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Traceability *in the* Canadian Red Meat Sector

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TRACEABILITY
in the
CANADIAN
RED MEAT SECTOR

by

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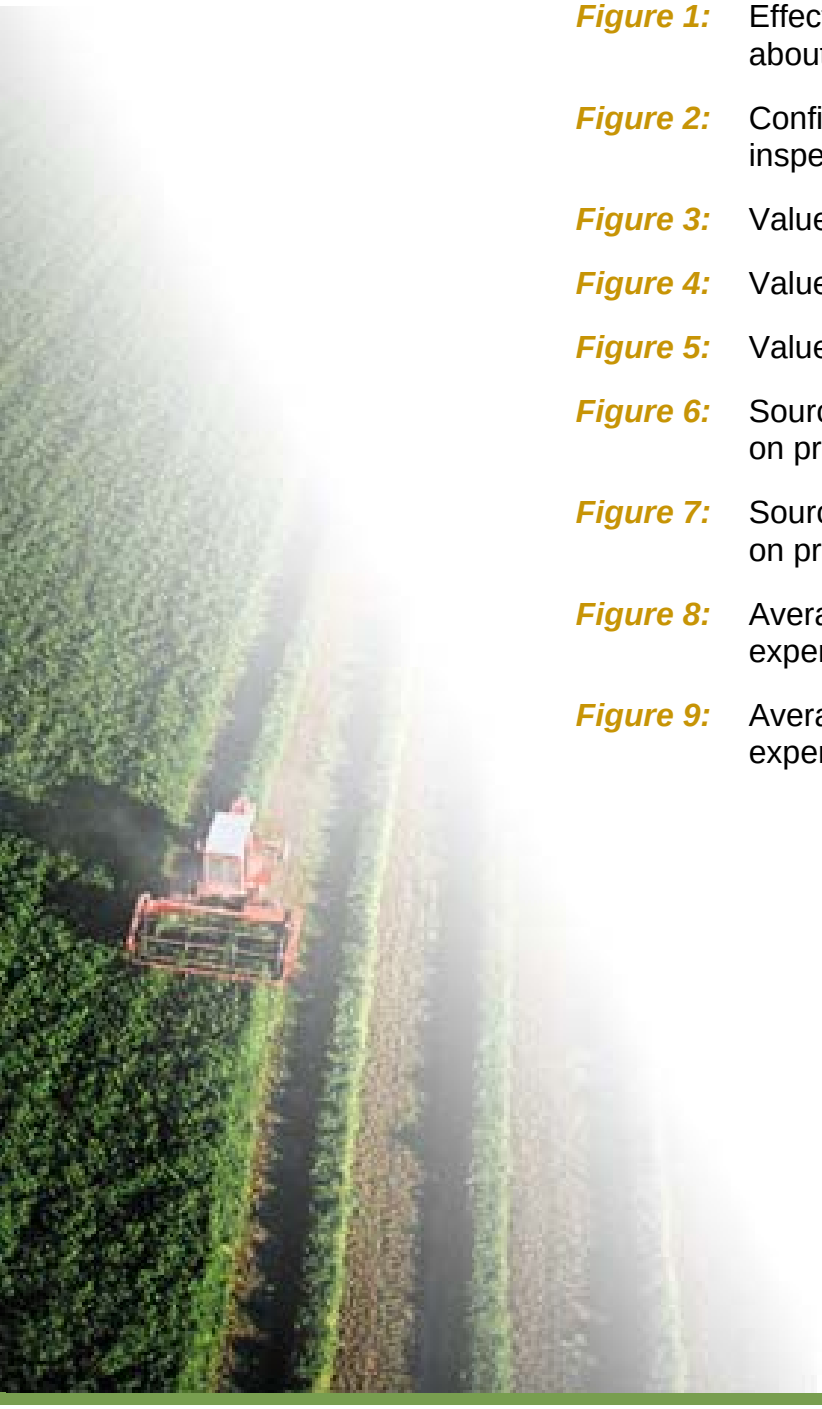

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Foreword

The agri-food chain today is significantly different from that of twenty years ago. Changing consumer demands, knowledge intensive technology, North American integration and globalization have all contributed to the evolution of the different segments of the chain, which include input suppliers, agricultural producers, food processors, and food distributors.

This report is part of Agriculture and Agri-Food Canada (AAFC)'s Performance Report Series. The purpose of this series is to create a picture of the competitiveness and profitability of the entire agri-food value chain to support a more informal discussion on changes in the agri-food value chain, and the challenges and opportunities it faces in the future. This information will provide a reference point for determining the preparedness of the agri-food value chain to take maximum advantage of the new Agricultural Policy Framework (APF) to build a more profitable future.

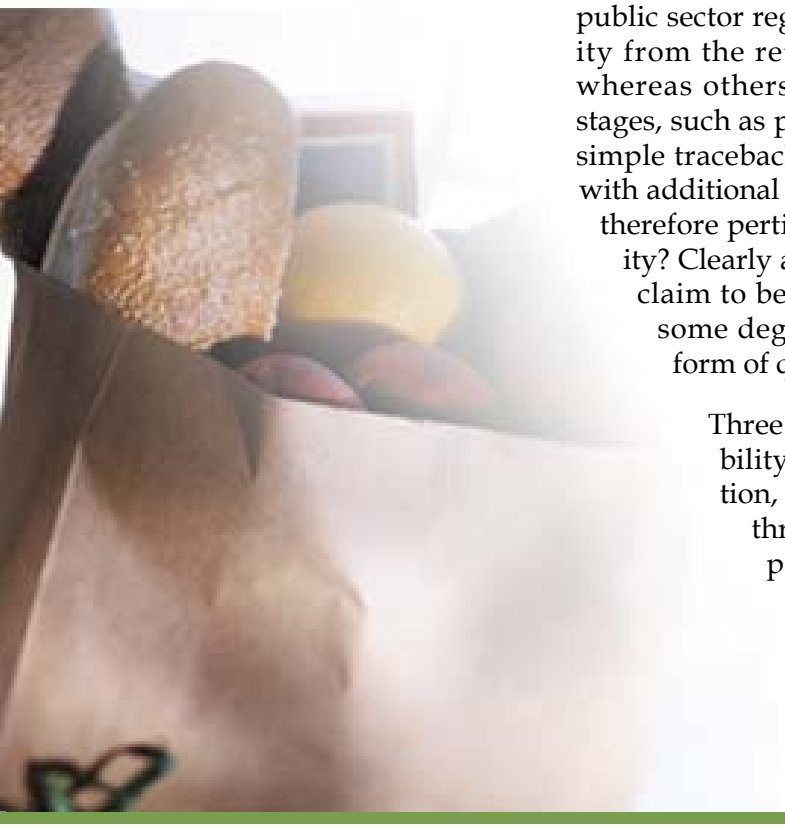
This report looks at traceability in the meat and livestock sector. As industry and government work together in developing traceability capacity, this report asks the question: 'What is meant by traceability?' The answer to this question has huge implications for the design of the traceability system. Traceability systems can vary from simple traceback systems to systems that provide identity preservation and quality assurances. Using experimental auctions of beef and ham sandwiches to estimate consumers' willingness to pay, this reports finds that while consumers are willing to pay non-trivial amounts just for traceability capacity, traceability is much more valuable to them when coupled with assurances with respect to superior food safety standards, or on-farm production practices (e.g., humane animal treatment). However, many of the traceability systems that are currently being put in place, for e.g., the Canadian national cattle identification system, are only designed to facilitate the traceback of products in the event of a food safety problem. While these simple traceback schemes can play an important role in reducing the risks or minimizing the

impact of a foodborne disease problem, the results of this report show that they might be of more value to consumers if they were also coupled with food safety and quality assurances.

EXECUTIVE SUMMARY

Given the interest in traceability, as evidenced by the public policy and private sector initiatives under way in different countries, it is timely to ask what is really meant by traceability and what are the expected economic benefits from traceability? Traceability is sometimes used to refer to simple traceback systems but 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 report examines the economic incentives for implementing traceability systems in the Canadian meat and livestock sector.

A variety of approaches to livestock and meat traceability have been adopted in different countries. These include industry-wide private sector initiatives, individual supply chain initiatives and public sector regulation. Some systems enable complete traceability from the retail package back to the farm production unit, whereas others provide limited traceability between specific stages, such as packer to producer. There are systems that provide simple traceback capability versus those that bundle traceability with additional meat quality or credence attribute assurances. It is therefore pertinent to ask: what do we really mean by traceability? Clearly a range of different systems exist, yet most of them claim to be traceability systems. While they all incorporate some degree of traceability, some offer much more in the form of quality or food safety assurances.



Three separate functions of a livestock and meat traceability system are identified. The first 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. These livestock traceability programs enable *ex post* cost reduction after a problem has arisen. The second function of a traceability system is to enhance the

effectiveness of Tort Liability law as an incentive for firms to produce safe food. A third function of traceability is to reduce information costs for consumers through labelling the presence of credence attributes, including those related to food safety, animal welfare, environmentally-friendly production practices, etc. This is an *ex ante* information function requiring proactive information provision and quality verification.

In reducing consumer information asymmetry, the challenge is to transform credence attributes into search attributes through identification and labelling. This requires *ex ante* provision (verification) of information on process attributes rather than simple traceback capability from retail back to the farm. The question "What do consumers really want?" lies at the heart of this issue. In other words, is traceability information useful to consumers? To address these questions, experimental auctions were 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 ham.

The results of the experimental auctions suggest that respondents were willing to pay non-trivial 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 yielded significantly more value to consumers than traceability alone, with the economic value of those additional assurances appearing to be higher for beef than for pork.

While traceability is clearly of some value to some consumers, traceability, by itself may not be enough. Traceability bundled with quality assurances with respect to specific credence attributes has more appeal. *Ex post* reactive traceability systems perform important economic functions in limiting the public and private costs from a food safety problem and in maintaining consumer confidence in an industry, however, they do little to reduce consumer information asymmetry. Traceability may be a necessary but not sufficient condition for *ex ante* verification of quality attributes.

