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COW-CALF PRODUCER PREFERENCES FOR
VOLUNTARY TRACEABILITY SYSTEMS AND SYSTEM
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Lee L. Schulz

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COW-CALF PRODUCER PREFERENCES FOR VOLUNTARY TRACEABILITY SYSTEMS AND SYSTEM ATTRIBUTES

By

Lee L. Schulz

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ABSTRACT

COW-CALF PRODUCER PREFERENCES FOR VOLUNTARY TRACEABILITY SYSTEMS AND SYSTEM ATTRIBUTES

By

Lee L. Schulz

Substantial losses can occur if animal identification systems cannot quickly and adequately identify individual animals, the premises where they were located, and their movements throughout production and processing. This creates a need met by this study in determining how traceability systems should be designed and promoted in order to improve voluntary participation rate. This research utilized a survey of U.S. cow-calf producers to identify cow-calf producer preferences and perceptions regarding voluntary traceability systems and system attributes and in turn determined what type of voluntary traceability systems would receive the greatest support. Meeting this core objective allowed for better identification of the potential success of alternative voluntary traceability systems that could exist in the beef industry. A second tier of research questions included examinations of mandatory vs. voluntary NAIS preferences, self-revelation of current NAIS participation, and the most current concerns and important issues to cow-calf producers regarding traceability. Results have policy implications as the optimal voluntary traceability system hinges critically upon cow-calf producer perceptions of traceability systems and system attributes. Results indicate the importance of considering producers' perceptions and preferences regarding traceability when designing traceability systems.

Dedicated to my Mom and Dad

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KEY TO SYMBOLS AND ABBREVIATIONS

Abbreviation	Definition
AIN	Individual Animal Identification Number
APHIS	Animal, Plant Health Inspection Service
BSE	Bovine Spongiform Encephalopathy
COOL	Country-of-Origin Labeling
CDF	Cumulative Distribution Function
ERS	Economic Research Service
FMD	Foot and Mouth Disease
GAO	Government Accountability Office
HACCP	Hazard Analysis Critical Control Points
ID	Identification
IIA	Independence of Irrelevent Alternatives
IRB	Institutional Review Board
LCM	Latent Classification Model
ME	Mean Marginal Effects
MLE	Maximum Likelihood Estimation
MNL	Multinomial Logit
NAIS	National Animal Identification System
NIWP	National Identification Work Plan
PIN	Premises Identification Number
PVP	Process Verified Program
QSA	Quality Assessment Program
RFID	Radio Frequency Identification
RPL	Random Parameter Logit
TTA	Traceability, Transparency, and Enhanced Quality Assurances
UCRIHS	University Committee on Research Involving Human Subjects
U.S.	United States
USAIP	United States Animal Identification Plan
USDA	United States Department of Agriculture
WTA	Willingness-to-Accept
WTP	Willingness-to-Pay

CHAPTER 1: INTRODUCTION

1.1 Problem Statement

Substantial losses can occur if animal identification systems cannot quickly and adequately identify individual animals, the premises where they were located, and their movements throughout production and processing. Recent events both domestically and internationally have identified the need for animal identification systems. One of these events was the announcement on December 23, 2003 that a cow in the U.S. was diagnosed with Bovine Spongiform Encephalopathy (BSE or Mad-Cow Disease). Even though consumer demand in the United States (U.S.) for beef products remained strong in the weeks following the announcement, the U.S. beef industry and U.S. government recognized the need for a traceability system that went beyond the current U.S. system which was not designed to routinely track individual or groups of animals once they leave a premise.

The National Identification Work Plan (NIWP) was the first official public effort in the U.S. to examine the possible implementation of a U.S. animal identification (ID) system. The NIWP was developed by a task force formed in April 2002 consisting of over thirty livestock organizations and was coordinated through the National Institute for Animal Agriculture. The working plan for the implementation of the animal ID system as suggested by the NIWP was later called the U.S. Animal Identification Plan (USAIP) in 2003. The USAIP called for the establishment of individual premises ID by the summer of 2004, individual animal ID by 2005, and full implementation and compliance (all covered species and their movements - both interstate and intrastate) by July 2006 (Bailey and Slade, 2004).

