INFORMATION

We now turn to the question "what do consumers really want?" Is traceability information per se of value to consumers or should traceability systems incorporate additional quality assurances? Can traceability add value to a quality assurance or is traceability redundant in the presence of an existing quality assurance? A set of experimental auctions, conducted in Saskatchewan and Ontario in 2002, shed light on these issues. The auctions used beef and pork products and provide insights into consumer WTP for a production method (animal welfare) assurance, a food safety assurance, and an assurance that the meat was traceable to the farm of origin. In the absence of publicly available market data on the demand for traceability and quality verification characteristics, experimental auctions provide a means of eliciting nonhypothetical bid data for these characteristics. Experimental auctions have become an increasingly popular tool for evaluating consumer preferences for credence attributes (Fox et al 1994; Hayes et al 1995; Dickinson and Bailey 2002).

Data Collection

Experimental auctions were run in groups of 12–14 people. Participants were paid Cdn$20 as an incentive to attend the session. Participants were given a beef (or ham) sandwich as part of a light lunch, and had the opportunity to bid to exchange their sandwich for a sandwich with additional verifiable characteristics. Four alternative sandwiches were used in the auction: (i)

animal welfare assurance, (ii) extra food safety assurance, (iii) meat that was traceable to the farm of origin, and (iv) a sandwich that combined all three attributes. Table 1 details the sandwich descriptions that were provided to participants. Sandwiches 1 and 2 offer simple (ex ante) quality assurances but without a specific assurance regarding traceability. Sandwich 3 provides a traceability assurance but does not offer any information about production methods on the farm of origin or along the supply chain. In this sense, it is closest to the ex post traceability function outlined earlier. Sandwich 4 bundles quality assurances with a traceability assurance and represents a traceability system with added breadth. In this context, the function of traceability is to facilitate the provision and enhance the credibility of the quality assurances.

Table 1. Sandwich Descriptions (Beef)[a]	
Sandwich 1	Information is available on certain *enhanced* processes and procedures used to produce the animal that provided the meat in this sandwich, and this is over and above what one would know from typical beef products (e.g., this meat product has extra assurances that the animal was raised in a state-of-the-art facility, the animal was fed high-quality feed and was processed in a low-stress environment—this is part of humane animal treatment).
Sandwich 2	We know that the meat for this sandwich was processed in a plant federally inspected by the Canadian Food Inspection Agency (not all Canadian meat plants are federally inspected). We also know that the processing plant follows a food safety hazard minimization certification program that not all Canadian meat plants follow, even if they are federally inspected.
Sandwich 3	The meat in this sandwich can be traced back to the specific farm on which the animal was raised.
Sandwich 4	The meat in this sandwich can be traced back to the specific farm on which the animal was raised). In addition: (1) information is available on certain *enhanced* processes and procedures used to produce the animal that provided the meat in this sandwich, and this is over and above what one would know from typical beef products (e.g., this meat product has extra assurances that the animal was raised in a state-of-the-art facility, the animal was fed high-quality feed and was processed in a low-stress environment—this is part of humane animal treatment *and* (2) the meat for this sandwich was processed in a plant federally inspected by the Canadian Food Inspection Agency (not all Canadian meat plants are federally inspected). We also know that the processing plant follows a food safety hazard minimization certification program that not all Canadian meat plants follow, even if they are federally inspected.

[a]Similar descriptions were used for the pork sandwich experiments. All statements were true.

A Vickrey second-price auction format was used, consistent with the previous experimental auctions to measure WTP, for example, Shogren et al (1994). Ten rounds of bidding were conducted for each auction sandwich. Participants bid the amount they would be willing to pay to exchange their (regular) sandwich for each auction sandwich; zero and/or negative bids were permitted. The rational strategy for each participant is to bid his/her true marginal value for the auction sandwich. Individual bids were private information, written down by participants and collected as each round of bidding progressed. Before starting each bidding round for a specific

sandwich, the second highest bid ("market price") from the previous round was announced. Using multiple rounds of bidding, and the provision of information on the "market price" from the preceding round, provides a corrective mechanism to assist participants in understanding the experiment and tends to lead to bid stabilization over the ten rounds of the auction (e.g., Shogren et al 1994; Dickinson and Bailey 2002).

After the entire bidding process was complete, one round of bidding and one sandwich were selected through a random draw as the binding auction. The highest bidder for the randomly selected sandwich in the selected round of bidding exchanged their sandwich for the auction sandwich and paid the second highest bid price. Only one sandwich was auctioned off in each session. The equal chance that any of the rounds of bidding could be binding provides rational participants with the incentive to bid honestly each time. This encourages participants to bid their true WTP and reduces the risk of strategic bidding behavior. At the end of the session participants completed a short questionnaire collecting demographic information and information on their attitudes toward food safety, animal welfare, and quality assurance issues.