If the objective is to reduce consumer information asymmetry with respect to quality assurances, "traceability" may be the wrong word to apply. It implies an *ex post* reactive process of tracing something to the source of origin, rather than *ex ante* provision of information on process attributes that verifies product quality. The research conducted for this report indicates 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. Future economic analysis of the role of traceability systems in improving food safety and food quality should distinguish between *ex ante* information provision and *ex post* traceability functions.

CHAPTER 1
INTRODUCTION

Consumers have become more discerning in their food consumption choices. Food safety and food quality are the focus of industry strategies, policy initiatives and consumer concerns in many countries. A variety of private sector and public policy traceability initiatives have emerged around the world, partly 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 in recent industry initiatives and in policy discussions within the Agricultural Policy Framework (APF). 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 report 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 to pay of Canadian consumers for a traceability assurance, a food safety assurance and an on-farm production method assurance for meat products. Results from these laboratory market experiments and additional survey data provide insights into the relative value of traceability and quality verification assurances and the credibility of different information sources for providing quality assurances to consumers.

Food safety and food quality as motivators for traceability

A series of high profile food safety incidences has heightened public awareness of food safety over the past decade. For example the Bovine Spongiform Encephalopathy (BSE) crisis in the United Kingdom's (UK) beef industry; outbreaks of *E. coli* O157:H7 infections attributed to ground beef in the U.S. (Jack-in-the-Box; Tyson meats); the deaths of 22 senior citizens in Scotland linked to *E. coli* O157:H7 contaminated meat purchased from a local butchers shop; the contamination of Belgian animal feed with potentially cancerous dioxins in 1999; the 'Garibaldi' incident in Australia in 1995 in which *E. coli* O157:H7 from a contaminated meat sausage resulted in several illnesses and the death of a child (Hobbs et al., 2001).

The increased emphasis on food quality is partly supply driven, as a result of technological changes and increased product differentiation possibilities. It is also partly demand driven, with increased consumer interest in a wider array of intrinsic and extrinsic food attributes. Intrinsic quality attributes include palatability, nutrition, the functional (health) properties of food, etc. Extrinsic quality attributes include elements of the production environment, such as farm animal welfare, environmental stewardship, and organic food. Many of these are credence attributes

that cannot be detected by consumers without a quality signal, such as a label. Often the same is true of food safety. Unless severe product deterioration has occurred, consumers cannot detect food safety hazards through sensory means prior to purchase. Occasionally food safety can be an *experience attribute* if a consumer experiences a food borne illness immediately following consumption of a specific food item. Usually, food safety has *credence attribute* properties. This was the case for BSE in the UK beef industry – it was impossible for a consumer to know whether he/she had consumed BSE-infected beef even after consumption[1].

Consumers incur information costs in determining whether experience or credence attributes are present. Market failure can arise as a result of information asymmetry if the market adversely selects lower quality (or unsafe) food in the absence of information signals to consumers. In other words, if consumers cannot distinguish between "low quality" (unsafe) food and "high quality" (safe) food, there will be uncertainty regarding the safety of any given food product, which will be reflected in a lower willingness-to-pay for all similar foods. At lower prices there is a reduced incentive for producers of food to invest the necessary resources in producing safer food (e.g. increased microbial testing, improved sanitation procedures, employee training and monitoring, etc.). Lower cost (lower quality/less safe) food will "chase" higher cost (higher quality/safer) food from the market.

A similar argument applies to credence quality attributes, such as GM food, animal welfare friendly or environmentally friendly food. However, whether consumers perceive the credence attribute as a negative attribute or a positive attribute affects the market incentives for firms to signal quality information accurately. The role of information asymmetry and product quality has been explored extensively in the economics literature and serves as a basis for the discussion of traceability systems that follows.

Grossman (1981) finds that when *ex post* verification is costless and there are negligible communications costs between consumers, even a monopolist has an incentive to voluntarily and truthfully disclose product quality *ex ante*. Due to adverse selection, sellers of high quality products have an incentive to disclose true quality; therefore nondisclosure implies low quality. Grossman extends his model to consider the role of warranties when quality can be determined through *ex post* observation or use. He concludes that there is no role for government intervention to encourage quality disclosure if (and only if) disclosure is costless.

In an analysis of the incentives for voluntary approaches to food safety versus mandatory regulation, Segerson (1999) uses a game theoretic model to show the conditions under which a firm would adopt voluntary food safety standards, given the threat of mandatory standards being imposed. She finds that the market is likely to work well to induce voluntary adoption of food safety measures for search and experience goods but not for credence goods. However, the threat of government regulatory action or publicly funded inducements (subsidies) may still be sufficient to induce voluntary food safety measures provided that the regulator is prepared to follow through to ensure that it is a credible threat.

McCluskey (2000) discusses information asymmetry and the role of policy in the case of organic foods. She shows that due to the credence nature of the good, a profit-maximizing producer will gain from deceiving consumers with false quality claims. Repeat-purchase relationships and third party monitoring are necessary for efficient markets in high quality credence goods. Stand-

1. *New-variant Creutzfeld-Jacob Disease (nv-CJD) in humans, which is thought to be caused by consuming BSE infected beef, has an incubation period of several years. Thus, symptoms do not emerge for several years after consumption has occurred and it is not possible to link these symptoms to consumption of a specific beef product.*

ardization of label claims and public sector certification may improve market efficiency. Traceability systems facilitate the provision of quality signals to consumers. Yet (as discussed below), the primary function of many of the emerging livestock traceability systems is to reduce the risks and costs of a food safety problem rather than to provide credible *ex ante* quality signals to consumers. The credibility of quality assurances delivered through traceability systems is also examined in this report.

CHAPTER 2

TRACEABILITY SYSTEMS IN MEAT AND LIVESTOCK SECTORS

Reflecting the growing interest in meat traceability, a number of livestock identification and meat traceability systems have emerged in various countries in recent years. Most of these are private sector systems, although there are also 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 full traceability from the retail counter back to the farm. This section discusses recent examples of private and public sector traceability initiatives enabling partial and full traceability.

Private sector traceability initiatives

Voluntary labelling by firms, sometimes supplemented by third party certification, can identify credence attributes. If there is a market premium for "safer" food, there is an incentive for firms producing products with enhanced levels of food safety to identify this attribute in a label. Irradiated meat products in the U.S. are a good example. A credible monitoring and enforcement mechanism is necessary to reduce the risk of cheating through mislabelling. A self-policing industry quality assurance or safety labelling program could be effective if those firms producing "high quality" (or demonstrably safer) food are able to censure those firms who free-ride on the certification program through false or misleading labelling. In the absence of an effective self-policing mechanism, the market failure problem persists for products with negative quality or safety attributes. A firm will not voluntarily disclose low quality.

Is there a competitive advantage to firms in offering a food safety guarantee that allows them to capture rents from the marketplace by differentiating their products on the basis of safety? This is a contentious issue. On one hand, it can be argued that a safe food supply is a basic expectation of all consumers, therefore premiums for "safe food" do not exist. Others argue that it may be possible for firms to market "food safety" by differentiating their products on the basis of safety (Roberts et al. 1997). This strategy may provide a first-mover advantage even if the food safety standard becomes an implicit expectation of consumers if a firm is the first to offer this guarantee. In the UK, for example, Lion brand eggs differentiated their product on the basis of food safety with a claim that the eggs are Salmonella-free because the hens that produced them were vaccinated against Salmonella.

Private sector traceability initiatives in the livestock sector include individual supply chain initiatives and industry-wide programs. Supply chain partnerships delivering traceability have emerged in the UK beef industry, largely as a result of the loss in consumer confidence following the BSE crisis. One example is Tracesafe, a small farmer-owned company that developed a network of cattle breeders and finishers who reared cattle to specific production guidelines. The

production protocols specified the purchase of feed from a set of contracted feed mills and included an extensive system of on-farm record keeping. Tracesafe differentiated its beef on the basis of the ability to trace the history of individual meat cuts to the animal of origin, with an implied safety assurance. Using an extensive system of record keeping and operating within a closed supply chain, Tracesafe was able to trace the history of individual meat cuts to the animal of origin. Independent auditing of the system was carried out regularly. Marketing was targeted at specialist retail outlets and high quality restaurants where consumers were willing to pay a premium for the assurance of guaranteed traceability. The brand name, Tracesafe, was stamped on all accredited beef carcasses both to help prevent fraud and act as an endorsement of the traceability system (Fearne, 1998).

The Canadian meat processing sector has recognized the potential role of traceability in bolstering consumer confidence in food safety, and as a product differentiation strategy. Michael McCain, President and CEO of Maple Leaf Foods Inc. (a major Canadian pork and poultry processor) is quoted as referring to traceability as the "holy grail of the food supply chain" (Powell, 2002). Maple Leaf is currently funding the development of DNA identification technology to facilitate the traceback of meat to the farm of origin (Powell, 2002). Pressure from export markets, particularly the Japanese market, appears to be a significant driver for this development.

Food retailers can be a catalyst for improved traceability, if it can reduce their risk exposure, improve product recall effectiveness or reduce the transaction costs of monitoring product quality including supplier production methods. UK supermarkets require their beef suppliers to be members of accredited quality assurance programs, although the meat may not be traceable to the specific farm of origin. The Canadian retailer Sobeys reportedly requires its suppliers to demonstrate that specific production, processing, transport and handling processes have been implemented. While traceability back to the farm may not be an explicit requirement, it can be a necessary condition for providing information on production and processing methods (Hobbs, 1996; Fearne, 1998; Bredahl et al. 2001). These are supply chain management motivations for traceability from the retail sector back down the food chain. However, this does not necessarily mean that traceability information would be made available to consumers on retail packages. The motivation is usually to reduce transaction costs of supply chain management rather than to provide information to consumers on credence attributes.