Many of the efforts for these initial goals saw opposition and encountered many obstacles. Through this initial groundwork, the United States Department of Agriculture (USDA), Animal, Plant Health Inspection Service (APHIS) has attempted to implement a nationwide beef traceability system to help producers and animal health officials respond quickly and effectively to animal disease outbreaks (e.g., Foot and Mouth Disease-FMD, Bovine Spongiform Encephalopathy-BSE, etc.) and food recalls (e.g., ground beef due to E. coli O157:H7). With traceability taking the forefront of supply chain issues, the reality is that traceability systems are imminent, whether voluntary as they currently are or mandatory, which have been discussed within the industry. Many of the efforts of the USAIP have evolved into the National Animal Identification System (NAIS) with the only significant difference being that NAIS is listed as "tech neutral" in its policies relating to animal identification, meaning that NAIS eliminated radio frequency identification (RFID) as the stated standard for animal ID. The National Animal Identification System is the broadest and most comprehensive effort ever launched in the U.S. to enhance the ability to quickly identify and contact animal premises, promote animal identification, and develop animal movement and tracing capabilities (Schroeder et al., 2007). Initial deadlines for full implementation and compliance have elapsed with participation rates for the establishment of individual premises ID and individual animal ID below expectation. This creates a need met by this study in determining how traceability systems should be designed and promoted in order to improve voluntary participation rate. Furthermore, a national livestock ID system can be used to launch more extensive quality assurance programs.

In addition to animal health management, U.S. and international consumers demand meat product safety assurances and they have revealed a willingness-to-pay (WTP) for meat traceability (Dickinson and Bailey, 2002; Hobbs, 2003) and for attributes that could easily be verified by traceability systems (Loureiro and Umberger, 2003). Traceability is being used as the basis of competitive product differentiation strategies by food firms seeking to assure consumers of the presence of credence attributes related to production or processing methods (Hobbs, 2006) as well as by producers who seek proactive information and quality verification throughout production.

Because cow-calf producers are the first player in the beef supply chain and vary widely in scale and production practices of their operations, it is crucial to consider the demographics and perceptions of cow-calf producers when attempting to implement industry-wide programs/systems. This is especially important when attempting to implement individual animal traceability and maximize participation rates of these systems as the views of these producers will most certainly impact the success or failure of these efforts.

1.2 Scope

One of the core objectives of this research was to determine preferences cow-calf producers have for alternative voluntary traceability systems and their attributes. Questions addressed include, how sensitive are producer preferences to price adjustments (premiums/discounts), what are producer preferences for the entity maintaining data, and what composition of additional advanced traceability information (e.g., age verification vs. production practice information) maximizes expected voluntary participation rates?

Furthermore, how do producer demographics, perceptions, and current production/technology practices affect each of these questions and are these impacts homogeneous or heterogeneous across producers? A second tier of research questions included examinations of mandatory vs. voluntary NAIS preferences, self-revelation of current NAIS participation, and the most current concerns and important issues to cow-calf producers regarding traceability. In addition, our analysis obtained producer forecasts of expected voluntary participation rates, self-revelation of current participation, and examination of other issues to improve government and industry efforts to further increase voluntary traceability participation in the U.S. cow-calf industry.

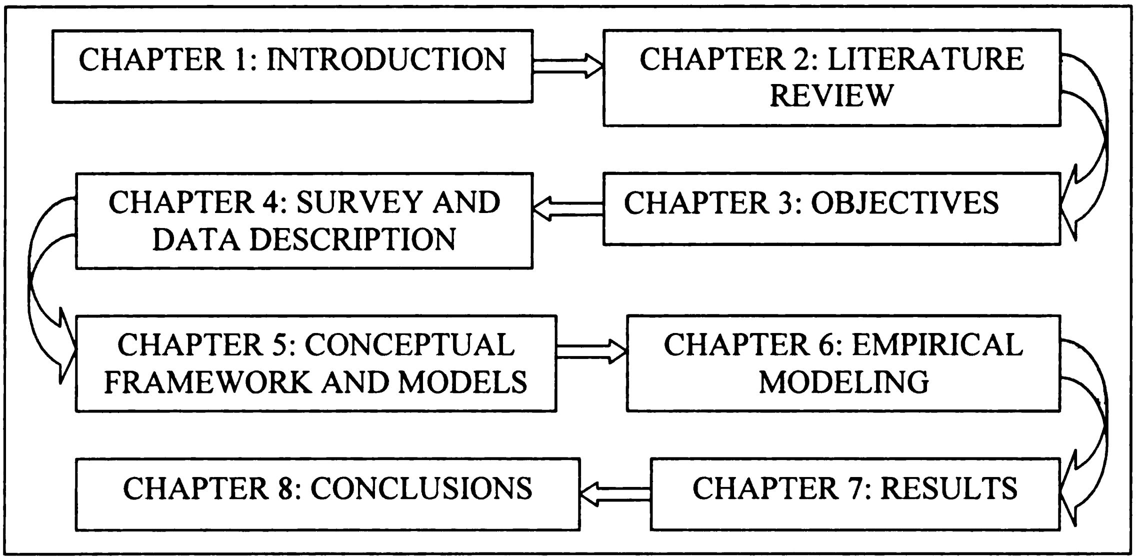
Various methods were employed in model specification including: multinomial Logit (MNL), random parameter Logit (RPL), and latent classification models (LCM) for examining producer preferences for traceability participation, Probit models for examining producer perceptions and current practices regarding traceability systems, and Tobit models to identify the most optimistic and pessimistic of producers regarding future voluntary participation rates. For each research question addressed, alternative model specifications were used to identify the impact of producer demographics and perceptions, while also considering producer heterogeneity.

