CHAPTER 7

LIABILITY AND TRACEABILITY IN AGRI-FOOD SUPPLY CHAINS

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Abstract. Improving food safety, reducing the impacts of food safety problems, and providing a means to verify food quality attributes are driving the development of traceability initiatives in agri-food systems. Numerous and varied examples exist, from regulatory traceability initiatives, to industry-wide livestock traceability programmes, to individual supply-chain systems that combine traceability with quality verification. This paper explores the economic functions of traceability, examining the extent to which traceability can bolster liability incentives for firms to practice due diligence. The extent to which consumers value traceability per se, versus verifiable quality assurances delivered through traceability, is evaluated empirically using survey and experimental auction data.
Keywords: traceability; food safety; quality verification; credence attribute; experimental auction

INTRODUCTION

Food safety and methods to verify food quality are critical components of modern differentiated food systems. Food safety has garnered significant public policy interest in the wake of highly publicized breakdowns in food safety, particularly those resulting in fatalities (see, for example MacDonald and Crutchfield 1997; Hobbs et al. 2002). For agri-food firms, the implications of a major food safety failure can be commercially devastating, and include: product recalls, damage to reputation and punitive liability damages. Ensuring that acceptable food safety practices are adhered to may require knowledge of actions at prior stages of the supply chain, such as verifying the use of permitted chemical pesticides or food ingredients. In the event of a food safety problem, rapid identification of affected products or batches of products can reduce the number of consumers exposed to a potential harmful foodborne illness.

A highly differentiated food market, with consumers exhibiting diverse preferences, also provides opportunities for firms to gain a competitive advantage through verifying the presence of a desirable quality attribute. Often, this requires identity preservation or quality verification throughout the supply chain, particularly

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for process attributes derived from on-farm production methods. It is apparent that, for both food safety and food quality, verifying information flows and identifying positive or negative practices along the supply chain are increasingly important. Traceability of food has become integral to food safety and food quality.

This paper explores the role of traceability in agri-food supply chains, beginning with a discussion of the economic functions of traceability, including the relationship between traceability and liability. It examines the extent to which traceability systems can bolster liability incentives for firms to practice due diligence. The paper shows that, while traceability can perform an important role with respect to strengthening food safety incentives, traceability systems also have an important function in quality verification. The extent to which consumers value traceability per se, versus verifiable quality assurances delivered through traceability, is evaluated empirically using data collected through a survey and an experimental auction.

EMERGING TRACEABILITY SYSTEMS

Food safety incidents, the demand for differentiated food products from an increasingly sophisticated and discerning consumer market, and innovations in quality measurement, tracking and information management technologies have pushed traceability to the forefront of supply-chain issues in the agri-food sector. Traceability is a core component of recent regulatory initiatives in the European Union affecting the entire food and feed sector (for example, Article 18 of the General Food Law, EC 178/2002). It is being used as the basis of competitive product differentiation strategies by food firms seeking to assure consumers of the presence of credence attributes related to production or processing methods. It has been introduced on an industry-wide basis by commodity associations to ensure traceability of livestock from the processing plant to the herd of origin. Thus, traceability appears in many guises, performs many functions and is being driven by many different actors depending on the context. This begs the question: why have traceability? What functions does a traceability system perform? To answer these questions, it is useful to distinguish between the various regulatory, industry-wide and supply-chain-based traceability systems emerging in agri-food sectors, particularly in meat and livestock industries.

Within the EU, traceability has been enshrined in a number of regulatory initiatives. For example, the EU beef-labelling regulation (EC1760/2000) required each member state to introduce a national cattle identification and registration system. The regulation also requires that beef products be labelled with a traceability number at the retail level, enabling the product to be traced back through the supply chain in the event of a problem. Article 18 of the EU General Food Law (EC178/2002) addresses traceability directly, with wide-ranging traceability requirements that came into effect in January 2005[1]. The article requires that traceability of food, feed, food-producing animals and any substance incorporated into food or feed be established throughout the supply chain (from production, through processing and distribution). The regulation requires both upstream and

downstream traceability through each adjacent stage of the chain. Specifically, it requires that food and feed business operators be able to identify the supplier of a food, feed or food-producing animal and be able to identify the other businesses to which their products have been supplied. Adequate labelling to facilitate traceability is required. The regulation stops short of specifying how traceability should be ensured, leaving Member States to introduce domestic measures to ensure compliance within their jurisdictions.