Industry associations or producer groups have introduced industry-wide traceability programs. The Canadian Cattlemen's Association established the Canadian Cattle Identification Agency (CCIA) in 2001. The CCIA implemented a national cattle identification system to facilitate the traceback of cattle in the event of a food safety problem, which became mandatory in July 2002. The industry initiated CCIA as a risk reduction strategy. Prior to the introduction of the traceback system, the identification and tracing of Canadian cattle in the event of a major crisis on the scale of BSE would have been virtually impossible.

Cattle leaving the herd of origin are issued a unique ID number displayed on a CCIA tag with a barcode. Tags are distributed by authorized service centres that record which ID numbers are allocated to which producers. The unique ID number is maintained to the point of carcass inspection in the packing plant. The monetary penalty for non-compliance ranges from $100-$450 for non-commercial violations and $500-$6000 for commercial violations (CFIA, 2000a; 2000b). The system is enforced by the Canadian Food Inspection Agency (CFIA), which in the case of a serious violation that poses significant health or animal health risks, can prosecute under the *Health of Animals Act*.

In the event of a food safety problem, the CFIA initiates a traceback procedure using information from the CCIA database to identify the last location of the animal and the herd of origin (CCIA, 2002). This information is used to track cattle movements both backwards and forwards in the supply chain. Producers are not required to maintain records. In this regard the Canadian system is quite different from the "cattle passport" system in the UK. The UK system requires producers to register all cattle from birth and record all movements on or off a farm with the national identification agency. In the UK system the unique animal ID number allows immediate identification of all farms on which the cattle have been located. The Canadian system only allows direct identification of the herd of origin and the final location of the cattle, with traceback beyond those two points relying on the ability of producers to provide this information.

The CCIA explain that a national cattle identification system was needed in Canada to maintain consumer confidence and market share:

> ***If a health or safety issue were to happen in Canada, over half of our production could suddenly be without a market. We need to do what we can today to ensure market access, both domestically and internationally. A National Identification Program will help protect our markets. . . . If we as an industry do not put into place our own national identification system, we will lose market share and may find a system not of our choosing imposed upon us (CCIA, 2002).***

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) as a joint industry/government initiative. Cattle are identified using devices embedded with an electronic microchip. The identification may be through an ear tag or a rumen bolus. The information on the chip can be read electronically and is stored on a national database. The system goes beyond simple identification however, and allows the storage of information on disease and residue status of the animal, market eligibility and other commercial information. Cattle producers can access individual animal information through the database, linking it back to their own farm records on feed performance, genetics and management techniques (Meat and Livestock Australia, 2001).

An Australian quality assurance system including DNA sampling for traceback piggybacks on the NLIS. It is essentially a series of quality management protocols that cover production, handling and processing. These protocols are called Cattle Care. A National Vendor Declaration form identifies the seller and provides basic production information (e.g. whether the cattle were treated with a growth-promoting hormone, information about the feeding program, etc.). This information, combined with the NLIS cattle tag, enables the traceback of cattle in the event of a problem (Lawrence, 2002).

A voluntary grading system, Meat Standards Australia (MSA), uses a series of pre and post-slaughter measures to predict the eating quality of meat. Blood samples are taken from each carcass that qualifies for the MSA program while the carcass can still be identified with a seller. If a consumer complains of a bad eating experience from MSA-graded meat, a DNA sample from the meat can be matched with the blood sample from the carcass. In this way, meat cuts can be traced through the supply chain and to the farm of origin. Although there is a food safety element, the traceback in the MSA system is focused primarily on eating quality. It can assist in identifying where improvements may be necessary or in identifying sellers who consistently misrepresent cattle on their National Vendor Declaration form (Lawrence, 2002).

The Australian identification and quality assurance systems are voluntary. They establish the information infrastructure onto which individual supply chains can bolt their own quality branded beef programs. There are several examples of Australian branded beef programs that use the MSA system as part of a product differentiation strategy (Lawrence, 2002).

Regulatory traceability initiatives

Mandatory traceability and labelling initiatives have been introduced in some jurisdictions. In 1997, the European Union (EU) introduced a regulation establishing rules for beef labelling systems in Member States[2]. There are three components to the regulation. First, each Member State will have a national cattle identification and registration system. Second, beef products will be labelled with a traceability number identifying origin, including where the animals from which the meat was derived were born, reared, slaughtered and processed. Third, the regulation introduces rules for voluntary labelling with additional information (e.g. production information, animal welfare information, etc.). Individual Member States of the EU have introduced additional voluntary beef labelling systems. A few of the labelling schemes are more extensive than simply indicating the origin of the cattle and include, for example, animal welfare information, the breed of the animal or the method of fattening. Third country labelling systems for beef imported into the EU are subject to the approval of the European Commission (EC).

The EU beef labelling and traceability regulation represents a more extensive regulatory involvement in meat traceability than is evident in many other countries. Stanford et al. (2001) indicate that 25 countries are at varying stages of implementing individual animal identification programs, ranging from basic systems such as those developed by the CCIA in Canada, to more complex passport programs, as in the UK, that directly track an animal throughout its life. In some cases, the public sector role is limited to developing and enforcing a national cattle identification system, rather than requiring full traceability labelling throughout the supply chain.

In Mexico, the Ministry of Agriculture is working with livestock associations to develop a national record of brands, tattoos and other permanent livestock markings for identifying livestock. A 1999 law moved responsibility for maintaining records of livestock markings to state offices of the Ministry of Agriculture. This was previously handled by municipalities and local livestock associations. The federal ministry of agriculture will keep a national record of livestock associations and their respective registered markings (Food Traceability Report Weekly, 2002). This system falls short of a national cattle identification and tracking system and instead appears to be aimed at distinguishing between breeds and regional production areas.

Following the loss of its European markets for beef following an outbreak of foot-and-mouth disease in 2001, Argentina has scrambled to put in place a livestock traceability system. In mid-2002, Argentinian legislators considered a Bill to create a national commission for cattle identification and meat traceability. The existing Argentinian system had been criticised for being duplicative and overly burdensome on the industry, with separate approaches for traceability of organic products, cattle in feedlots, cattle destined for the EU market and traceability for disease control purposes. The proposal for an overhaul of these procedures in the Argentinian beef industry included the potential to develop a genetic tracking system that could be used with a conventional barcode identification system to track animals and meat through each stage of production, processing and distribution (Lewis, 2002). The cost effectiveness of such a system and its potential to re-open and maintain access to key export markets has not been determined.

2. *Regulation No. 820/97 subsequently amended by Regulation EC 1760/2000.*

In July 2001, New Zealand introduced a compulsory identification system for all livestock and domesticated deer, which includes a declaration card detailing where and when the animals were born (Thornton, 2002). A voluntary DNA tracking system builds on the compulsory livestock identification system. Processors keep a DNA sample of every animal slaughtered. Packs of meat destined for export have identification information on the farm of origin and slaughterhouse, enabling tracking from the retail counter back through the supply chain. A recent test of this system successfully traced a package of New Zealand lamb chops from a supermarket in the UK through the UK importing networks, the New Zealand export and transportation system, the packing plant and back to the farm on which the lambs were born (Thornton, 2002). In New Zealand the basic livestock identification system - with traceability from the packing plant back to the farm - is mandated by law. However, the DNA component of the system enabling full traceability throughout the supply chain is market driven – unlike in the EU where full traceability in the beef sector is mandated by the beef labelling regulation

The 2002 U.S. Farm Bill introduced retail-level country of origin labelling for beef, lamb, pork, fish, fresh and frozen fruits and vegetables and peanuts. In the interim this is voluntary but a mandatory regulation will be established by September 30, 2004. To receive a U.S. country of origin designation livestock must be born, raised and slaughtered in the U.S. Mandatory country of origin labelling has ramifications for the traceability, record keeping and information systems that will be required in order to substantiate the "born, reared and slaughtered" claim for any meat products (Hobbs, 2002; Buhr, 2002).

To summarize, there are many approaches to enhancing traceability in the livestock sectors. These include industry-wide private sector initiatives, individual supply chain initiatives and public sector regulation. They can involve complete traceability from the retail package back to the farm production unit or limited traceability between specific stages, such as packer to producer. There are systems that provide simple traceback capability versus those that bundle traceability with additional meat quality or credence attribute assurances. This raises the pertinent question of what do we really mean by traceability? Clearly a range of different systems exist, yet most of them claim to be traceability systems. While they all incorporate some degree of traceability, some offer much more in the form of quality or food safety assurances. The next section examines the functions of traceability in the meat and livestock sector and the economic incentives for putting traceability systems in place.

CHAPTER 3

ECONOMIC INCENTIVES FOR TRACEABILITY SYSTEMS

Given the interest in traceability, as evidenced by the public policy and private sector initiatives under way in different countries, it is timely to ask what is really meant by traceability and what are its expected economic benefits? Traceability is sometimes used to refer to simple traceback systems but has also been applied to programs that provide identity preservation and quality assurances throughout the supply chain. A review of the recent literature reveals a number of potential motivations for traceability in the meat and livestock sector.

Liddell and Bailey (2001) make a useful distinction between traceability, transparency and quality assurance. They define traceability as the ability to track inputs used to make food products backward through the supply chain to their source. Transparency is the public disclosure of information on the rules, procedures and practices used to produce a food product as it moves through the supply chain. Quality assurance includes a range of practices aimed specifically at enhancing food safety or quality, including hygiene practices, quality grading and measurement and the ability for product recalls.

Golan et al. (2002) identify three private sector motivations for establishing traceability systems, including differentiating products with credence attributes, facilitating traceback for food safety and quality, and cost reductions and enhanced inventory control through improving supply-side logistics management. They also identify government incentives for mandated traceability including: the ability to monitor traceback to enhance food safety; to correct market failures from consumer information asymmetry with respect to credence attributes (a consumer right-to-know argument); and to protect consumers from fraud or producers from unfair competition through mislabelled products or unsubstantiated claims with respect to credence attributes (e.g. organic food labels).