Results have policy implications as the optimal voluntary traceability system hinges critically upon cow-calf producer perceptions of traceability system attributes. Overall, this research was able to provide valuable information for future policy deliberations and may assist organizations in charge of program administration to better manage resources used in animal ID practices.

1.3 Organization of Thesis

The thesis proceeds in the following manner: Chapter 2 reviews the literature drawing reference from existing traceability systems, shows how traceability has and will continue to be vital to the beef industry, and overviews methods used to analyze preferences of cow-calf producers; Chapter 3 identifies the objectives of this research; Chapter 4 gives a description of the cow-calf producer survey including the design and data obtained; Chapter 5 provides the conceptual framework and models; Chapter 6 describes the empirical modeling to be used in estimation; Chapter 7 applies the modeling techniques to the data to give results and policy implications; and Chapter 8 summarizes and concludes. Figure 1.1 is provided as a visual flow chart of the thesis.

Figure 1.1. Organization of Thesis



CHAPTER 2: LITERATURE REVIEW

The literature review provides information regarding traceability systems and the methods used for determining cow-calf producer preferences for voluntary traceability systems and attributes. The literature review is divided into for main sections: (1) Traceability System Definition, (2) Economics and Current Status of Traceability Systems, (3) Consumer Impacts/Preferences for Traceability, and (4) Work Needed.

2.1 Traceability System Definition

There is no international agreement or a "one-type-fits-all" definition of traceability; however, past literature has provided various definitions of traceability. Bulut and Lawrence (2007) provide a collection of traceability definitions. The International Organization for Standardization (ISO 9001, 2000) defines traceability as "the ability to trace the history, application, or location of an entity by means of recorded identifications" (The Food Business Forum, 2005). Golan et al. (2004) found this definition quite broad and suggests: "record keeping systems that are designed to track the flow of product or product attributes through the production or supply chain". According to Smyth and Phillips (2002), the supply chain literature sees traceability as "(an) information system necessary to provide history of products and services from origin to the point of sale." Mennecke et al. (2006) define traceability as "the ability to retrieve the history, treatment, and location of the animal that a cut of meat comes from, through a recordkeeping and an audit system or registered identification program" (Bulut, and Lawrence, 2007).

More specifically within the beef supply chain, full 'gate to plate' or 'farm to fork' traceability is an extensive form of beef traceability which provides the ability to follow products forward from their source animal (i.e., birth or ancestry), through growth and feeding, slaughter, processing, and distribution, to the point of sale or consumption (or backward from the consumer to the source animal) (Becker, 2007). Particularly, a two-part-system has developed in the beef and cattle industry; meat traceability and live animal traceability (Bulut and Lawrence, 2007). Linking these two systems at the stage of slaughter and processing is an ongoing challenge for the industry (Golan et al., 2004).

For this two-part system it is important to define certain aspects of traceability. Bulut and Lawrence (2007) provide definitions of external traceability, internal traceability, chain traceability, forward traceability, and backward traceability. External traceability refers to traceability of product or product attributes through the successive stages of production (e.g. cow-calf producer, auction barn, feedlot, slaughter, and processing). Where as, internal traceability refers to traceability within the plant or production unit, which may be a part of Hazard Analysis Critical Control Points (HACCP) plans. External traceability may require some degree of internal traceability (Lupin, 2006). Chain traceability refers to traceability throughout the entire food chain. Backward traceability, traceback, or tracing is defined as "the ability to identify the origin of a particular unit and/or batch of product located within the supply chain by reference to records held upstream" (New Zealand Trade and Enterprise, 2006). Forward traceability, traceforward, traceup, or tracking is defined as "the ability to follow the path of a specified unit of a product and/or batch through the supply chain as it moves between organizations toward the final point-of-sale or point-of-service" (New Zealand Trade and Enterprise, 2006).

Liddell and Bailey (2001) further distinguish traceability from transparency and quality assurance notions. Transparency refers to the public availability of production information at each stage of production and quality assurances refer to practices to ensure food quality and safety, which could be intrinsic such as back fat and curing or extrinsic such as animal welfare and environmental preservation (Bulut and Lawrence 2007).