Saskatchewan participants were recruited from a range of demographic groups at the University of Saskatchewan in Saskatoon (faculty, students, professional, administrative, and maintenance staff). Ontario participants were recruited from the consumer database of a private consumer research firm in Guelph. Participants were provided with a minimum of information during recruitment to reduce the risk of sample selection bias. Auctions were run with ham and beef at both locations. The beef auctions had 104 participants (54 in Saskatchewan and 50 in Ontario). One hundred people participated in the pork auctions (52 in Saskatchewan and 48 in Ontario).

The Regression Model

We are interested in the factors affecting the WTP for traceability and quality assurances in meat, and the relative value of quality assurances, and quality assurances bundled with traceability, compared with traceability alone. The dependent variable is the average WTP bids for each sandwich from the final five rounds of bidding for a given subject. Consistent with the approach used elsewhere in the literature, we assume that by the sixth round the bids will have stabilized around a participant's true marginal WTP for the attribute in question (Shogren et al 1994; Hayes et al 1995). Data from the first five bidding rounds are excluded so that any bidding errors due to participants' misunderstanding of the auction process at the outset of the experiment will not contaminate the data set. Figures 1 and 2 display average bids over the 10 rounds for beef and pork, respectively, and confirm that using the last five rounds of bidding data is a conservative approach.
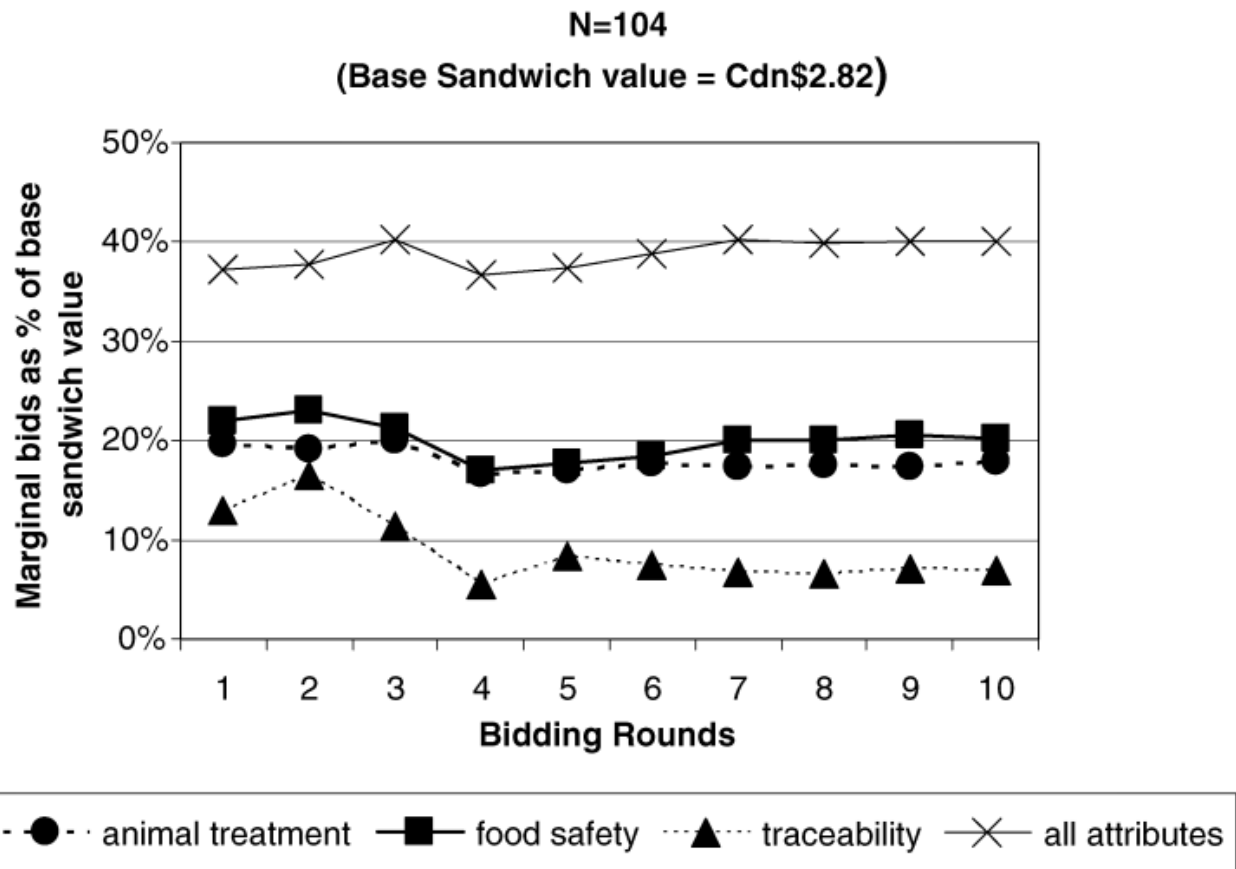
N=104
(Base Sandwich value = Cdn$2.82)