In an analysis of traceability in the UK livestock sector, Pettitt (2001) identifies a variety of purposes that are more regulatory in focus than those of Golan et al. The effects of the BSE crisis and the recent foot and mouth disease crisis in the UK livestock industry likely influence this list of perceived benefits. According to Pettitt, traceability of livestock and food serves a number of purposes including: the protection of animal health; the protection of public health (food recall, enforcement of drug withdrawal periods); protection of both animal and human health from zoonotic diseases (such as tuberculosis, salmonella and BSE); the protection of animal welfare through the enforcement of standards; and the protection of taxpayer investments through the ability to audit publicly-funded livestock support schemes (Pettitt, 2001).

Ex post cost reduction through traceback

Traceability systems can be introduced for a wide variety of reasons. Identifying the economic incentives for introducing traceability systems is useful in understanding the extent to which traceability is likely to deliver net economic benefits. For the purposes of this analysis, three separate functions of a livestock and meat traceability system are identified. The first 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 food borne 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, reducing product recall costs through more targeted recalls and protecting firms who practice due diligence from free riders who fail to invest in good production practices. An effective traceability system may also help to maintain 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. Most livestock traceability programs, for example, the Canadian cattle identification system perform this reactive function. They enable *ex post* cost reduction after a problem has arisen, as such, they are a risk reduction tool for the industry.

Strengthening liability incentives

The 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. 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.

Reducing information costs for consumers

A third function of traceability is to reduce information costs for consumers through labelling the presence of credence attributes, including those related to food safety, animal welfare, environmentally-friendly production practices, etc. This is an *ex ante* information function requiring proactive information provision and quality verification. However, most livestock identification and traceability systems and the EU beef traceability and labelling regulation are reactive in nature. They are *ex post* information systems – in the event of a problem, they allow the traceback of the product. However, they do not facilitate the *ex ante* provision of information on product attributes necessary to reduce consumers' information asymmetry.

Paradoxically, the frequent justification for introducing mandatory traceability and labelling, such as the EU beef labelling regulation, is the provision of useful information to consumers that the market would otherwise fail to provide. Several EU Member States have already imple-

mented beef labelling regulations. Initial experiences suggest that this is an *ex post*, reactive labelling system rather than an *ex ante* information system that would reduce consumer information asymmetry with respect to important credence attributes.

> ***Other Member States report that their consumers, even when well informed, have not notably changed their patterns of consumption of beef (Commission of the European Communities, 1999, p.7)***

This statement suggests these countries introduced *ex post* reactive labelling systems, rather than *ex ante* systems that provided information on credence attributes of importance to consumers. Further, it appears that this regulation raised the transaction costs of vertical supply chain relationships in some Member States:

> ***Denmark, France, Austria and the United Kingdom indicate that the increased administrative and control procedures arising from beef labelling have reduced the ease with which operators can trade freely between themselves and has made management of meat supplies more problematical (sic) and bureaucratized. (Commission of the European Communities, p.7).***

A comprehensive cost-benefit analysis of these labelling regulations, including implications for vertical coordination and an assessment of whether the labels provide information of value to consumers, was not conducted:

> ***Finally, Member States reserved their strongest comments for their assessment of the high costs associated with the current labelling 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, p.7).***

It is apparent that the EU regulation, although appearing to offer *ex ante* information on beef products, is in fact an *ex post* traceability system. In the event of a problem, it will facilitate the traceback of beef products and affected livestock but it does little to provide consumers with *ex ante* product quality information.

Instead, a more important role for a regulator may be in establishing credible third party monitoring and verification of *ex ante* quality claims. The challenge is to transform the credence attributes into search attributes through identification and labelling. This requires *ex ante* provision (verification) of information on process attributes. The question "What do consumers really want?" lies at the heart of this issue. In other words, is traceability information useful to consumers? If so, is the absence of traceability information an indication of market failure and therefore a justification for mandatory traceability and labelling programs to correct the market failure? Or can voluntary traceability labels be a useful product differentiation strategy for individual firms or supply chain alliances? Before we can begin to answer these questions, we need a better understanding of consumer responses to traceability and quality verification information, and we need to recognise the breadth of traceability systems than can exist. A taxonomy of traceability, identity preservation and quality assurance systems is presented below. This is followed by an analysis of consumer preferences for simple traceability versus quality assurances that relate to specific food safety and production practices.

CHAPTER 4

TAXONOMY OF TRACEABILITY SYSTEMS

Table 1 assesses the nature of the information problem and the role (if any) of traceability/identity preservation systems for a number of food quality and food safety attributes. The taxonomy illustrates the diverse information needs and differing roles of potential traceability systems. Each example is identified by the broad classification to which it belongs. A positive or negative attribute for (some) consumers indicates the extent to which firms have an incentive to voluntarily disclose product quality information – although not whether this disclosure is "honest". If the firm does not know the true product quality an incomplete information problem exists. Different degrees of information asymmetry exist for consumers depending on whether the attribute has search, experience or credence properties. While consumers are not able to detect credence attributes, third party testing may reveal them in some cases (e.g. GMOs, residues). Benefits to the firm from cheating by misrepresenting or mislabelling food is important if *ex post* monitoring cannot accurately assess product quality (or safety); this has implications for the establishment of legal liability. Also, market failure is greater in these situations. Finally, the table identifies the relevant traceability or identity preservation system and its purpose.

For intrinsic quality characteristics with experience properties, such as palatability, private sector branding mechanisms serve as a quality signal to consumers and an industry-wide traceability system is not relevant. Process attributes such as whether the product was produced in an animal welfare friendly or environmentally friendly manner create an information asymmetry problem for consumers and are not detectable *ex post* by a third party monitor. Cheating through misrepresentation (false labelling) is a problem given the potential returns to a profit-maximizing firm[3]. An *ex ante* traceability or quality verification system may solve this information problem. In the absence of negative health outcomes or *ex post* quality measurement, legal liability is not relevant or cannot be established.

Attributes with immediate food safety effects, such as *E.coli* are detectable by consumers *ex post* (an ensuing illness). An *ex post* traceability system reduces negative externality effects, e.g. by tracing and removing potentially contaminated batches from the market, thereby reducing the number of individuals affected. It facilitates assignment of liability, inducing firms to adopt measures that reduce the probability of contamination occurring.

Attributes with uncertain long-run food safety outcomes include BSE. Unlike foodborne pathogens that result in (relatively) immediate illness, negative health consequences may only emerge after several years. Even third party testing is not able to identify the presence of the attribute[4]. An *ex post* traceability system may reduce negative externality effects by enabling potentially

3. *See McCluskey (2000) for a discussion of this issue with respect to false organic claims.*

infected source herds to be identified. Producer-to-consumer externalities are reduced if contaminated meat is removed from the food chain. Producer-to-producer externalities are reduced for producers with BSE-free herds if they are protected against a general loss of consumer confidence. Cheating may occur if products can be misrepresented as originating from "assured" BSE-free herds (i.e. those with no recent cases of the disease). Given the time lag discussed earlier, direct liability for BSE-contaminated meat is unlikely.

Table 1 is not intended to be an exhaustive list; instead it emphasizes the multidimensional nature of information problems related to food safety and food quality. It also indicates that for some food attributes, an *ex post* traceability system may be appropriate to resolve any market failures, while for others, an *ex ante* system is more suitable. In some cases, the potential information asymmetry or externality problems suggest that both an *ex ante* and an *ex post* traceability system is required.

4. *While it may be possible to identify BSE-infected animals in the advanced stages of the disease post-slaughter through examination of brain tissue, it is not possible to test for BSE-contaminated meat after processing.*

Table 1: Product attributes, information problems and the role of traceability systems

Example	Classification	Positive/ Negative attribute	Firm quality information	Consumer information asymmetry	3rd party *ex post* detection	Benefits from cheating	Liability	Potential market failure	Traceability system	Purpose of traceability system
Palatability (taste, texture)	Intrinsic quality - sensory	Positive	Yes	Experience	Yes	Yes (one-shot)	No	None	No (private branding)	
Colour, size	Intrinsic quality	Positive/ Negative	Yes	Search	Yes	No	No	None	No	
Fat, cholesterol, nutritional content	Intrinsic quality (health)	Negative	Yes	Experience/ Credence	Yes	Yes	No	Information asymmetry (cheating)	*Ex ante*	1) Identifying presence of attributes 2) Prevent false labelling
Origin (region)	Extrinsic quality (ethical)	Positive	Yes	Credence	No	Yes	No	Information asymmetry	*Ex ante*	1) Information provision
Animal welfare, enviro friendly, organic	Process attribute	Positive	Yes	Credence	No	Yes	No	Information asymmetry (cheating)	*Ex ante*	1) Identify presence of attributes 2) Prevent false labelling
Output-trait GMOs - health benefits for consumers	Process attributes (health)	Positive	Yes	Credence	Yes	Yes	No	Information asymmetry (cheating)	*Ex ante*	1) Information to inform purchase 2) Prevent false labelling
Input-trait GMOs - producers benefits, no direct consumer benefits	Process attribute	Negative	Yes	Credence	Yes	Yes	No	Information asymmetry	1) *Ex ante* 2) *Ex post*	1) Information provision (avoid) 2) Prevent/punish cheating
E. coli, salmonella, etc.	Immediate food safety	Negative	No (probability may be known)	Experience	Yes	No	Yes	1) Health care externalities 2) Information asymmetry	*Ex post*	1) Reduce externality cost 2) Liability
BSE	Potential long-term food safety	Negative	No (probability may be known)	Credence	No	Yes	No	1) Health care externalities 2) Information asymmetry	1) *Ex post* 2) *Ex ante*	1) Reduce externality cost 2) Information provision (avoid)
Residues	Potential long-term food safety	Negative	No (probability may be known)	Credence	Yes	Yes	Yes	1) Information asymmetry 2) Health care externalities	1) *Ex ante* 2) *Ex post*	1) Information provision (avoid) 2) Reduce externality costs 3) Liability

CHAPTER 5

CONSUMER ATTITUDES TO TRACEABILITY AND QUALITY ASSURANCES

Recognising that traceability is a multifaceted concept and can encompass both *ex post* cost reduction through traceback and *ex ante* information provision on credence attributes, we now turn to the question "what do consumers really want?" Is traceability information, by itself, of value to consumers or should traceability systems incorporate additional quality assurances?