2.1.1 Meat Traceability

Smith et al. (2000) define meat traceability as the ability to identify the origin of animals or meat as far back in the production sequence as necessary to ascertain ownership, identify parentage, assure safety and determine compliance in branded or source-verified beef programs. A method commonly referred to as farm-to-retail traceability is a system that maintains the identity of all cuts from the farm through the cutting and distribution system. Farm-to-retail tracability is very expensive and essentially requires new construction and extensive capital investment and data infrastructure. This type of system is very rare although many consumers think that this is the system in place for beef (Jensen and Hayes, 2006). A more common type of traceability involves traceability from the farm-to-carcass. This type of system is termed batch traceability. The life history of the animal is tracked for each carcass or primal cut, but the ability to trace the animal parts through the cutting floor is lost. Instead, the meat is cut and processed in batches. The final retail product can be traced to a particular batch in the processing plant. This type of system is relatively inexpensive, especially if the batches are large (Jensen and Hayes, 2006). For U.S. meat slaughter and processing plants, traceability is currently voluntary beyond the record keeping required by Federal Meat Inspection Act, Wholesome Meat Act, HACCP plans of 1996, and BSE regulations of 2004 (Bulut and Lawrence, 2007).

Past literature provides definitions and descriptions of the roles and functions of meat traceability. Sanderson and Hobbs (2006) have broadly defined, five roles of traceability systems that include: (i) improve inventory and logistic management; (ii) improve management of food recalls in the event of a food safety problem; (iii) limit the broader (public) impacts of food safety and/or herd health problems; (iv) strengthen due diligence and liability incentives; and (v) create demand side incentives, including facilitating product differentiation strategies and provide stronger economic signals to producers.

Many of the roles of traceability are served by the functions in which the systems serve. Traceability serves as a reactive function, which means reduction of both the cost of a recall and damage to a reputation caused by a delayed or slow recall. Traceability also allows liability for food/product safety problems to be more easily established along the supply chain, hence, there is an incentive for firms to produce safe, high quality, food. Furthermore, information costs arising from quality verification for consumers are reduced by facilitating the labeling of credence attributes, including those related to food safety, animal welfare, environmentally-friendly production practices, etc. (Golan et al., 2003; Hobbs, 2003). Two final functions that these traceability systems perform is to provide information ex ante on quality attributes, enabling consumers with an ethical objection or food safety concerns to avoid the product and the systems may help prevent or punish false labeling (Hobbs, 2004).

Hobbs (2004) notes that the key features of a traceability system depend on the attribute that drives its development and highlight the need to consider fully the nature of the information asymmetry problem before implementing a traceability system. The diversification in the roles and functions of traceability systems contribute greatly to how and why traceability systems differ. Further discussion and analysis in this thesis will be based on live animal traceability, leaving meat traceability issues for future research.

2.1.2 Live Animal Traceability

Live animal traceability can be accomplished via a variety of systems; an example being NAIS which is currently scheduled to be fully implemented in 2009 (Bulut and Lawrence, 2007). The main function of these live animal traceability systems is to quickly identify agricultural premises exposed to an animal disease so that the disease can be more effectively controlled or eradicated. The USDA (2005) has set a long-term goal of 48 hour traceback. Furthermore, live animal traceability provides proactive information and quality verification, which is essentially an increase in production information available to producers throughout the supply chain.

More specifically related to livestock and in this case beef cattle, traceability is a system that can identify individual animals or groups of animals, the premises where they are located, and the date of entry to each premises. Traceability systems vary greatly with some systems being deep and tracking beef and beef cuts from the retailer back to the farm, while other systems only extend back to a key point in the production process.

Some systems are very precise tracking product to the minute of production, exact premises produced at, and animals commingled with. Others are less precise, tracking cattle only to premises in a large geographical area. Finally, some traceability systems collect and track information on a broad range of attributes, while others collect and track only a few.

There are certain differences among traceability systems and in order to understand these differences, standard characterization of these systems is helpful and assists in defining the function of a particular system. These standard characterizations may be made in terms of their breadth, depth, and precision (Golan et al., 2004). Breadth is the amount of information recorded by the traceability system and could include information such as age verification, production practice information, performance/genetic information, health records as well as a host of additional information. Depth describes how far back or forwards the system tracks. A deeper system will enable the establishment of links among more agents further up or down the supply chain, where as a broader traceability system enables tracking of a larger variety of attributes throughout supply chains. In most cases, the depth of a system is largely determined by its breadth because once the firm or regulator has decided which attributes are worth tracking, the depth of the system is fundamentally determined (Mus, 2006). Precision reflects the ability of the system to pinpoint an attribute of interest. One example in the supply chain may be pinpointing a particular wholesale or retail cut of beef to an animal or lot of beef to a processing plant. That is, the unit of analysis used in the system and the acceptable error rate determines precision (Golan et al., 2004).