Legend: animal treatment · food safety · traceability · all attributes

Figure 1. Average WTP bids—beef

N=100
(Base sandwich value = Cdn$2.85)

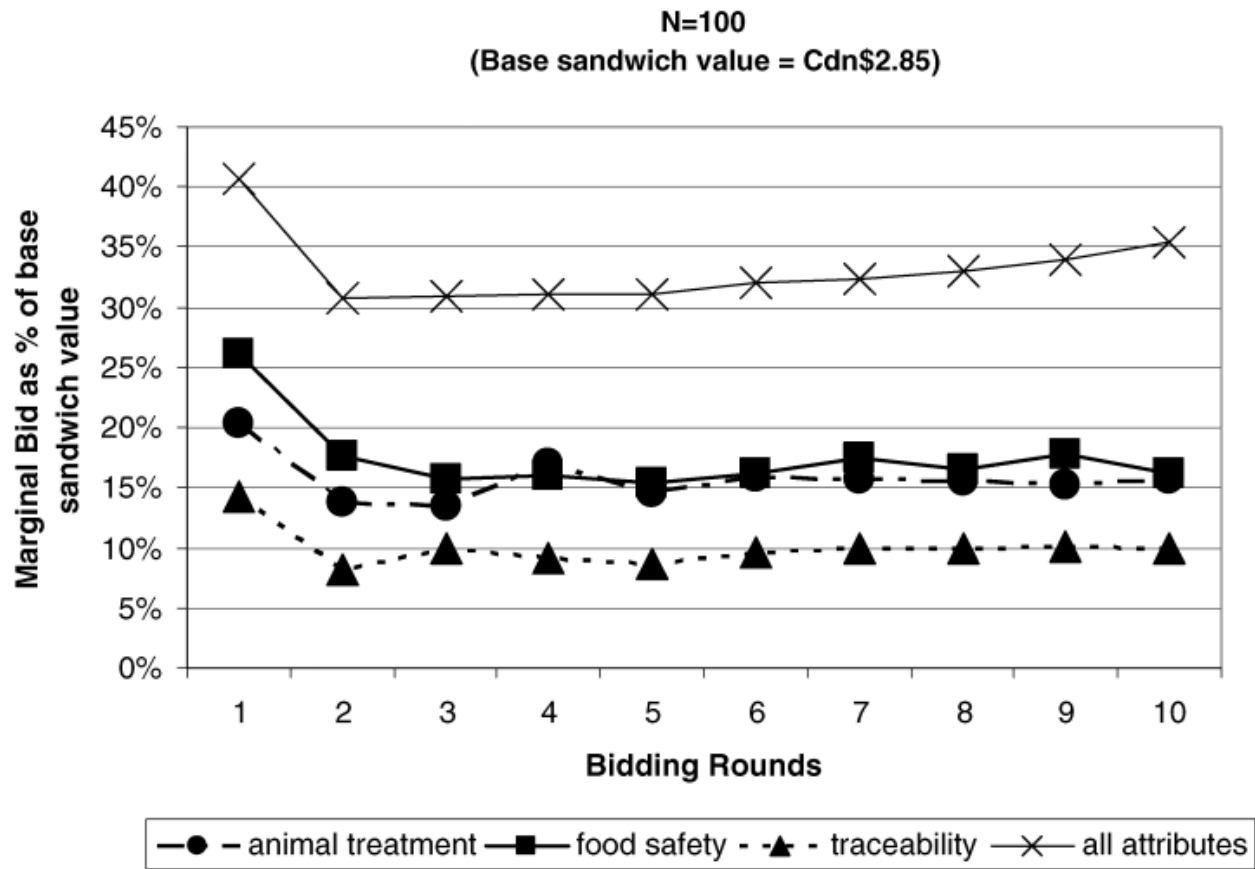Legend: —●— animal treatment —■— food safety - -▲- - traceability —✕— all attributes