Sector-specific traceability initiatives include the introduction of livestock identification programmes that facilitate partial traceback through specific segments of the supply chain. For example, the Canadian Cattle Identification Agency, established in 2001, was largely an industry-driven initiative to put in place a cattle identification system to allow the traceback of cattle from the point of slaughter to the herd of origin. Backed by the Federal Health of Animals Act and Regulations, the system became mandatory in 2002. The Canadian Food Inspection Agency, an agency of the Canadian government, enforces the system and applies penalties where necessary. All cattle must be identified with an approved ear-tag when they move beyond their herd of origin. Similar systems are in place, or being assessed, in other countries.

In 2001, Australia introduced a voluntary National Livestock Identification System (NLIS). Subsequent regulatory initiatives between the state and territory governments, in conjunction with the industry, will move the system to a mandatory status. At its most basic level, the mandatory component of the system will require only that participants identify each animal with an approved tag. However, the traceability infrastructure can also be used to combine animal identification with improved farm management practices and market feedback information through storage of additional information linked to each animal (Meat and Livestock Australia 2005). In the US, the National Cattlemen's Beef Association created an Animal Identification Commission charged with developing a National Animal Identification System (NAIS) for the US beef industry. Concerns over confidentiality, privacy and liability have inhibited the development of a national US cattle traceability system (Beef USA 2005; Souza-Monteiro and Caswell 2004).

Private-sector traceability initiatives are the most sophisticated at the level of the individual supply chain. Individual supply-chain-based traceability initiatives are numerous and varied. These systems have emerged in response to perceived market premiums for quality assurances that can be verified through traceability. An early example was Tracesafe in the UK beef industry (see Fearne 1998), which used a network of cattle breeders and finishers following specific production guidelines, and used traceability as a means of providing a safety and quality assurance to consumers. Other examples include the VanDrie Group in The Netherlands, operating a traceability system for veal, enabling meat cuts to be traced from the retail shelf to the farm of origin and providing information on animal husbandry and production methods (see Buhr 2002).

In Japan, consumer pressure has encouraged a number of supermarkets to implement retail-level traceability capabilities. Through in-store computers or over the Internet, consumers can access information on the source of the beef and the methods used to rear the animal – so called 'story meats' (see Clemens 2003). In Canada, Maple Leaf

Foods, a major processor of fresh and prepared meats and other food products, has identified traceability as an important component of its differentiation strategy for pork products. Early in 2004, the company announced the commercialization of a DNA-based traceability system for its pork products, which is being piloted in the Japanese market (Maple Leaf Foods Inc. 2004). In the event of a future food safety problem in Japan linked to imported pork products, the DNA-based system is also intended to help the company to verify through DNA testing that the affected product did not originate through the Maple Leaf Foods supply chain.

DIVERSE ROLES FOR TRACEABILITY

As the above discussion indicates, traceability systems are emerging in various guises, as a result of both regulatory and industry initiatives. In this context, three key functions of a traceability system can be identified. The first is to allow the efficient traceback of products and inputs (including animals) in the event of a food safety or herd health problem. The primary objective in so doing is to minimize the public and private costs of a problem (Golan et al. 2003; Hobbs 2003; Hobbs et al. 2005). Efficient and timely traceback could limit the size of product recalls or herd quarantine or irradication programmes, and limit the number of people exposed to tainted food, thereby limiting human-health impacts, minimizing productivity losses from illness, etc. The ability to identify and trace affected products or animals may also assist in protecting firms that practice due diligence from free riders. Most national livestock traceability systems, including the Canadian cattle identification system, primarily perform this function. The EU beef-labelling regulation and the traceability article of the General Food Law also primarily perform this function.

Another function of traceability is to reduce information costs for consumers by identifying credence attributes (Hobbs 2003; Hobbs et al. 2005; Golan et al. 2003). For example, this may include labelling of environmentally-friendly production practices, or assurances about feed, other ingredients or production practices. The information requirements tend to be more complex than simple traceability, and are a means through which product differentiation occurs. The private-sector supply-chain-based traceability systems alluded to above, including Tracesafe, the VanDrie system and, to some extent, Maple Leaf Foods, are driven primarily by this motivation. In this respect, traceability is a vehicle through which to deliver quality assurances to consumers that go beyond simple traceback information. Rather than food safety, this function is more broadly linked to verifying quality attributes.