To investigate Canadian consumer attitudes to traceability, food safety and quality assurances in the food supply chain, a series of consumer panels were conducted in Saskatchewan and Ontario in 2002. The panels enabled data collection on willingness to pay (WTP) for traceability, food safety and on-farm production information on meat products. Additional information was gathered on consumers' awareness of and concern for food safety, for on-farm production methods and the level of trust in public and private sector sources of information about production methods. The following sections present an analysis of the Canadian consumer panel research.

Consumer panel sample recruitment

The primary objective of the consumer panels was to conduct a series of experimental auctions to evaluate WTP for traceability, food safety and on-farm production information for beef and ham[5]. In the absence of publicly available market data on the demand for traceability and quality verification characteristics, experimental auctions provide a means of eliciting non-hypothetical bid data for these characteristics. The experimental auctions were conducted in Saskatoon, Saskatchewan and Guelph, Ontario. Saskatchewan participants (106) were recruited from a range of demographic groups at the University of Saskatchewan (faculty, students, professional, administrative and maintenance staff). Campus-wide emails, flyers and class announcements were used to recruit participants for the Saskatchewan panels. Ontario participants (98) were recruited from the consumer database of a private consumer research firm. Participants were provided with a minimum of information during recruitment to reduce the risk of sample selection bias – they were told they would be participating in an economic decision making experiment and would be provided with a light lunch consisting of a beef (or ham) sandwich. The University of Saskatchewan Ethics Committee on Behavioural Research approved the recruitment methods, experiment design and surveys. Auctions were run with ham and beef at both locations, with 104 people participating in the beef auctions and 100 in the ham auctions.

5. *The experimental auction research was carried out in collaboration with DeeVon Bailey and David Dickinson from Utah State University who were conducting consumer panels in the U.S., the UK, Japan and Canada on a USDA-funded study (Dickinson and Bailey, 2002). Funding from Agriculture and Agri-Food Canada enabled additional data collection to expand the Canadian portion of the study.*

A complete demographic breakdown of the sample is available in Appendix A. Overall, the Saskatchewan sample had a higher proportion of males and tended to be younger on average. There was a range of education levels among the participants, although the higher education levels tended to be more heavily represented. Relative to the Saskatchewan group, a higher proportion of Ontario respondents had some college and an undergraduate degree, whereas a lower proportion had a graduate degree. This is to be expected given that the Saskatchewan sample was drawn from a university population, albeit from a broad cross-section of employees and students. Income distribution was similar across the participants in both provinces, although Saskatchewan had a higher proportion of respondents in the lower income groups.

Experiment design

The consumer panels were run in groups of 12-14 people. 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, with different information available for each sandwich: (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. Participants were paid $20 as an incentive for attending the session, which usually lasted about one hour. The sandwich descriptions provided to participants are included in Appendix B.

The Vickrey second-price auction for the Canadian experiments was consistent with the format used by Dickinson and Bailey (2002) in their comparable experiments for the U.S., the UK and Japan. Previous experimental auctions to measure WTP have also used this format, e.g., Shogren et al. (1994). The auction is designed so that the rational strategy for each participant is to bid his/her true marginal value for the auction sandwich. In a series of ten rounds, bids were collected for each auction sandwich. Participants bid the amount (if any) they would be willing to pay to exchange their sandwich for each auction sandwich. Individual bids were private information, written down by participants and collected by monitors. At the beginning of each bidding round, the second highest bid ("market price") for that sandwich from the previous round was announced. Conducting multiple rounds of bidding and announcing the market price allows for bid stabilization over the ten rounds and provides a corrective mechanism to assist participants in understanding the experiment (Shogren et al. 1994; Dickinson and Bailey 2002).

At the end of the tenth round, a random draw was used to determine which of the simultaneous sandwich auctions and which round of bidding would be binding. The highest bidder for the randomly selected sandwich and round paid the second highest bid price and exchanged their sandwich for the auction sandwich. Only one sandwich was auctioned off in each experiment. There was an equal chance that any of the rounds of bidding would be binding; thus participants had an incentive to bid honestly each time. Following the bidding exercise participants completed a short questionnaire, collecting demographic information and additional data on attitudes towards food safety risks and animal welfare issues, and the credibility of quality assurances from different sources. The questionnaire is included in Appendix C. The following sections will present information on the stated importance of food safety issues to the participants. The subsequent regression analysis of the WTP bids draws on these consumer attitudinal variables.

Food safety awareness and concern

The post-bidding survey questions revealed that Ontario respondents tended to be more sensitive to food safety issues – a larger proportion having experienced foodborne illness within their families and a larger proportion having altered their food purchases in responses to media articles about foodborne illness (Figure 1). In general, most respondents were reasonably confident in the Federal government's food inspection and safety program, with the level of self-reported confidence slightly higher in Saskatchewan, as can be seen in Figure 2.

Food safety, traceability and production method assurances

Respondents were asked whether they would value additional assurances about meat safety, on-farm production methods and traceability to the farm of origin. A higher proportion of Ontario consumers stated that they would highly value additional assurances about meat safety and on-farm production assurances compared to those in Saskatchewan. A minority also said they would highly value traceability to the farm of origin (Figures 3-5). In general, people indicated that assurances about specific credence attributes, such as food safety and on-farm production methods, were more valuable to them than simple traceability.

If the respondent indicated that they valued information on the procedures and processes used by the farmer to produce the animal, an additional question asked for the reason. Fifty eight percent of those responding to this question indicated that they wanted more confidence about the safety and/or quality of the meat they purchased. Twenty percent indicated that they wanted to be able to identify the source of a problem should one arise, and 12 percent provided their

Figure 1: Effect on food purchases of media reports about foodborne diseases

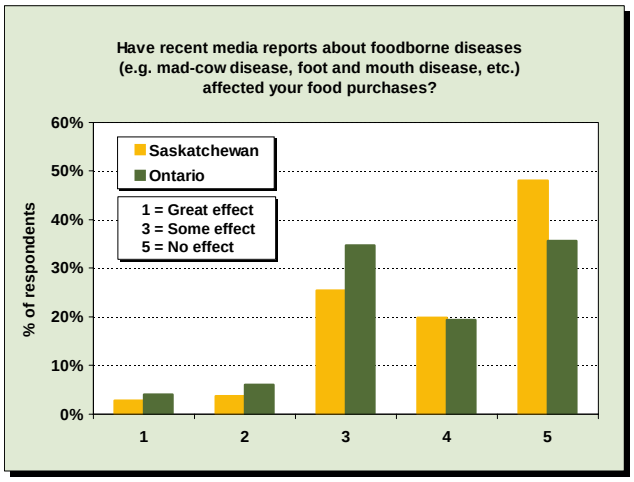
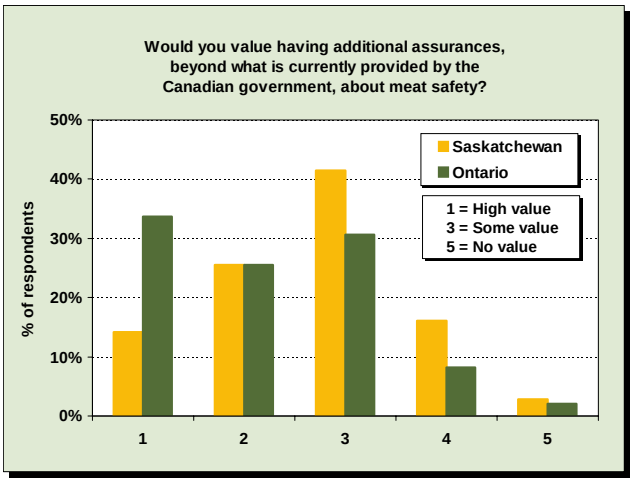


Figure 2: Confidence in Canadian food safety and inspection system

Figure 3: Value of food safety assurances



own reason, most of these indicating animal welfare or knowledge about how the animal was raised and what it was fed.

Participants were asked to indicate which sources they most trusted and least trusted to provide information about on-farm production methods. Possible answers included various levels of industry: producer associations[6], processors and retailers; government: Federal[7] and Provincial; and third parties: animal welfare or environmental groups[8], independent quality assurance firms, or other sources specified by the participant. Figures 6 and 7 compare the results for Saskatchewan and Ontario for the most trusted and least trusted sources respectively.

In both provinces, a Federal government agency was the most trusted by participants, some of whom indicated that they believed the Federal government was more likely to protect the interests of consumers, although the level of trust was higher in Ontario than in Saskatchewan. An independent quality assurance firm was the most trusted source for over 20 percent of respondents in both Ontario and Saskatchewan. There appeared to be some scepticism of animal welfare or environmental groups (such as Greenpeace or PETA) among participants in Saskatchewan (least trusted source for 37 percent of respondents). Results for Ontario were mixed, 16 percent of respondents listed these groups as their least trusted source, but 11 percent named animal welfare or environmental groups as the most trusted information source. Some respondents commented that they did not trust these groups as an objective source of information since they were seen to have an agenda.