Figure 2. Average WTP bids—pork

For both pork and beef, traceability to the farm of origin, without additional quality assurances (sandwich #3), elicited the lowest average WTP (7% for beef, 10% for pork) [5]. Quality verification with respect to credence attributes, such as an additional food safety assurance or an animal welfare assurance, elicited higher bids on average [6]. The fourth sandwich, which bundled traceability information with positive quality assurances, yielded the highest bids (40% for beef and 33% for pork). Consistent with results obtained from a similar WTP study with U.S. consumers (Dickinson and Bailey 2002), there was a decreasing marginal WTP for the attributes. Thus, the average bid for the "all inclusive" sandwich was less than the sum of bids for the individual attributes. It is worth noting that there were a high number of zero bids for the traceability only sandwiches (46%), whereas only 7% of participants bid zero on the beef/pork sandwich that combined traceability with an extra food safety assurance and animal welfare assurance. This is consistent with the conceptual discussion outlined earlier. We would expect a simple traceability system with limited breadth, offering only ex post traceability, to be of relatively less value to individual consumers (although there may be broader public good benefits from ex post traceability that are not captured here). In contrast, for the fourth sandwich, it may be that traceability facilitates more credible ex ante quality assurances and therefore has relatively more value. Due to the nature of a 1-day experiment, the bid information

is usually considered to be an upper bound on WTP (Hayes et al 1995; Dickinson and Bailey 2002) [7].

The following regression model was estimated:

$$
\begin{aligned}
\text{Average Bid} = {} & \alpha + \beta_1(\text{HUMANETREAT}) + \beta_2(\text{MEATSAFETY}) \\
& + \beta_3(\text{ALLATTRIBS}) + \beta_4(\text{FPOISON}) + \beta_5(\text{ARTICLES}) \\
& + \beta_6(\text{CONFSAFE}) + \beta_7(\text{VALUESAFE}) + \beta_8(\text{VALUETRACE}) \\
& + \beta_9(\text{VALUEPROCESS}) + \beta_{10}(\text{AVEMKTP}) + \beta_{11}(\text{LOCATION}) \\
& + \beta_{12}(\text{GENDER}) + \beta_{13}(\text{AGE}) + \beta_{14}(\text{EDUCATION}) + \beta_{15}(\text{INCOME})
\end{aligned}
$$

Data for the independent variables were drawn from the post-bidding survey. The independent variables are listed in Table 2, along with the details of their measurement and, where appropriate, a priori expectations regarding the sign of the coefficient.

Table 2. Variable descriptions for regression analysis

Variable name	Description	Measurement	Expected sign
HUMANETREAT	Sandwich #1: Humane animal treatment assurances	Dummy variable: 1 = Sandwich #1	+
MEATSAFETY	Sandwich #2: Additional food safety assurances	Dummy variable: 1 = Sandwich #2	+
ALLATTRIBS	Sandwich #4: Traceability plus food safety & humane animal treatment assurances	Dummy variable: 1 = Sandwich #4	+
FPOISON	Subject or family member experienced food poisoning	1 = Yes, 0 = No	+
ARTICLES	News articles/reports read/heard regarding foodborne disease in the last 6 months	Number of articles/reports 0–5 articles = 1; 6–10 = 2; 11–15 = 3; 16–20 = 4; 21–25 = 5; 26–30 = 6; >30 = 7	+?
CONFSAFE	Confidence in the Canadian food inspection and safety program	Score 1–5, where 1 = complete confidence and 5 = no confidence	+
VALUESAFE	Value additional assurances about meat safety	Score 1–5, where 1 = highly value and 5 = no value	−
VALUETRACE	Value knowing exact farm that produced the animal	Score 1–5, where 1 = highly value and 5 = no value	−
VALUEPROCESS	Value knowing processes used by farmer to produce the animal	Score 1–5, where 1 = highly value and 5 = no value	−
AVEMKTP	Market price from first five rounds	Average of announced market price from first five rounds	?
LOCATION	Location of panel	1 = Saskatchewan; 0 = Ontario	?
GENDER	Gender	Male = 1; female = 0	?
AGE	Age	Age in years	?
EDUCATION	Education	High school or less = 1; college = 2; undergraduate degree = 3; graduate degree = 4	?
INCOME	Annual household income	1 = <$30,000; 2 = $30,000–$60,000; 3 = $60,000–$90,000; 4 = >$90,000	+?