In addition to cost reduction in the event of a food safety problem, a third function of traceability may be as a means of strengthening liability incentives to produce safe food (Hobbs 2003; Golan et al. 2003; Hobbs et al. 2005). If effective, the penalties from statutory or civil liability should discipline firms to practice due diligence with respect to food and feed safety. This potential function of traceability systems is controversial, and may have inhibited the acceptance and adoption of traceability systems among producer groups in some countries, including the USA (Souza-Monteiro and Caswell 2004). Furthermore, it is not clear whether liability could be proven in practice, and therefore whether the threat of liability is an

effective incentive (Buzby and Frenzen 1999). Nevertheless, discussions of traceability are often laced with references to liability implications, and it is useful to explore the nature of liability in agri-food systems in more detail.

Liability in the food system

Statutory liability

Liability arises in a number of guises in the food system, and we can distinguish broadly between regulatory or statutory liability and civil or contractual liability. Regulatory liability results from failure to meet mandatory standards and is potentially a criminal offence; for example, if a firm's actions are found to be in violation of food safety legislation that mandates or prohibits specific practices. The penalties to being found liable with respect to a regulatory offence depend on the jurisdiction but generally range from financial penalties to imprisonment. Typically, a government agency monitors compliance with regulatory standards.

In many legal systems, including under Canadian law, for a party to be subject to criminal or statutory liability, two elements of a regulatory offence must be proven. First, it must be proved that the *actus reus*, or guilty action, contained in the offence was committed by the accused. For example, if under the food safety legislation it was an offence to allow food to come into contact with carcinogenic chemicals, and a firm allowed to this occur, the firm/management would have committed the guilty act specified in the offence. Second, it must be proved that there was wilful negligence or recklessness on the part of the accused; this is known as *mens rea* (Wasylyniuk et al. 2003).

In many jurisdictions, regulatory offences may be treated as absolute or strict liability offences for the purposes of prosecution. An absolute liability offence only requires proof that the offence was committed, and allows liability to be imposed without proof of a fault element. However, the strict liability offence is more commonly used, and requires proof that the prohibited act occurred, but bases the fault element on negligence. Once the *actus reus* is proved beyond a reasonable doubt, negligence is presumed, and a reverse onus is placed on the accused party to prove that he or she was not negligent. It is within this context that a due-diligence defence arises, wherein the accused party must show that he or she took all reasonable care to fulfil their legal obligations in meeting the statutory requirement (Wasylyniuk et al. 2003).

The UK 1990 Food Safety Act was notable for extending legal liability to food retailers for the safety of food sold through their stores. Rather than rely on a food manufacturer's warranty in the event of a food safety incident caused by the actions of the manufacturer, retailers are required to show evidence of adequate monitoring of supplies or of suppliers to satisfy their due-diligence defence. This change in regulatory liability had significant implications for supply chain relationships and traceability in the UK food system, encouraging food retailers to form closer and longer-term relationships with their suppliers in order to facilitate monitoring (Hobbs and Kerr 1992).

To return to the hypothetical example of preventing carcinogenic chemicals from coming into contact with food. If the relevant food safety statute in a jurisdiction specified that in order for a party to have committed an offence, the party must have wilfully or recklessly allowed carcinogens to contaminate a food product, it must be proved that this subjective fault (or *mens rea*) was present when the carcinogens were allowed to come into contact with food. However, if the offence does not specify the mental element (wilfulness), the offence could become either absolute liability, wherein the accused would be found guilty regardless of whether they knew about the carcinogenic contamination, or one of strict liability, in which it would have to be shown that negligence played a part in allowing the contamination to occur.

Food safety legislation attempts to deter unfavourable practices, while providing for penalties in the event of an offence under the legislation. Mandatory standards represent an ex-ante set of precautions to limit risk, while monitoring compliance and the application of penalties under the law provide an ex-post method of compensation for harm caused (Wasylyniuk et al. 2003). Avoiding statutory liability requires firms to be aware of, and to comply with, food safety regulations. However, while compliance with a statute absolves a firm of statutory liability, the firm may still be subject to civil liability. Often, the criteria on which civil liability is based are much more general, and the burden of proof is less onerous than is the case with statutory liability.

Civil liability

Firms may be subject to civil liability (often also referred to as contractual or tort liability) for damages for non-criminal acts that injure or cause damage to others. This could include negligence in the production, preparation or handling of food or food ingredients by various parties throughout the supply chain. Liability can also arise in the case of misrepresentation of products. This could include misrepresentation of a credence quality attribute to induce a buyer to purchase the product. In practice, it is often difficult to determine fault in civil-liability claims (Boyer and Porrini 2002), particularly in lengthy supply chains where the product passes through a number of stages before reaching the consumer, making it difficult to determine which party was at fault.