Ever since traceability has been brought to the public eye, the concept has been confused with that of animal ID. Animal ID is indispensable for live animal/meat traceability to work effectively, but in addition to the ID of animals, traceability often requires premises to be identified and cross-checking of data. Animal ID is critical for proving ownership and providing a means to track or trace animals; so, coupled with premise registration and data management, ID can be utilized in a traceability system. It is important to note that ID and traceability are not ends in themselves, but rather means or tools available to achieve a given objective. To the extent that it is understood that traceability is a tool, that ID is one of the aspects of traceability, and that it goes hand-in-hand with the analysis of recorded information, the various components involved can be successfully implemented (Ammendrup and Barcos, 2006). Traceability systems allow producers and animal health officials to respond more quickly and effectively to animal disease outbreaks, provide the basis for certifications, and provide valuable production information for producers and consumers.

Because no single recipe can be provided for traceability, responsibility and design typically falls on the different sectors, trading partners, and parties defining the objectives and implementing the traceability systems. Undeniably, economic and technical decisions on which type of traceability system should be designed and implemented involve trade-offs between system features and their related benefits and costs (Souza-Monteiro and Caswell, 2004).

2.2 Economics and Current Status of Traceability Systems

2.2.1 Economics of Traceability Systems

Economics of traceability systems involves describing the economic incentives motivating traceability systems. The economic incentives pushing these new systems originate from the forces changing the meat marketplace and include improving animal health management and rapid response systems, meeting consumer demands for meat safety, maintaining and building international trade, verifying product credence attributes, properly assigning liability, and in improving management throughout the meat supply chain (Tonsor and Schroeder, 2006).

Traceability is key to improving animal health management because it allows for quick and effective response to an animal disease event (whether it is a single incident or a full-scale outbreak). Retrieving animal location and movement data within a short time frame (i.e., USDA (2005) long-term goal of 48 hour traceback) is necessary for efficient, effective disease containment.

Consumers have become increasingly concerned about the processes (i.e., inputs and methods) used to produce the beef that they eat and the intrinsic quality attributes (i.e., tenderness and nutrition) that beef possesses. Food safety and food quality issues have moved to the forefront of consumer concerns; this is much attributed to high profile food safety scares.

If competitors are able to differentiate their beef and beef products as being superior to U.S. products in terms of the additional attributes provided and verified, the U.S. may lose market share in various international export markets. A prime example of this is the effect of food safety concerns on Japanese markets, including the discovery of

BSE in the U.S., which lead to heightened import restrictions and regulations. Japan was (from 1991 to 2003) the U.S.'s principal export market for beef and such concerns have lead to a loss of U.S. market share, because competitors such as Australia have succeeded in convincing Japanese buyers that their products are "safer" than U.S. products because their system provides more assurances than the U.S. system (Dickinson and Bailey, 2002). Finally, consumers may simply be willing to pay for traceable beef and a market opportunity may be lost to U.S. producers if such products are not produced in the U.S. (Dickinson and Bailey, 2002). Therefore, the increasing likelihood of losing export markets, due to the failure to instill confidence in foreign consumers (or in foreign political leaders) of the beef industry's ability to produce safe food, offers an increasing return to implementing a traceability system in the U.S. beef industry (Golan et al., 2004).

Traceability provides information on the quality of the product, because traceability systems allow producers and consumers to observe more of the production process. Traceability systems may help to verify the existence of credence attributes and can instill additional confidence in consumers that they are in fact purchasing a product possessing the characteristics they desire (Tonsor and Schroeder, 2006). Credence attributes are those quality attributes that are of concern for the consumer, but where no clues are accessible in the process of buying and consuming to confirm the attributes existence (Becker, 2000; Tonsor and Schroeder, 2006). Some examples of credence attributes offered by Hobbs (2003c) include: enhanced food safety practices on the farm or in the processing plant. Alternatively, they may identify credence attributes with respect to the reduction of environmental externalities or those related to ethical preferences with respect to animal welfare.

Tonsor and Schroeder (2006) indicate that traceability systems do not alter the liability of an event; however, they can provide useful information in properly accessing legal responsibility by those involved in the production chain. An economic argument for adopting traceability systems arises from the threat of civil legal action against a firm producing unsafe food and the resulting financial damages including legal penalties, damages to a firm's reputation, and its loss of brand capital. The ability to trace products allows liability for food safety problems to be more easily established along the supply chain and reduces the monitoring and enforcement costs for consumers and downstream food distributors by identifying the party at fault and in seeking legal compensation (Hobbs, 2004)

Golan et al. (2004) and Mus (2006) defined improving management throughout the beef supply chain as the ability of a firm to reduce the cost such as movement, storage, and control of products in the supply chain and listed this as a main determinant for a company to be successful. Companies operate in the food industry where profit margins are very low, thus, supply-side management has become increasingly important for firms to remain competitive in the market. Therefore, an effective and efficient traceability system is a key factor to reducing the cost associated with the above given supply-related activities. Brester (2002) and Tonsor and Schroeder (2006) also note that implementation of a traceability system in the beef industry may aid in bringing the beef industry's ability to transfer information throughout the production process and become more competitive with the pork and poultry industries.