Three dummy variables represent the different sandwiches from the experimental auction: food safety assurance (MEATSAFETY), animal welfare assurance (HUMANETREAT) and combined traceability, food safety, and animal welfare assurances (ALLATTRIBS). Sandwich #3, with a

traceability assurance, is the reference category. Coefficients on these dummy variables will indicate whether respondents were willing to pay a premium over basic traceability for the sandwiches that offered information on specific credence attributes. We expect consumers to place more value on assurances that reduce information asymmetry with respect to quality assurance attributes relative to a simple ex post traceability assurance that does not deliver as much value to an individual consumer. Therefore, we expect positive coefficients for the sandwich-related dummy variables.

Four variables measure consumer awareness and concerns over food safety issues: direct experience with food poisoning (FPOISON), exposure to media coverage of food safety issues (ARTICLES), and the level of confidence in the current Canadian government food inspection and safety program (CONFSAFE). Experience with food poisoning is expected to induce a higher WTP for additional food safety assurances, although not necessarily for increased traceability or humane animal treatment assurances. Approximately 64% of respondents in the pork sessions had experienced food poisoning, either personally or through a family member, compared with 54% from the beef sessions. The survey data did not allow us to ascertain whether this was a mild or more serious experience.

Exposure to media stories on foodborne diseases (ARTICLES) could have a positive effect on WTP, assuming that those media stories are negative. The survey data did not allow us to determine whether the media reports were positive or negative, however, if we assume that the negative foodborne disease stories are more newsworthy, we would expect this variable to have a positive coefficient. There was a wide range of exposure to media stories related to food safety, ranging from 0 to 400, with an average of 17 articles. The average belies the distribution of the responses to this question, with about 38% of people having read 1–5 articles in the past 6 months and a further 25% seeing 6–10 articles. For this reason, ARTICLES is specified as a categorical variable.

A lower level of confidence in the current food inspection and safety program is represented by a higher score for the variable CONFSAFE. The variable is expected to have a positive coefficient, reflecting a higher WTP for stronger safety and quality assurances than are currently available from the existing food safety inspection system. In general, panelists had relatively high levels of confidence in the current Canadian system for food inspection and food safety.

Three variables measure the value that respondents said they placed on additional assurances about meat safety (VALUESAFE), traceability (VALUETRACE), and on-farm production methods (VALUEPROCESS). These variables are included as a validity check on the stated preference and experimental auction bidding process. We would expect a correlation between the value people say they place on extra assurances of food safety, traceability, and animal welfare and the amount they were actually willing to bid on food, which includes these additional assurances. However, the reliability of stated preferences is often questioned—do people act on their stated preferences when faced with actual purchase decisions? Therefore, this data set allowed us to test the strength of the relationship between what people say is important to them and how they actually respond when faced with a choice involving monetary payments. Given the specification of these variables, where a higher rating means the assurance had less value

to the respondent, we expect these coefficients to be negative if stated preferences are a good indicator of revealed WTP.

AVEMKTP measures the announced average market price during the first five rounds of bidding. This variable is included to isolate any market feedback effects from the announced market price, which may indicate strategic bidding on the part of the auction participants. The market price variable is based on the first five rounds of bid data whereas the dependent variable is based on the last five rounds of bid data to ensure that the market price is exogenously determined with respect to the dependent variable. As this variable is included to isolate any potential market feedback effects, there are no a priori expectations for the sign of the coefficient.

A dummy variable (LOCATION) was included to control for the location of the panel—Saskatchewan or Ontario. This serves to isolate any location-specific effects yielding bid differences between the provinces. Four demographic variables are included: gender, age, education, and income level. There are no a priori expectations regarding the effect of these variables on the bids for the four sandwiches, with the possible exception of income where there is a weak expectation of a positive income effect if higher income individuals are less budget constrained. However, given that the bids were for the marginal difference in valuation of the extra information in the sandwiches—not the whole value of the sandwich—and that each participant was provided with an equal income endowment (Cdn$20) at the start of the experiment, household income should be relatively unimportant as a budget constraint in this case.

Regression Results

There are two distinct regression models available for this analysis: a pooled model or a panel data model. The pooled model assumes the intercepts and response parameters are not different for each individual, which means the data are simply pooled for estimation and inference purposes. The panel data model treats each individual as a cross-sectional unit in the panel data set, as there were bids on four separate sandwich types for each of many individuals. The bids across sandwiches for each individual are treated as a time series data set (Dickinson and Bailey 2002, 2003). By accounting for the fact that we have multiple observations (i.e., the time series) on each individual subject (i.e., the cross-sectional unit) in our data set, we can consider the possibility of correlation of individual bids across sandwich types through panel data techniques. It is therefore necessary to determine which model (pooled versus panel data) is appropriate to this analysis.