Traceability systems that allow food products to be tracked through the food supply chain could assist in determining fault, thereby strengthening the liability incentive for firms to adopt good food safety practices. The effectiveness of liability as a deterrent in the case of food safety practices has been questioned (Buzby and Frenzen 1999; Wasylyniuk et al. 2003). Buzby and Frenzen (1999) argue that there are only limited legal incentives in the US to produce safer food, suggesting that less than 0.01% of cases are litigated, with even fewer paid compensation. The lack of traceability through the US food supply chain may have contributed to this outcome, although Buzby and Frenzen also find that ambiguity about whether microbial contamination is natural or an adulterant has hindered the US legal system from dealing effectively with food safety issues.

Mojduszka (2004) discusses the role that liability insurance can play in encouraging optimal behaviour. In isolation, liability insurance may appear to weaken the incentives to control losses: the primary purpose of ex-post liability is to make the risk imposer pay, whereas the primary role of insurance is to spread risk. However, if insurance premiums are adjusted to reflect the insured firm's behaviour, then insurance encourages efficient decisions (Mojduszka 2004). Insurers have an incentive, ex ante, to screen the firms they intend to insure to guard against adverse selection. They have an incentive, ex post, to monitor the insured to prevent moral hazard.

Whether for statutory or civil liability, it is clear that legal proof of responsibility is essential for liability to be an effective incentive for firms to produce safe, high-quality food. Traceability remains a key element of this proof. However, it is also clear that traceability has a far wider role to play in agri-food supply chains than simply bolstering liability incentives. The product differentiation potential of traceability systems may be the 'carrot' necessary to induce farmers to participate in traceability systems despite liability fears. The introduction of traceability systems, whether regulatory or through the private sector, is often accompanied with rhetoric about consumers demanding more traceability. The remainder of this paper presents empirical results from a study evaluating consumer attitudes toward traceability, food safety and quality assurances.

CONSUMER ATTITUDES TOWARD TRACEABILITY AND PROCESS VERIFICATION

The extent to which consumers value traceability per se, relative to quality verifications about production and process methods, is central to understanding the incentives for firms to structure their supply-chain relationships so as to provide these assurances. While examples are emerging of food products with a traceability assurance, or various quality assurances related to food safety or on-farm production methods, it is rare to find an example of a product that encompasses all three assurances. Furthermore, even in the presence of these products, market data is difficult to access and usually cannot be linked back to individual consumer characteristics. Therefore, an experimental auction and survey were used to gather data on Canadian consumer preferences for traceability, food safety and quality assurance attributes in meat products. Experimental auctions have become a popular tool for obtaining non-hypothetical bids for credence attributes (see, for example, Fox et al. 1994; Hayes et al. 1995; Dickinson and Bailey 2002).

An experimental auction was used to elicit willingness-to-pay bids for beef products with additional assurances regarding food safety, on-farm production methods related to humane animal treatment, and traceability to the farm of origin. Following the experimental auction, participants completed a brief questionnaire gathering socio-economic data and additional stated-preference information. Consumer panels were recruited in two locations, in western Canada (Saskatchewan) and central Canada (Ontario), in 2002. Recruitment was a consumer research company in Ontario, and from a range of demographic groups on the campus of the

University of Saskatchewan. Just over one hundred (104) individuals participated in the beef consumer panels, in groups of 12-14 people[2].

Stated preferences for traceability and quality assurances

The post-experiment questionnaire enabled a direct evaluation of respondents' stated attitudes toward food safety, traceability and process verifications. Participants were asked how much confidence they placed in the Canadian government's current food inspection and safety programme and whether they valued having additional assurances about meat safety, beyond what was currently provided by the Canadian government. Figure 1 indicates that there was a reasonably high degree of confidence among Canadians regarding the food safety regulatory system in Canada. Yet, despite this apparent high level of confidence, Figure 1 also shows that many people indicated that they would still value extra food safety assurances. Two explanations are possible. One, that although the participants are generally happy with the current food safety system, there may be other meat safety assurances that food firms could bolt onto the existing system to differentiate their products further. Alternatively, the results may indicate inconsistency in responses, an inherent weakness in stated-preference surveys. Fortunately, the experimental auction analysis (discussed below) allows us to investigate the robustness of participants' stated preferences in terms of whether they acted on these stated preferences in their revealed preference bidding behaviour.