Figure 4: Value of on-farm production assurances

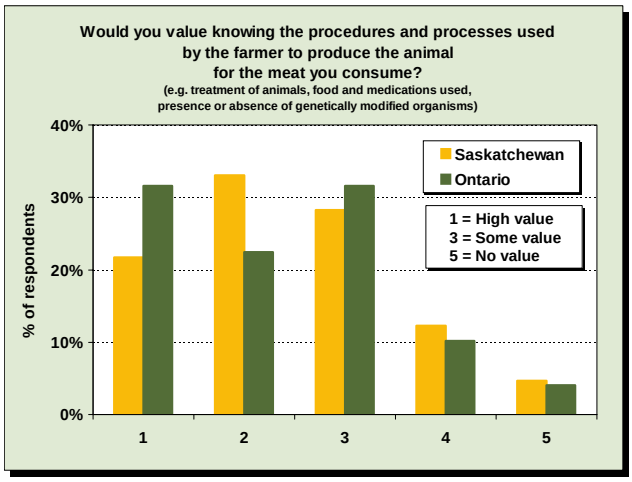


Figure 5: Value of traceability to farm of origin

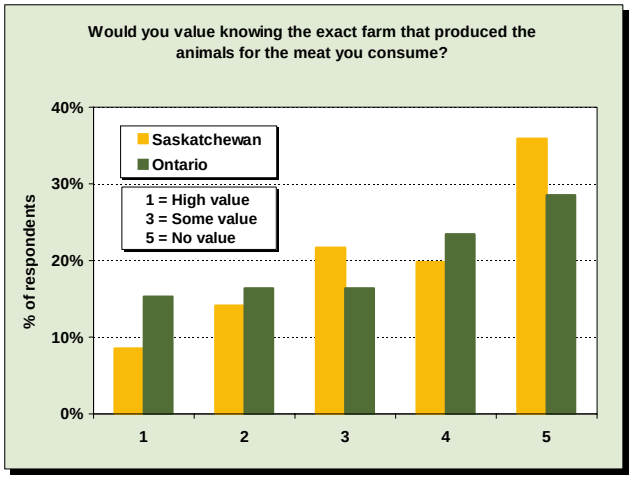
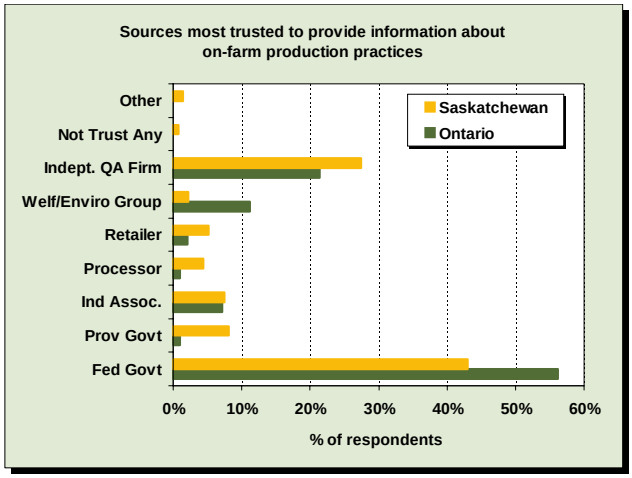
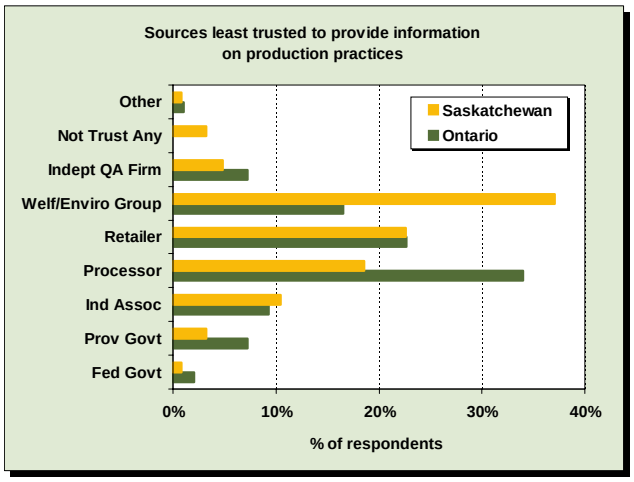


Figure 6: Sources most trusted to provide information on production practices



Another striking difference is the trust in the respective provincial governments, with 8 percent of Saskatchewan respondents listing the provincial government as the most credible source of information, whereas 7 percent of Ontario respondents regarded their provincial government as the least trusted source. One Ontario participant referred to the budget cutbacks of the Progressive Conservative government as the reason for their distrust. One might also speculate that the lower level of trust could be a residual reaction to the outbreak of *E. coli* contamination of the municipal water supply in Walkerton in 1999 that resulted in seven deaths. Without more information, however, it is not possible to provide a clear interpretation of this difference between the two provinces.

Figure 7: Sources least trusted to provide information on production practices



Interestingly, downstream food firms did not engender a great deal of trust among the respondents. Food processors were regarded as the least trusted source of information by 34 percent and 18 percent of Ontario and Saskatchewan respondents respectively, while food retailers were the least trusted source for 18 percent of respondents in both provinces. Comments from some people revealed that these sources were perceived as having a vested commercial interest that might give them an incentive to mislead consumers. Paradoxically, these members of the supply chain are in the best position to communicate directly with consumers, indicating a potential credibility problem for industry sources in providing traceability and quality assurances. Cooperation along the supply chain will be necessary to facilitate credible quality assurances about on-farm production methods. Building individual branding and product assurances onto a nationally accredited identification and quality verification system, as in the Australia meat industry, could offer a solution.

Are consumers willing to pay for traceability?

Before presenting a regression analysis of the experimental auction WTP data, it is useful to consider the average bid information for each sandwich and highlight any differences between the two locations. The participant's average bid for each sandwich in the last five rounds of bidding is used as the dependent variable in the regression analysis that follows. Following Dickinson and Bailey (2002), data for the dependent variable is restricted to the last five rounds of bidding on the assumption that the bids will have stabilized around a participant's true marginal WTP for the attribute in question. Any bidding errors due to participants' misunderstanding of the auction process during the first few rounds of bidding will therefore not contaminate the data.

6. *The Canadian Cattlemen's Association or the Canadian Pork Council, as appropriate, were given as examples*
7. *The Canadian Food Inspection Agency and Agriculture and Agri-Food Canada were given as examples.*
8. *Greenpeace and People for the Ethical Treatment of Animals (PETA) were given as examples.*

Average bid information for each sandwich across the full ten rounds is presented in Figures 8 and 9. Marginal bid information is presented as a percentage of the base sandwich value of C$2.82 for the beef sandwich and C$2.85 for the ham sandwich. The base sandwich value was calculated by asking respondents how much they would typically expect to pay for the type of sandwich provided to them in the experiment, and averaging these responses. For both ham and beef, the figures indicate that traceability to the farm of origin, without additional quality assurances, elicited the lowest average WTP. Quality verification with respect to credence attributes such as an additional food safety assurance or an animal welfare assurance elicited higher bids on average. Bundling traceability information with positive quality assurances yielded the highest bids. 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.

Figure 8: Average willingness-to-pay bids: beef experiments

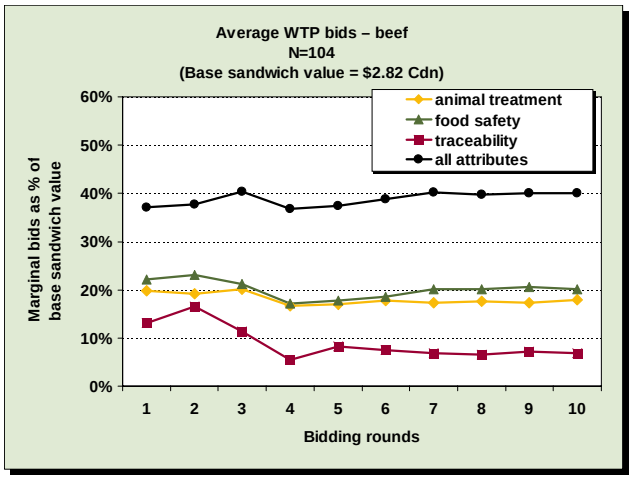
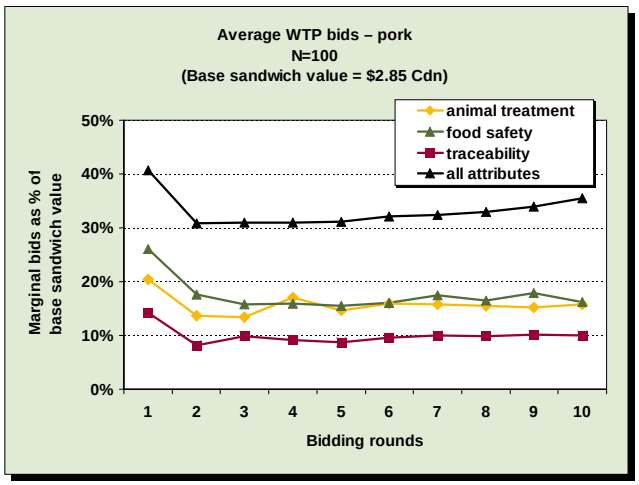


Figure 9: Average willingness-to-pay bids: pork experiments



Some important caveats accompany the interpretation of this bid data. These average values mask considerable variations in bids across participants. For example, there were a high number of zero bids for the traceability only sandwich. Forty six percent of participants bid zero for the traceability only sandwiches (beef and ham) during the last five rounds of bidding, when bids can be expected to have stabilized. This compares with 27 percent who bid zero on the sandwich with the humane animal treatment assurance, and 17 percent who bid zero on the sandwich with the additional food safety assurance. Only 7 percent of participants bid zero on the fourth sandwich that combined traceability with an extra food safety assurance and animal welfare assurance. Due to the nature of a one day experiment, the bid information is usually considered to be an upper bound on WTP (Dickinson and Bailey, 2002; Hayes et al, 1995). Caution should be exercised in extrapolating these WTP bids into other contexts. Budget constraints typically limit WTP. Differences in perceived food safety risks across products could also affect consumers' WTP for safety assurances depending on the product in question.