2.2.2 Current Status of Traceability Systems

Golan et al. (2004) report the existence of several beef traceability systems in the U.S. Though state authorities have promoted some, current systems have been mainly private and market driven. The National Animal Identification System is the well known federal beef traceability system which evolved from previous efforts to implement a national voluntary beef traceability system. The National Institute for Animal Agriculture assembled a task force in April 2002 to create the NIWP, which was later called the USAIP as presented in 2003. The USAIP called for the establishment of individual premise ID by the summer of 2004, individual animal ID by 2005, and full implementation and compliance (all covered species and their movements - both interstate and intrastate) by July 2006 (Bailey and Slade, 2004). When USDA adopted the plan it was renamed NAIS. The National Animal Identification System has become quite well known among U.S. livestock producer groups after December 2003 when a dairy cow in the state of Washington was diagnosed with bovine Spongiform Encephalopathy (BSE or Mad Cow Disease). Many of the efforts and goals of NAIS, as it was originally developed and implemented, saw opposition and encountered many obstacles. The National Animal Identification System was initiated to enhance previously existing disease programs through the establishment of standards that could be used for all state/federal disease programs nationwide. The focus of NAIS is on animals that enter commerce, that is, those animals that move from their farm and ranch to markets and/or locations where they commingle with animals from other premises. This is where the impact of a disease is the greatest, both in terms of value of animals and the potential cost of lost production (Cattle Network, 2008).

The following NAIS component descriptions were taken from the NAIS website (USDA APHIS, 2008). Premise registration is the foundation of NAIS and is seen as fundamental to containing animal diseases. Owners of premises involved in production or commerce of animals can voluntarily register their premises with their state or tribal animal health authority. Once registered, their premises are assigned a unique premises identification number (PIN) that corresponds to the contact information that was voluntarily provided. Producers who choose to participate in voluntary premises registration will be notified quickly when a disease outbreak or other animal health event might put their animals at risk. It is important to note that registering premises does not require producers to participate in the other two NAIS components (animal ID and animal tracing as described below). As of July 6, 2008 only about 32.86% of the 1,438,280 estimated premises nation-wide were registered (USDA APHIS, 2008).

Animal ID is the second voluntary component of NAIS. Animal ID, whether individual or group/lot provides producers and owners a uniform numbering system for their animals to help manage them more closely. The individual animal identification number (AIN) is unique and stays with the animal for its lifetime. This number allows the data base to link the animal to its birthplace or premises of origin; when combined with animal tracing, the AIN also allows the data base to link the animal to each premises/location that has been reported for it. The Animal and Plant Health Inspection Service allow firms to use supplemental technologies such as a RFID and compatible ear tags as a part of their identification system (USDA APHIS, 2008; Mus, 2006). Animal ID offers a valuable tool for producers and owners whose animals enter commercial production or move to locations where they come into contact with animals from multiple/other premises. In these situations, there is an increased potential for the animals to be exposed to or impact the spread of disease. Individual ID is many times the standard for animal ID; however, group/lot identification is best suited for animals that "stay together" and are raised as one group (e.g., poultry). When animals "stay together," individual ID of each animal in the group is not necessary because it would not enhance disease response efforts. In addition to protecting animal health, animal ID is many times used as a valuable tool for other, "non-NAIS" purposes - such as animal management, genetic improvement, and marketing opportunities. When used in conjunction with other NAIS components, animal ID can also help protect producers' access to markets. If a disease outbreak or other animal health event occurs, and a producer's animals are not linked to any affected premises or areas, they could use animal ID numbers and movement records (included in the third NAIS component) to demonstrate that their animals are disease free. Producers may choose whether to submit their information to a privately-held or state-held database. Animal health officials will only request access to animal ID records in the case of an animal health event (USDA APHIS, 2008).

Animal tracing is the final component of NAIS and is under development by states and the private sector. Once this component is complete, animal tracing should offer an additional option to improve animal management and better protect animal health. Producers will be able to choose an animal tracking database (owned and operated by private industry groups or states) and report certain animal movements that might pose a significant risk of disease transmission. When there is a disease outbreak or other animal health event, the animal tracking databases provide timely, accurate records that show where animals have been and what other animals have come into contact with them. Once the animal tracing component is complete, there will be several important points to consider when choosing whether to participate. Participating in animal tracing helps animal health officials receive accurate information about where a disease outbreak or other animal health event is occurring. Under NAIS, USDA will not have direct access to animal movement records. Private or state databases will house and maintain information regarding animal movements. Federal and state animal health officials will request access to this information only if a disease or animal health event - such as an outbreak of avian influenza or brucellosis - occurs. Federal law protects individuals' private information and confidential business information from disclosure (USDA APHIS, 2008).