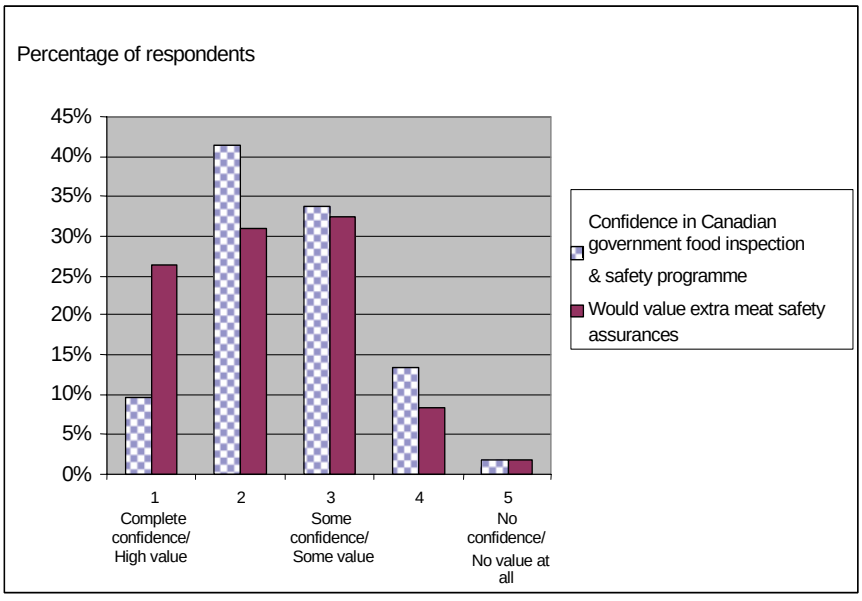

Figure 1. *Confidence in food safety system vs. value of additional assurances (beef) (N=104)*

In the post-experiment survey, participants were also asked whether they would value knowing the exact farm that produced the animals for the meat that they consume. Figure 2 displays the results for the stated preferences with respect to traceability. Only just under one-third (30%) of beef-experiment respondents indicated that this was highly or reasonably highly valued (a score of 1 or 2 out of 5). Again, the experimental auction data allow us to verify whether respondents' stated preferences are supported by their revealed preference bid data.

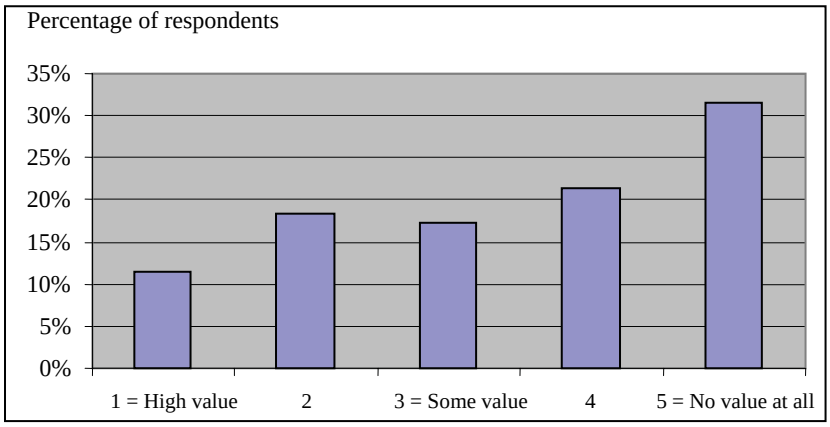

***Figure 2**. Value of traceability to the farm of origin (N=104)*

Finally, the post-experiment survey asked whether the participants would value knowing the procedures and processes used by the farmer to produce the animal, such as treatment of the animals, feeds and medication used, presence or absence of genetically modified organisms, etc. It is important to note that traceability systems per se do not necessarily provide additional process verification information. While they may be a vehicle to deliver verification on production methods, simply knowing that the farm of origin could be identified (ex post) does not inform consumers (ex ante) about the production methods used on that farm. Likewise, process verification does not necessarily imply traceability. A downstream food manufacturer may provide an assurance that it only sources products from farms which follow designated production protocols, and may source from a variety of farms, without necessarily being able to trace products back to an individual farm of origin. Therefore, it was of interest to separate attitudes toward process verification from traceability. Figure 3 summarizes the responses to this question.

Relative to simple traceability assurances, receiving information about on-farm production methods appears to be more valuable, with almost 60 % of respondents indicating that this type of information would be highly, or relatively highly, valued (scoring 1 or 2 out of 5). The experimental auction data provide a means to verify this finding in the context of actual bidding behaviour.

Respondents who indicated that they would value production method assurances were further prompted to explain why. Almost 60 % indicated that they would value this information because it would give them more confidence in the safety and/or quality of the meat they purchased. Twenty-three percent indicated that being able to identify the source of a problem, should one arise, was the primary reason they valued this information.