Regression analysis enables a more extensive assessment of the factors affecting the WTP for traceability and quality assurances in meat. The dependent variable in the regression analysis is the average of the final five rounds of bidding for each sandwich for a given subject. Figures 8

and 9 confirm that there may be a learning process during the early rounds. Bids tended to stabilize after about the third or fourth round of bidding, by which time each subject probably realized that the rational strategy was to bid their true WTP. The independent variables for the regression analysis are listed in Table 2, along with details on the measurement of the variable 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
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	+?
LOCATION	Location of panel	1=Saskatchewan 0=Ontario	?
FPOISON	Subject or family member experienced food poisoning	1=Yes, 0=No	+
ARTICLES	News articles/reports read/heard regarding foodborne disease in last 6 months	Number of articles/reports	+?
MEDIA	Effect of media reports about foodborne diseases (e.g. BSE, foot and mouth disease) on food purchases	Score 1-5, where 1 = great effect and 5 = no effect	-
CONFSAFE	Confidence in 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	-
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	+
AVEMKTP	Market price from first five rounds	Average of announced market price from first five rounds	?

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 constrained by a budget constraint. However, it

should be emphasized 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 (C$20) at the start of the experiment. A budget constraint may not be relevant in this case, hence there is only a weak expectation for a positive coefficient for the income variable. 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 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), the effect of media reports about foodborne disease on food purchase decisions (MEDIA) and the level of confidence in the current Canadian government food inspection and safety program (CONFSAFE). It is expected that experience with food poisoning would induce people to pay more for additional food safety assurances, although not necessarily for increased traceability or humane animal treatment assurances. Exposure to media stories on foodborne diseases would 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.

An alternative interpretation, however, might be that more informed consumers are less concerned about food safety, and therefore a negative coefficient would be appropriate. An alternative measure is given by the variable MEDIA, which asks whether reports about foodborne diseases have affected food purchase decisions. ARTICLES and MEDIA will not be used together in the regression analysis as there is a reasonable expectation that they could be correlated – higher exposure to media articles about foodborne diseases might affect food purchases. The coefficient on MEDIA is expected to be negative given the specification of the variable, where lower levels of the independent variable correspond to a greater effect of media reports on food purchases. 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.

Three variables are used to measure the stated value respondents' 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 should 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 include these additional assurances. 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.

Three dummy variables are used to represent the different sandwich types: extra food safety (MEATSAFETY), animal welfare (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. Given the economic functions of a traceability system outlined earlier, one would expect consumers to place more value on assurances that reduce information

asymmetry with respect to credence attributes relative to a simple *ex post* traceability assurance. We expect positive coefficients for the three sandwich dummy variables.

The final independent variable, AVEMKTP, measures the announced average market price during the first five rounds of bidding. This is included to capture 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. This variable is included to separate out any potential market feedback effects, and as such, there are no *a priori* expectations for the sign of the coefficient.

Separate regressions were run for the pork and beef data. The 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). This procedure allows a more accurate assessment of the bid for each sandwich type.

Table 3 reports pooled least squares estimates of the average bids for pork and beef. The numbers in parentheses are p-values and indicate the probability level at which the coefficient is significant[9].

Beef results

In the beef model, ARTICLES, LOCATION, VALUESAFE, VALUEPROCESS and the three sandwich coefficients, MEATSAFETY, HUMANETREAT and ALLATTRIBS were all highly 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 will be discussed below. The coefficients for the three sandwich dummy variables indicate that a beef sandwich with an extra food safety assurance might command a $0.33 marginal premium relative to one with only a traceability guarantee. Beef with humane animal treatment assurances had on average a $0.27 premium over beef that was traceable. Bundling traceability with both quality assurances yielded an $0.83 premium over the traceability-only sandwich[10].

The positive and highly significant coefficient on LOCATION implies that Saskatchewan respondents were willing to pay, on average, $0.29 more to exchange their sandwich with one that had additional verifiable characteristics relative to the Ontario respondents. Results for the variables VALUESAFE and VALUEPROCESS suggest that people who said they placed more value in additional food safety and production method assurances were actually willing to pay more for beef products with additional assurances.

9. *Thus if P-value < level of significance, α, we reject the hypothesis. If p-value > level of significance, α, we fail to reject the hypothesis. For example, a p-value of 0.00 indicates that the variable is significant at all values of α, whereas a p-value of 0.05 indicates that the variable is significant at the 5% confidence level, a p-value of 0.09 (or 0.10) indicates that the variable is significant at the 10% confidence level, etc.*

10. *As a percentage of the base sandwich value, $2.82, these premiums are 11% for an extra food safety assurances, 9.5% for an animal welfare assurance and 29% for a sandwich with all three attributes, relative to just traceability.*

Table 3: Results of pooled OLS regression analysis for beef and pork

Variable name	Beef	Pork
Constant	0.776567 (0.0003)	0.355021 (0.0935)
GENDER	0.047250 (0.5172)	0.014428 (0.8221)
AGE	0.001393 (0.6316)	0.003137 (0.2441)
EDUCATION	-0.013490 (0.7178)	0.041554 (0.1866)
INCOME	-0.037623 (0.2835)	0.031528 (0.2885)
LOCATION	0.286763 (0.0019)	0.033368 (0.6673)
FPOISON	0.093755 (0.1816)	-0.104349 (0.0750)
ARTICLES	-0.005248 (0.0040)	0.000755 (0.2415)
CONFSAFE	-0.054462 (0.1526)	-0.091573 (0.0240)
VALUESAFE	-0.117218 (0.0042)	-0.059164 (0.1102)
VALUETRACE	-0.021872 (0.4450)	-0.067365 (0.0157)
VALUEPROCESS	-0.104316 (0.0058)	-0.039210 (0.2460)
HUMANETREAT	0.274847 (0.0029)	0.135942 (0.0833)
MEATSAFETY	0.332459 (0.0004)	0.092634 (0.2429)
ALLATTRIBS	0.832770 (0.0000)	0.276046 (0.0020)
AVEMKTP	0.071162 (0.1087)	0.425612 (0.0000)
Adjusted R-squared	0.304657	0.428255

The negative coefficient for ARTICLES indicates that the more news articles about foodborne diseases individuals had read in the previous six months, the lower their bids for the sandwiches with the verifiable information. This is surprising and perhaps indicates that media articles on these subjects have served to reassure Canadians about food safety and quality assurance attributes in their food. Using the same model but substituting the variable MEDIA for ARTICLES resulted in a coefficient that was not statistically significant and had the wrong sign, thus ARTICLES seems to be a more appropriate variable.

The two other variables measuring food safety awareness and concern (FPOISON and CONFSAFE) were significant at the 25% level. Food poisoning experience tended to increase WTP, as expected. Lower levels of confidence in the current food safety and inspection system tended to increase WTP[11] as hypothesized. The coefficient for average market price was positive but statistically insignificant at the 5% and 10% levels, although was significant at the 25% level. There may be only limited market feedback effects in the beef data. Dickinson and Bailey (2002) suggest that it is not important whether this represents strategic bidding, instead the variable isolates this effect so that the remaining coefficient estimators are unbiased. The four demographic variables, AGE, GENDER, EDUCATION, INCOME were not statistically significant.

Pork results

The pork model yielded mixed results, some of which differ from the beef model. Attitudes towards 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. 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 an increased WTP of $0.28 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 $0.13 premium over the traceable-only sandwich[12]. The coefficient on the sandwich with the additional food safety assurance (MEATSAFETY) indicates a $0.09 premium over the traceable sandwich but this coefficient was only significant at the 25% confidence level; this result should be interpreted with caution.

The variable VALUETRACE had the expected sign and 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 sandwich. The variables VALUEPROCESS and VALUESAFE had the correct signs but were not significant at the 5% and 10% levels but did become significant if the confidence level was raised to 25%.

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 articles or media reports dealing with foodborne diseases tended to increase WTP, as expected, but this was only significant at the 25% level. These results suggest that the food safety issues were less important or there was less awareness of these issues for pork compared to beef. Age, gender and income levels did not affect WTP, and education was only significant at the 25% (19%) level, wherein higher levels of education increased WTP. Unlike the beef model, there was no statistical difference in the bids between respondents in Ontario and Saskatchewan.

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11. *As indicated earlier, this is represented by higher values of the categorical variable CONFSAFE.*

12. *As a percentage of the base sandwich value of $2.85, this represents a 4.6 percent premium over the traceable ham sandwich, compared with 9.8 percent for the sandwich with all three attributes.*

Chapter 6
Conclusion

The results of the experimental auctions suggest that respondents were willing to pay non-trivial 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. Combining traceability with these additional assurances yielded significantly more value to consumers than traceability alone. The economic value of the specific combination of traceability and quality assurances evaluated in this research appeared to be higher for beef ($0.83) than for pork ($0.28). This may reflect more media attention and therefore a heightened consumer awareness to food safety issues with respect to beef in general, such as problems with BSE and *E.Coli*.

The regression results support first impressions from a casual observation of the bid data and are consistent with the different economic functions of a traceability system discussed in this report. While traceability is clearly of some value to some consumers, traceability, by itself, may not be enough and does not address the issue of consumer information asymmetry with respect to credence quality attributes. Traceability bundled with quality assurances with respect to specific credence attributes has more appeal. This is consistent with results obtained in a comparable study of U.S. consumers (Dickinson and Bailey, 2002). *Ex post* reactive traceability systems can of course perform important economic functions 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. Traceability may be a necessary but not sufficient condition for *ex ante* verification of quality attributes.

The development of private sector traceability systems in meat supply chains is primarily driven by cost and risk reduction motivations. Traceability systems can also facilitate *ex ante* quality assurances, but they do not necessarily always provide consumers with this additional information. Although some Canadian consumers indicated a WTP for a simple traceability assurance particularly for beef, the results of the consumer research suggest that combining traceability with other quality assurances about farm production or processing methods may be a more viable product differentiation strategy in the Canadian red meat sector. To be effective as a product differentiation strategy, however, these quality assurances need to be credible. Participants in the consumer panels indicated relatively high levels of trust in public sector assurances about production methods relative to those from the private sector. The question of credible quality signals in the food industry is an important topic for further research.