In the context of panel data, both fixed and random effects models could initially be considered. However, since the sample observations were drawn from a large population for which inferences from the data were to be made, we consider the random effects model more appropriate. While allowing error terms for an individual to be correlated across bids for different sandwiches, the random effects approach implicitly assumes that there is no correlation between the time-invariant unobserved effects and the predictors of the model. Therefore, we

tested for the appropriateness of using a random effects panel data model (versus a pooled model) using the Lagrange Multiplier (LM) statistic test, which examines the null hypothesis of no correlation of the individual-specific error term across sandwich bids. The LM statistic yielded p-values of 0.1553 and 0.1552 for the beef and pork models, respectively. Therefore, failure to reject the null hypothesis indicates that the pooled OLS model with a common intercept term is appropriate for our data. [8]

Separate regressions were run for the pork and beef experiments using LIMDEP (Version 7.0). Table 3 reports pooled least squares estimates of the average bids for pork and beef. The numbers in parentheses are p-values indicating the probability level at which the coefficient is significant.

Table 3. Results of pooled OLS regression analysis for Beef and Pork (*p*-values in parenthesis)

Variable name	Beef	Pork
Constant	0.894073*** (0.0000)	0.357080* (0.0926)
HUMANETREAT	0.2738471*** (0.0028)	0.135783* (0.0840)
MEATSAFETY	0.331288*** (0.0003)	0.092234 (0.2458)
ALLATTRIBS	0.828754*** (0.0000)	0.274780*** (0.0022)
FPOISON	0.093275 (0.1810)	−0.111314* (0.0579)
ARTICLES	−0.071054*** (0.0003)	0.010451 (0.5015)
CONFSAFE	−0.068306* (0.0708)	−0.094547** (0.0197)
VALUESAFE	−0.128752*** (0.0013)	−0.059668 (0.1084)
VALUETRACE	−0.029843 (0.2980)	−0.070428** (0.0112)
VALUEPROCESS	−0.087259** (0.0203)	−0.038515 (0.2551)
AVEMKTP	0.074036* (0.0925)	0.426987*** (0.0000)
LOCATION	0.281482*** (0.0021)	0.040572 (0.6008)
GENDER	0.055950 (0.4405)	0.004158 (0.9478)
AGE	0.001084 (0.7068)	0.003437 (0.2032)
EDUCATION	−0.005423 (0.8843)	0.041867 (0.1843)
INCOME	−0.032209 (0.3560)	0.029327 (0.3229)
Adjusted R^2	0.31320	0.42684
Number of observations[†]	412	388

*Significant at 0.1.
**Significant at 0.05.
***Significant at 0.01.
[†]After deleting missing information, there were observations from 103 individuals in the beef auctions and 97 individuals in the pork auctions, with four sandwich bid observations per individual.

Beef Results

In the beef model, ARTICLES, LOCATION, VALUESAFE, the three sandwich coefficients, MEATSAFETY, HUMANETREAT, and ALLATTRIBS and the constant, were all significant at the 1% level. Signs were commensurate with a priori expectations, with the exception of ARTICLES with a negative coefficient, the implications of which are discussed below. The positive and

significant coefficient for the constant indicates, at least in part, a positive WTP for the "traceable-only" sandwich (the base category). The coefficients for the three sandwich dummy variables indicate that a beef sandwich with an extra food safety assurance could command a $0.33 marginal premium relative to one with only a traceability guarantee. Beef with humane animal treatment assurances, on average, had a $0.27 premium over beef that was traceable. Bundling traceability with both of these quality assurances yielded a $0.83 premium over the traceability-only sandwich. [9]

The positive and highly significant coefficient on LOCATION implies that Saskatchewan respondents were willing to pay, on average, $0.28 more to exchange their sandwich with one that had additional verifiable characteristics relative to the Ontario respondents. Results for the variables VALUESAFE and VALUEPROCESS (significant at 5%) suggest that people who said they placed more value on additional food safety and production method assurances were willing to pay more for the reference sandwich (traceability only) in the beef experiments. Interestingly, VALUETRACE was not significant. Whether people say they value traceability or not, therefore, appears to be less important in influencing their actual WTP than an interest in tangible quality assurances with respect to food safety and animal welfare. This is consistent with the economic functions of traceability outlined earlier. While the additional information imbedded in quality assurances delivers information that will be of value to some consumers, traceability information, although facilitating ex post cost reduction, does not significantly reduce information asymmetry for most consumers.