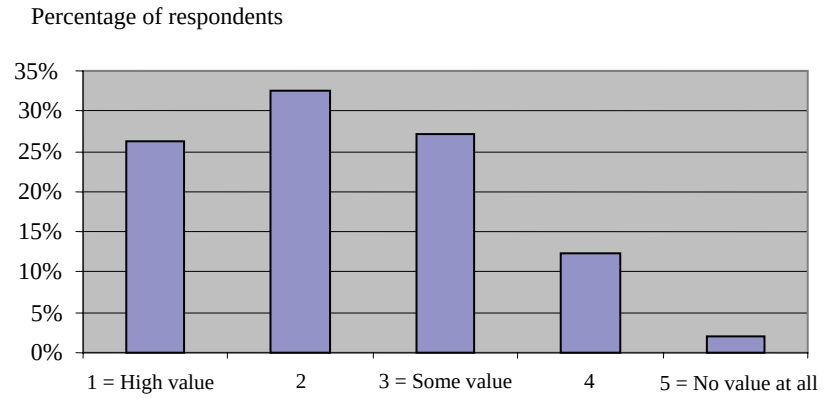

Figure 3*. Value of production method assurances (N=104)*

Preferences revealed through the experimental auction

Prior to answering the survey questions, respondents had participated in an experimental auction to provide a more robust evaluation of the value they placed on traceability and quality assurances. The experimental auction results, briefly summarized here, provide a means to verify the initial findings regarding the relative value of traceability versus other quality assurances[3].

Groups of participants were provided with a beef sandwich as part of a light lunch, and had the opportunity to bid to exchange their sandwich for a sandwich with additional verifiable characteristics, but otherwise identical to their lunch sandwich. Four alternative sandwiches were presented: (i) a sandwich with an animal welfare assurance regarding the beef in the sandwich, (ii) a sandwich with an extra food safety assurance regarding the beef; (iii) a sandwich in which the beef was traceable to the farm of origin; and (iv) a sandwich that combined an animal welfare assurance, a food safety assurance and a traceability assurance. Participants were paid Cdn$ 20 as an incentive for attending the session, and to keep the income endowment constant across participants.

In ten rounds of bidding for each auction sandwich, participants bid the amount they would be willing to pay to exchange their sandwich for the auction sandwich. Individual bids were written down privately by participants and collected as each

round of bidding progressed. A Vickrey second-price auction format was used (Shogren et al. 1994). Before starting each bidding round for a specific sandwich, respondents received market information in the form of an announcement of the second-highest bid from the previous round. At the end of the experiment, 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 his/her 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.

To evaluate the factors affecting willingness-to-pay (WTP) for traceability and quality assurances in beef, the average WTP bids for each sandwich was regressed against a range of socioeconomic and attitudinal variables using a pooled ordinary least-squares regression model[4]. Three dummy variables represent the different sandwiches from the auction: food safety assurance (MEATSAFETY), animal welfare assurance (HUMANETREAT) and combined traceability, food safety and animal welfare assurances (ALLATTRIBS). The sandwich with a traceability assurance was treated as the reference category. Coefficients on these dummy variables indicate whether respondents were willing to pay a premium over basic traceability for the sandwiches that offered information on specific credence attributes. We expect positive coefficients for the sandwich-related dummy variables if consumers place more value on assurances that reduce information asymmetry with respect to credence (process) attributes, relative to simple traceability.

Three variables measured consumer awareness and concerns over food safety. Direct experience with food poisoning (FPOISON) is expected to induce a higher WTP for additional food safety assurances. Exposure to media coverage of food safety issues (ARTICLES) should impact WTP positively if we assume that these news items were negative. The level of confidence in the current Canadian government food inspection and safety programme (CONFSAFE) is also expected to influence WTP for additional assurances. Given the specification of this variable (see Figure 1), a lower level of confidence in the current food inspection and safety programme is represented by a higher score for the variable CONFSAFE. A positive coefficient would reflect a WTP for stronger (or more reliable) safety and quality assurances than is currently available from the existing food safety inspection system.