Finally, a key question is what do we really mean by traceability? While there has been much discussion of traceability, there has been relatively little analysis of the economic benefits and costs of different traceability systems and assessments of whether these systems will achieve their objectives. Whether traceability should be a public or a private sector responsibility remains

an important question. Clearly, the answer depends on the degree to which market failure exists and, therefore, the extent of the information asymmetry problem. Traceability systems are evolving rapidly in meat and livestock sectors in different countries. In many cases basic livestock traceability has been mandated or is enforced through regulatory agencies. Traceability beyond the point of slaughter, however, remains by and large the purview of the private sector, with the exception of the EU beef labelling regulation. Although the EU regulation at first glance appears to be consumer-driven, in fact, it does not provide additional information for consumers on credence attributes – it is simply a means to trace beef products through the supply chain should a problem arise.

The economic model and empirical analysis presented in this report suggest that the notion of simple livestock traceback systems as a means to reduce consumers' information asymmetry is misguided. While *ex post* reactive traceability systems have an important role in limiting the extent of food safety outbreaks and in maintaining consumer confidence in an industry, they do little to reduce the *ex ante* information problem. If the objective is to reduce consumer information asymmetry with respect to quality assurances, traceability may be the wrong word to apply. It implies an *ex post* reactive process of tracing something to the source of origin, rather than *ex ante* provision of information on process attributes that verifies product quality. The research conducted for this report indicates 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. Future economic analysis of the role of traceability systems in improving food safety and food quality should distinguish between *ex ante* information provision and *ex post* traceability functions.

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Demographic Breakdown of Sample

The following presents a demographic analysis of the consumer panel participants by gender, age, education and income levels. There were 98 Ontario participants and 106 from Saskatchewan. Statistics are presented for the whole sample and broken down by location.

Gender

Table A1 shows that males were over-represented in Saskatchewan, whereas the Ontario sample was more representative of the Canadian population (50.5 percent female, 49.5 percent male) (Statistics Canada(a))

Table A1: Sample distribution by gender (%)

Gender	Male	Female
Full sample (n=204)	60.78%	39.22%
Ontario (n=98)	46.94%	53.06%
Saskatchewan (n=106)	73.58%	26.42%

Age

The Saskatchewan sample was over represented by the younger age groups relative to the Ontario sample. In general, older consumers were under-represented relative to the Canadian population. Statistics Canada data indicates that 17 percent of the Canadian population are over 60, whereas 4.41 percent of the full sample were over 60 (Statistics Canada(b)).

Table A2: Sample distribution by age (%)

Age	18-25*	26-35	36-45	46-55	56-65	>65
Full sample (n=204)	19.61%	24.02%	25.98%	20.10%	8.82%	1.47%
Ontario (n=98)	8.16%	28.57%	27.55%	23.47%	12.24%	0.00%
Saskatchewan (n=106)	30.19%	19.81%	24.53%	16.98%	5.66%	2.83%

**People had to be over 18 years of age to participate in the panels*

Education

A similar proportion of respondents at both locations had high school or grade 10 as their highest education level. While the Saskatchewan sample was over-represented by people with a graduate degree, a higher proportion of Ontario respondents had either some college or an

undergraduate degree. Relative to the Canadian population, the sample has higher education levels. This probably reflects the locations chosen for the study – both Saskatoon and Guelph are university towns, and of course the Saskatchewan sample was drawn from the university population, albeit from a cross-section of employees (faculty, maintenance and administrative staff) and students. Thirty three percent of the Saskatchewan sample were students, compared with 12 percent in Ontario.

Table A3: Sample distribution by education (%)

Education	High school or less	Some college	Undergraduate	Graduate
Full sample (n=204)	24.02%	35.29%	20.59%	20.10%
Ontario (n=98)	22.45%	44.9%	23.47%	9.18%
Saskatchewan (n=106)	25.47%	26.46%	17.92%	30.19%

Income

The higher proportion of Saskatchewan respondents in the lower income category probably reflects the fact that there were more students in this sample, although it more closely reflects Canadian income distribution. A higher proportion of the Ontario sample instead fell into the $60,000 to $90,000 income range.

Table A4: Sample distribution by annual household income (%)

Income	<$30K	$30K-$60K	$60K-$90K	>$90K
Full sample (n=204)	25.98%	27.45%	25.98%	20.59%
Ontario (n=98)	17.35%	28.57%	32.65%	21.43%
Saskatchewan (n=106)	33.96%	26.42%	19.81%	19.81%

EXPERIMENTAL AUCTION SANDWICH DESCRIPTIONS

The following information about each sandwich was provided to participants in the experimental auctions.

BEEF

The following brief descriptions of Sandwiches #1, #2, #3, and #4 highlight the ***verifiable*** characteristics of the meat in that sandwich. **Such characteristics have not been certified and cannot be verified for the meat in your current sandwich.**

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 in 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.

PORK

The following brief descriptions of Sandwiches #1, #2, #3, and #4 highlight the ***verifiable*** characteristics of the meat in that sandwich. **Such characteristics have not been certified and cannot be verified for the meat in your current sandwich.**

Sandwich #1

Certified information is available on certain *enhanced* processes and procedures used to produce the animal that provided the meat in this sandwich (e.g., this meat product has extra assurances of animal well-being and high health status of the animals—this is part of humane animal treatment, including standards that exceed the Canadian pork industry's Canadian Quality Assurance Program)

Sandwich #2

The plant that processed this meat conducts additional food safety testing (over and above the industry standard) and its ham exceeds the Canadian industry standard for (microbiological) food safety.

Sandwich #3

The meat in this sandwich can be traced back to the farm on which the animal was produced (i.e., we can identify the farm that produced the animal).

Sandwich #4

The meat in this sandwich can be traced back to the farm on which the animal was produced (i.e., we can identify the farm that produced the animal). **In addition**: (1) Certified information is available on certain *enhanced* processes and procedures used to produce the animal that provided the meat in this sandwich (e.g., this meat product has extra assurances of animal well-being and high health status of the animals—this is part of humane animal treatment, including standards that exceed the Canadian pork industry's Canadian Quality Assurance Program) and (2) The plant that processed this meat conducts additional food safety testing (over and above the industry standard) and its ham exceeds the Canadian industry standard for (microbiological) food safety.

APPENDIX C QUESTIONNAIRE

QUESTIONNAIRE

Are you: ☐ male ☐ female	Are you: ☐ married ☐ single ☐ divorced
What is your age?: _____	How many children do you have?: _____

What is the highest level of education you have ***completed***?

- ☐ High school
- ☐ Some college
- ☐ Bachelors degree
- ☐ Postgraduate degree
- ☐ Other (if so, please describe) _____

Who typically makes most decisions about food purchases in your household?: ☐ You ☐ Someone else

What is you current employment status?

- ☐ Employed _____ hours a week, $ _____ per hour in pay
  OR
  _____ hours a month, $ _____ per month in pay
- ☐ Unemployed

Are you a student? ☐ Yes ☐ No

What is your best estimate of your annual ***household*** income?

☐ <$10,000	☐ $70,000-$80,000
☐ $10,000-$20,000	☐ $80,000-$90,000
☐ $20,000-$30,000	☐ $90,000-$100,000
☐ $30,000-$40,000	☐ $100,000-$110,000
☐ $40,000-$50,000	☐ $110,000-$120,000
☐ $50,000-$60,000	☐ $120,000-$130,000
☐ $60,000-$70,000	☐ $>130,000

Have you or any member of your family had food poisoning? ☐ Yes ☐ No

If ***YES***, did it require medical attention? ☐ Yes ☐ No

Have recent media report about foodborne diseases (e.g., mad-cow disease, foot and mouth disease, etc.) affected your food purchases?

Circle one of the following

1	2	3	4	5
great effect		*some effect*		*no effect*

What is your best estimate of the number of ***news*** articles or reports that you have read or heard about on foodborne diseases in the last 6 months? _____

How much confidence do you place in the Canadian government's current food inspection and safety program?

Circle one of the following

1	2	3	4	5
complete confidence		*some confidence*		*no confidence*

QUESTIONNAIRE

Do you belong to any organization whose stated goals are to protect the environment and/or protect animals? ☐ Yes ☐ No

Would you value having additional assurances, beyond what is currently provided by the Canadian government, about ***meat*** safety?

Circle one of the following

1	2	3	4	5
highly value		some value		no value at all

Would you value knowing the exact farm that produced the animals for the meat you consume?

Circle one of the following

1	2	3	4	5
highly value		some value		no value at all

Would you value knowing the procedures and processes used by the farmer to produce the animal for the meat you consume (e.g., treatment of animals, foods and medications used, presence or absence genetically modified organisms, etc.)?

Circle one of the following

1	2	3	4	5
highly value		*some value*		*no value at all*

If you value the information from question 17, is it because:

Circle one of the following

a) You want more confidence about safety and/or quality of the meat you purchase

b) You want to be able to identify the source of the problem, should one arise

c) Other (please describe) _____

_____

_____

Which source would you ***most*** and ***least*** trust to provide the information from question 17?

To provide this information I would ***most (least)*** trust:	Please circle your ***most (only one)*** and ***least (only one)*** trusted		Comments (why would you most or least trust the source)
1) The Canadian government (Canadian Food Inspection Agency or Agriculture and Agri-Food Canada)	***most***	***least***	_____
2) The provincial government	***most***	***least***	_____
3) A beef industry association (Canadian Cattlemen's Association)[a]	***most***	***least***	_____
4) The company that processed and packaged the meat	***most***	***least***	_____
5) The retailer where I buy the meat	***most***	***least***	_____
6) An animal welfare group or environmental (PETA - People for the Ethical Treatment of Animals or Greenpeace)	***most***	***least***	_____
7) An independent quality assurance firm	***most***	***least***	_____
8) Other (please specify) _____	***most***	***least***	_____
9) I wouldn't trust any such assurance	***most***	***least***	_____

What would you normally pay for a meat sandwich similar to the one you were given at the start of the experiment (not the auction sandwiches, but your original one)? _____

Please just enter your estimate of the value of the original sandwich, ***not*** the value of the entire lunch

Where would you buy such a sandwich? (that is, what type of store specifically) _____

a. For the pork questionnaire, this category read "A pork industry association (e.g. Canadian Pork Council)"