The negative coefficient for ARTICLES indicates that the more news articles consumers had read about foodborne diseases in the previous 6 months, the lower their bids for the sandwiches with the verifiable information. This was unexpected and may indicate that media articles on these subjects had reassured Canadians about food safety and quality assurances with respect to beef. An alternative explanation is that excessive negative news items on issues such as BSE may have made some consumers fatalistic. As a result, consumers with higher levels of awareness of news media are not willing to pay a premium for the beef sandwiches. This interpretation implies that not only information provision matters but also the presentation of that information will affect consumers. [10] This study did not ascertain whether the media reports to which consumers had been exposed were positive or negative. Nevertheless, in terms of economic significance, the magnitude of the coefficient on ARTICLES is fairly small. The discovery of BSE in the Canadian beef herd since these experiments were conducted, albeit in isolated cases, may change the impact of media articles on consumer WTP for beef products with these additional assurances.

The two other variables measuring food safety awareness and concern (FPOISON and CONFSAFE) were not significant. The coefficient for average market price was positive and significant at 10%. There may be limited market feedback effects in the beef data. Strategic bidding should not be a major concern; instead the variable isolates this effect so that the remaining coefficient estimators are unbiased (Dickinson and Bailey 2002). The four demographic variables, AGE, GENDER, EDUCATION, and INCOME, were not statistically significant.

Pork Results

Attitudes toward food safety, quality assurances, and traceability can be expected to vary among products depending on food safety risk perceptions, animal welfare images of the sector, etc. The pork model yielded some interesting results compared to the beef model. All three sandwich dummy variables had the expected sign. The coefficient for the fourth sandwich, traceability bundled with food safety and production method assurances (ALLATRIBS), was highly significant at the 1% level, indicating a marginal WTP of $0.27 on average for this sandwich over the traceability-only sandwich. The coefficient for the sandwich with the humane animal treatment assurance was significant at the 10% level, and suggests a $0.14 premium over the traceable-only sandwich. [11] These results indicate a lower WTP for additional assurances relative to simple traceability for pork compared to beef. The coefficient on the sandwich with the additional food safety assurance (MEATSAFETY) suggests a $0.09 premium over the traceable sandwich but this coefficient was not statistically significant.

As with the beef model, the coefficient signs for the information variables VALUETRACE, VALUESAFE, and VALUEPROCESS were consistent with a priori expectations. VALUETRACE was significant at the 5% level, indicating that respondents who stated that they would value knowing the exact farm that produced the animals for the meat they consumed were willing to bid more for the traceable pork sandwich, ceteris paribus. Thus, their stated preferences are reflected in the revealed WTP.

Results for the food safety awareness and concern variables were mixed. Lower levels of confidence in the meat safety and inspection system yielded lower, rather than higher WTP bids for the pork sandwiches, contrary to expectations, and the coefficient was significant at the 5% level. Similarly, the incidence of food poisoning tended to result in lower, rather than higher bids in the pork model, at a 10% confidence level. The number of media articles dealing with foodborne diseases tended to increase WTP, as expected, but this was not significant. These results suggest that the food safety issues were less important or there was less awareness of these issues for pork compared to beef. The positive and significant coefficient on AVEMKTP indicates that the average market price information announced at the start of each round of bidding influenced participants' bids. The inclusion of this variable in the model serves to isolate this influence so that other coefficients are unbiased by any feedback effects from the market price and therefore from strategic bidding. Gender, age, education, and income levels did not affect WTP. Unlike the beef model, there was no statistical difference in the bids between respondents in Ontario and Saskatchewan.

IMPLICATIONS

The results of the experimental auctions suggest that consumers were willing to pay nontrivial amounts for a traceability assurance, although these results are stronger for beef than for pork. However, quality assurances with respect to food safety and on-farm production methods for beef were more valuable to consumers than a simple traceability assurance. Bundling traceability with these additional assurances is likely to be of more value to Canadian

consumers. This is consistent with the results obtained in a comparable study of U.S. consumers (Dickinson and Bailey 2002). The economic value of the traceability and quality assurances evaluated in this research appeared to be higher for beef than for pork. This may reflect more media attention and therefore a heightened consumer awareness to food safety issues with respect to beef in general (i.e., not necessarily just in Canada), such as problems with BSE and Escherichia coli. This effect is likely to have become stronger since the Canadian experience with BSE in 2003.