Three variables measure the value that respondents said they placed on additional assurances, including assurances about meat safety (VALUESAFE), traceability (VALUETRACE) and on-farm production methods (VALUEPROCESS). These variables correspond to Figures 1-3 and provide a means of checking the validity of the stated preferences for these attributes. As shown in Figures 1-3, a higher rating indicates that the assurance had less value to the respondent. Therefore, we expect these coefficients to be negative if the stated preferences are a good indicator of revealed WTP. The effect of the announced average market price during the first five rounds of bidding was captured with the variable AVEMKTP. The 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

Table 1. *Results of pooled OLS regression analysis (p-values in parentheses)*

Variable name	Description	Coefficient estimates
	Dependent variable	
WTP	WTP bids on sandwiches, rounds 6-10	
	Independent variables	
Constant		0.894073*** (0.0000)
HUMANETREAT	Sandwich #1: Humane animal-treatment assurances (Dummy variable)	0.2738471*** (0.0028)
MEATSAFETY	Sandwich #2: Additional food safety assurances (Dummy variable)	0.331288*** (0.0003)
ALLATTRIBS	Sandwich #4: Traceability plus food safety & humane animal-treatment assurances (Dummy)	0.828754*** (0.0000)
FPOISON	Subject or family member experienced food poisoning (Yes = 1)	0.093275 (0.1810)
ARTICLES	News articles/reports read/heard regarding foodborne disease in last 6 months (1 to 7 where 1 = 0-5 articles; 7 = >30 articles)	-0.071054*** (0.0003)
CONFSAFE	Confidence in Canadian food inspection and safety programme (1-5, where 1 = complete confidence; 5 = no confidence)	-0.068306* (0.0708)
VALUESAFE	Value additional assurances about meat safety (1-5, where 1 = highly value; 5 = no value)	-0.128752*** (0.0013)
VALUETRACE	Value knowing exact farm that produced the animal (1-5, where 1 = highly value; 5 = no value)	-0.029843 (0.2980)
VALUEPROCESS	Value knowing processes used by farmer to produce the animal (Score 1-5, where 1 = highly value; 5 = no value)	-0.087259** (0.0203)
AVEMKTP	Average of announced market price from first five rounds	0.074036* (0.0925)
LOCATION	Location of panel (Saskatchewan = 1)	0.281482*** (0.0021)
GENDER	Gender (Male =1)	0.055950 (0.4405)
AGE	Age (Years)	0.001084 (0.7068)
EDUCATION	Education (1 to 4 where, 1=High school or less; 4=Graduate degree)	-0.005423 (0.8843)
INCOME	Annual household income (1 to 4 where 1=under Cdn$30,000; 4 = over Cdn$90,000)	-0.032209 (0.3560)
Adjusted R-squared		0.31320
Number of observations†		412

*=significant at 0.1; ** =significant at 0.05; ***=significant at 0.01

that the market price is exogenously determined with respect to the dependent variable. This variable isolates any market feedback effects from the announced market price, which may indicate strategic bidding on the part of the auction participants. The effect of location was isolated with a dummy variable to distinguish any differences in bidding behaviour between Saskatchewan and Ontario. Four demographic variables are included: gender, age, education and income level. There are no *a priori* strong expectations regarding the effect of these variables on the bids for the four sandwiches. It is unlikely that household income would have a major effect, given the nature of the experiment and the common income endowments with which participants began the experiment.

A cursory analysis at the bid data that form the basis of the dependent variable reveals that traceability to the farm of origin, without additional quality assurances, elicited the lowest average WTP (7% of base sandwich value for beef)[5], and the largest number of zero bids (45%). 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%). Due to the nature of a one day experiment, the bid information is usually considered to be an upper bound on WTP (Hayes et al. 1995; Dickinson and Bailey 2002).

Table 1 reports the results of the regression analysis. The coefficients for the three sandwich dummy variables MEATSAFETY, HUMANETREAT and ALLATTRIBS were all significant at 1%. Consistent with *a priori* expectations, the results suggest that a beef sandwich with an extra food safety assurance, or with a humane animal-treatment assurance, could command a premium over beef that was only traceable. Bundling traceability with both of these quality assurances yielded a considerably larger premium over the traceability-only sandwich.

People who said they placed more value on additional food safety (VALUESAFE) and production method assurances (VALUEPROCESS) were actually willing to pay more for the reference sandwich (traceability only) in the beef experiments, verifying the information presented in Figures 1 and 3. Interestingly, this was not the case for people who indicated that they would pay more for a traceability assurance (VALUETRACE). Consistent with the economic functions of traceability discussed earlier, whether people say they value traceability appears to have less of an influence on their actual WTP than an interest in tangible quality assurances with respect to food safety and animal welfare. Traceability information, although helping mitigate the costs of a food safety problem, does not significantly reduce information asymmetry for consumers. The positive and highly significant coefficient on LOCATION implies that Saskatchewan respondents were willing to pay more than Ontario respondents for a sandwich with additional verifiable characteristics.