Private sector traceability initiatives in the beef industry include individual supply chain initiatives and industry-wide programs. Within some of these programs, firms provide voluntary labeling of credence attributes and sometimes these programs are supplemented by third party certification. Credence attributes are defined as attributes that cannot be determined even after purchase or consumption, such as animal welfare or organic production (Weiss, 1995; Roberts et al., 1996). The credence nature of food safety and quality attributes may lead to markets being dominated by low-quality products if producers of high-quality (or "safer") food are unable to offer credible assurances to consumers (Golan et al., 2003; Hobbs, 2004). Supply chain partnerships delivering traceability have emerged for multiple reasons including to help deal with the loss of consumer confidence. The meat processing sector has also recognized the potential role of traceability in bolstering consumer confidence, and as a product differentiation strategy (Hobbs, 2003b). The emergence of traceability systems in the private sector can also be seen as a result of pressure from downstream food retailers who are motivated by the desire to reduce risk exposure or reduce the information costs of monitoring product quality or downstream production methods (Hobbs, 2003b). Finally, industry associations or producer groups have been responsible for introducing industry-wide private sector traceability programs.

Many of these U.S. private industry associations or producer group traceability systems tend to be motivated by economic incentives, not government traceability regulation. These private systems allow for the verification of many USDA accredited claims, such as age and source verification, organic, natural, etc. On the private, state, and national level the USDA has utilized Process Verified Programs (PVP) and Quality Assessment Programs (QSA) that have been historically used for verification purposes in many industries and for a variety of products. In the case of U.S. beef cattle the USDA has established PVP's and QSA's to ensure the credibility and authenticity of the process claims being made about traceable beef products. This includes claims such as: age and source verified, organic, etc. Currently PVP and QSA programs exist to back these claims and traceability systems are implicit in PVP and QSA programs for ensuring credibility and authenticity. Some countries require U.S. beef exporters to be accredited under a USDA Export Verification Program.

2.3 Consumer Impacts/Preferences

Past studies have focused on the value of information that characterizes products that could either be placed on labels or communicated to consumers in other ways. For example, research has recently focused on consumer acceptance of and government policy toward genetically modified (GM) food products (e.g., Caswell, 2000; Huffman et al., 2003a,b; and Lusk, Roosen, and Fox, 2003). Other research has examined the value to consumers of providing information of different single or bundled characteristics, including certifying enhanced food safety, the processes used to produce food, the location in which food was produced, or the certifying agency (e.g., Dickinson, Hobbs, and Bailey, 2003; Loureiro and Umberger, 2006). A few studies have addressed the issue of traceability directly and have found traceability to be a valuable characteristic in food products (e.g., Dickinson and Bailey, 2002).

Dickinson, Hobbs, and Bailey (2003) examined consumer WTP in Canada and the U.S. for traceability, transparency, and enhanced quality assurances (TTA) characteristics in red meat products. According to Liddell and Bailey (2001) traceability is sometimes called identity preservation and is defined as the ability to track the inputs used to produce food products backward and forward to/from their source at different levels of the marketing chain. Baines and Davies (1998) and Early (1998) indicate that transparency refers to the public availability of information on all the rules, procedures, and practices used to produce a food product at each level of the marketing chain. Enhanced quality assurances that can be provided by TTA are referred to as "extrinsic" qualities by Baines and Davies (1998) and are characteristics that affect neither food safety nor typical government grading, but which are still valued by consumers. This was an important analysis because valuable comparisons were identified considering the Canadian red-meat industry was moving toward more TTA, especially traceability, while the U.S. red-meat industry had been much slower in adopting TTA protocols. A sealed-bid Vickery style auction was the main instrument used to gain information and followed the basic design suggested in Shogren et al. (1994) for eliciting bids to upgrade a meat sandwich, thus determining consumers WTP for traceability and assured quality assurances. Results for both countries were very similar in how preferences for the characteristics were ordered, and they were also similar in comparing the average bids for characteristics, hence a very close correlation was found between consumers' WTP in both countries. One important note from this study was that traceability, while receiving positive bids, was the least valued of the three individual characteristics presented to consumers (e.g., animal welfare, food safety, and traceability). Dickinson, Hobbs, and Bailey (2003) suggested that traceability should be bundled with other characteristics that could be verified with traceability when food products were marketed with these characteristics.