While traceability is clearly of some value to consumers, traceability by itself does not address the issue of consumer information asymmetry with respect to credence quality attributes. Ex post reactive traceability systems can perform an important economic function in limiting the costs from a food safety problem and in maintaining consumer confidence in an industry, however, they do little to reduce consumer information asymmetry. The development of private sector traceability systems in meat supply chains is primarily driven by cost and risk reduction motivations. While traceability systems can facilitate ex ante quality assurances, they do not necessarily always provide consumers with this additional information. Traceability may be a necessary but not sufficient condition for ex ante verification of quality attributes.

The regression models treated the "traceability-only" sandwich as the reference category to evaluate WTP for quality assurances versus traceability, and for quality assurances bundled with traceability versus traceability alone. One may ask, why would consumers care about having traceability bundled with a quality assurance if they could purchase a sandwich with a food safety assurance or an animal welfare assurance—i.e., what value would knowing the meat is traceable to the farm then hold for them? The literature review revealed that traceability systems are indeed emerging that offer these bundled attributes, and that traceability in this context may act as a credibility signal to consumers. To test for the marginal value of traceability in this context, the regression models were run again with HUMANETREAT and MEATSAFETY alternately as the reference sandwich category.12 In all four cases, the results revealed a positive and significant coefficient for ALLATTRIBS, suggesting that having traceability in addition to a quality assurance was valuable. Interestingly, with the exception of the pork model with MEATSAFETY as the reference sandwich category, the dummy variable for the traceability-only sandwich was negative and statistically significant in the other three models. Thus, relative to a quality assurance guarantee (be it food safety or humane animal treatment), traceability alone was less valuable. These findings concur with our expectations.

An assessment of the different traceability initiatives emerging in the private sector and through regulatory intervention in various countries reveals that there are many different notions of what is meant by traceability. Often the underlying assumption appears to be that consumers want more traceability. However, there has been little economic research to evaluate the validity of this assumption and to assess the extent to which simple traceability delivers benefits to consumers. This paper has argued that, although simple traceback may have a role to play in limiting the extent of food safety outbreaks and in maintaining consumer confidence in an industry, traceability alone does little to reduce consumers' information asymmetry with respect to quality attributes. The experimental auctions show that Canadian consumers are likely to place a higher value on quality verification systems in which traceability facilitates the provision

of additional quality assurances, than on traceability alone. Quality assurances appear to be of more value when backed by a traceability capability. Future economic analyses of traceability within the context of promoting food safety and providing food quality assurances should distinguish between traceability systems that offer simple traceback, versus those that facilitate quality verification.

NOTES

1. Credence attributes are those which consumers cannot detect or evaluate even after consumption, in contrast to search attributes that can be evaluated prior to purchase through visual inspection, or experience attributes that can be evaluated through the consumption experience (Nelson, 1970; Darby and Karni, 1973).
2. Regulation No. 820/97 subsequently amended by Regulation EC 1760/2000.
3. We are indebted to an anonymous reviewer for drawing this point to our attention.
4. "Member States reserved their strongest comments for their assessment of the high costs associated with the current labeling legislation and the heavy administrative burden placed on both the public and the private sector. They do admit, however, to having few criteria or independent market studies for judging if the policy has been cost-effective" (Commission of the European Communities 1999, p. 7).
5. These averages are based on the last five rounds of bidding, and they are the marginal bids as a percentage of base sandwich value of Cdn$2.82 for the beef sandwich and Cdn$2.85 for the pork sandwich. Base sandwich value was calculated by asking respondents how much they would typically expect to pay for this type of sandwich and averaging the responses.
6. Average WTP for a beef sandwich with an additional food safety assurance was 20%, while an animal welfare assurance elicited an average WTP of 18% over the base sandwich value. For the pork experiments, average WTP bids were 17% and 16%, respectively, for food safety and animal welfare assurances.
7. For this reason it is not appropriate to extrapolate a WTP for traceability and/or quality assurances across the Canadian population in general or for a wider basket of goods. Of interest for the purpose of this discussion is the relative magnitude of WTP across the different sandwiches.
8. The estimation results from the two models are available from the authors upon request.
9. As a percentage of the base sandwich value, $2.82, these premiums are 11% for an extra food safety assurance, 9.5% for an animal welfare assurance, and 29% for a sandwich with all three attributes, relative to just traceability.
10. We are indebted to an anonymous reviewer for pointing out this plausible alternative explanation.
11. As a percentage of the base sandwich value of $2.85, this represents a 4.9% premium over the traceable pork sandwich, compared with 9.5% for the sandwich with all three attributes.
12. In the interests of brevity, the results from the four additional models are not reported here but are available from the authors upon request.

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