The negative coefficient for ARTICLES was unexpected and indicates that the more news articles consumers had read about foodborne diseases in the previous six months, the lower their bids for the sandwiches with the verifiable information. This may indicate that news items had reassured consumers, or perhaps that they were sceptical of the information in media articles. Prior experience with food poisoning,

and the level of confidence in the Canadian regulatory food safety system, were not significant determinants of WTP. This may explain the apparent inconsistency in Figure 1 between confidence in the food safety system and valuing additional food safety assurances. Even if consumers are confident in the regulatory system, it appears that they may still value additional assurances that offer other assurances with respect to food safety.

The coefficient for average market price was positive and significant at 10%, indicating that there may be limited market feedback effects in the WTP data that are isolated by this variable (Dickinson and Bailey 2002). The remaining variables, including the demographic variables, AGE, GENDER, EDUCATION and INCOME were not statistically significant.

IMPLICATIONS

As this paper has indicated, there are many different types of traceability system emerging as a result of regulatory intervention, at an industry-wide level or as a competitive strategy at the level of individual supply chains. These developments are often prefaced on the underlying assumption that consumers want more traceability. Previously 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.

The experimental auction methodology used in this study presents a powerful and flexible tool for evaluating consumer preferences for credence attributes. Firms can structure their supply-chain relationships so as to deliver those credence attributes that are valued by consumers. The experimental auction methodology also enables researchers to test the consistency of stated preference attitudes against those revealed through bidding behaviour.

The empirical analysis shows that consumers were willing to pay non-trivial amounts for a traceability assurance, as indicated by the statistical significance of the constant in the regression results. For some consumers, this may imply that they have more confidence in a food product backed by a traceability assurance or, in the event of a problem, that they value the ability to trace products back to source. However, the positive coefficients for the sandwich dummy variables imply that quality assurances with respect to food safety and on-farm production methods for beef were significantly more valuable than a simple traceability assurance. For consumers, traceability has the most value when bundled with additional quality assurances. This finding is consistent with the earlier discussions regarding the functions of a traceability system.

Since these consumer experiments were undertaken, Canada has experienced a few cases of Bovine Spongiform Encephalopathy (BSE), which have been shown to originate in domestic cattle. While these initial BSE cases do not appear to have weakened domestic consumer confidence in the beef industry, it is plausible that a repetition of this experiment post-BSE would reveal higher values for traceability and on-farm production method assurances. Certainly, these issues appear to be

garnering closer attention among beef industry stakeholders in the wake of the first domestic Canadian cases of BSE.

Simple trace-back systems are important in limiting the costs from a food safety problem, in maintaining consumer confidence in an industry, and in enforcing liability incentives for due-diligence behaviour. To date, the development of private-sector traceability systems in livestock sectors has primarily been driven by cost- and risk-reduction motivations. While traceability systems can provide the infrastructure to facilitate positive quality assurances, they do not necessarily provide consumers with this additional information. Traceability by itself does not address the issue of consumer information asymmetry with respect to credence quality attributes. As food firms seek to differentiate their products to gain a competitive advantage, bundling traceability with positive quality assurances within a closely monitored supply-chain environment can be the source of future competitive advantage. In this respect, a traceability capability may signal the credibility of quality assurances. The economic rents potentially available from bundling a product differentiation strategy with traceability may be the benefit necessary to offset industry concerns regarding the liability implications of traceability.

NOTES

[1] Article 18 "Traceability". In "Regulation (EC) No. 178/2002 of the European Parliament and of the Council as of January 2002 laying down the general requirements of the food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety". Official Journal of the European Communities.

[2] In an identical set of experiments at the same locations but with 100 different participants, willingness-to-pay for pork product attributes was also assessed. This paper presents only the results from the beef experiments and all statistics refer only to the beef panels. Interested readers are directed to Hobbs et al. (2005) for information and results from the pork experiments.

[3] For a more complete discussion of the experimental auction methodology, model and results, see Hobbs et al. 2005.

[4] The dependent variable was based only on the final five rounds of bidding for a given subject. Data from the first five bidding rounds can be affected by misunderstanding of the auction process, whereas we assume that by the 6th round the bids will have stabilized around a participant's true marginal WTP (Shogren et al. 1994; Hayes et al. 1995).

[5] The average is based on the last 5 rounds of bidding, and is the marginal bid as a percentage of base sandwich value of Cdn$ 2.82 for the beef sandwich. The 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 willingness-to-pay 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.

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