Another related study by Loureiro and Umberger (2006) determined the relative value U.S. consumers place on several beef attributes including: traceability, country-of-origin labeling (COOL), food safety inspection, and tenderness. A mail survey was used to solicit information regarding respondents' purchasing behavior and attitudes about beef products, beef qualities found most desirable, food safety attitudes, questions involving a choice modeling experiment, and socio-demographics. Findings in this study were comparable to that of Dickinson, Hobbs, and Bailey (2003) which found that consumers placed the highest relative value on food safety certification.

In a study addressing the issue of traceability directly results by Dickinson and Bailey (2002) suggest that although traceability for beef products was found to be valued to some extent; subjects placed an even larger value on specific attributes that might be verified by a traceable meat system. Bids for beef traceability were statistically lower than bids for both animal treatment assurances and bids for increased food safety.

2.4 Work Needed

The only known economic study examining beef industry perceptions and preference is Bailey and Slade (2004) who conducted a survey to measure the level of support among state veterinarians and representatives of producer groups. They examined how support for a specific animal ID proposal (USAIP) varied based on concerns about animal health and the perceived costs and benefits accrued to different levels of the marketing chain. Of most importance are the representatives of the producer groups because producers will likely incur a majority of the costs. The study found that over 90% of state cattle producer association respondents indicated support for a national cattle ID program, while only 41% indicated that they supported the USAIP (Bailey and Slade, 2004). The results of this study provide evidence showing that producers do support traceability. The lack of confidence in initial programs, as indicated by the 41% in favor of the USAIP, documents the need for determining the most important characteristics/attributes of voluntary traceability systems to aid in design and promotion of a more accepted traceability system. This in turn should help increase voluntary participation rate amongst producers in voluntary systems.

A majority of the past research has sought to analyze consumer's perceptions towards voluntary traceability systems; however, there has been little research on producer's perceptions towards these same traceability systems. This thesis sets forth models that will examine cow-calf producer's preferences for traceability systems and system attributes which may be characterized by heterogeneity. Throughout this thesis, the term preference heterogeneity refers to variability or differences between preferences of producers. Accounting for heterogeneity of producers will be useful in estimating unbiased models. Incorporating and understanding heterogeneity may provide information on the distributional effects of traceability policy alternatives.

CHAPTER 3: OBJECTIVES

The overall purpose of this research was to identify U.S. cow-calf producer preferences and perceptions regarding voluntary beef traceability systems. Meeting this core objective allowed for better identification of the potential success of alternative voluntary traceability systems that could exist in the beef industry. This "potential success" was primarily measured by producers' preferences for traceability systems varying in attributes including premiums and discounts, entities maintaining traceability data, and the quantity and type of maintained information. This analysis sought to build upon the existing literature and prior traceability system studies by gathering and analyzing survey data from cow-calf producers to allow for the economic analysis of various voluntary traceability systems. Survey data was used to parameterize the economic analysis and inform the discussion regarding implications of traceability system design and promotion.

This research sets the groundwork for identifying participation rates for various traceability programs, which future research could utilize to obtain conclusions regarding animal disease response implications. Increasing voluntary participation rate should allow producers and animal health officials to respond more quickly and effectively to animal disease outbreaks in the U.S. Furthermore, a national livestock identification system can be used to launch more extensive quality assurance programs. This type of traceability system may be used as a platform on which additional quality assurances can be provided to producers further down the supply chain and to consumers. Traceability systems that are most aligned with the preferences of cow-calf producers will experience higher voluntary participation. However, traceability systems based solely on cow-calf producer preferences may not maximize the nation's ability to respond to animal disease or meet alternative goals of nationwide traceability systems. Producers and animal health officials must be conscious that lower voluntary participation in a stringent system may well be better than higher voluntary participation in a weaker system for accomplishing many of the traceability system initiatives and goals.

In order to achieve the main purpose of the study as laid out above, the research was set up where a first tier of objectives was identified as well as a second tier of objectives. These objectives identified hypotheses to be evaluated which provided guidance in subsequent chapters in properly analyzing these objectives. An outline of the tier 1 objectives is as follows:

- Tier 1: Determine preferences of cow-calf producers for alternative voluntary traceability systems and system attributes.
  - Objective 1.1: Evaluate how sensitive producer preferences are to price adjustments (premiums/discounts).
  - Objective 1.2: Examine if producer preferences are sensitive to the entity in charge of data maintenance.
  - Objective 1.3: Examine how the inclusion of additional information requirements affects voluntary participation rate.
  - Objective 1.4: Investigate how producers' welfare is affected if alternative levels of traceability become mandatory.
  - Objective 1.5: Identify if producer preferences are sensitive to producer demographics, perceptions, and current production/technology practices.

The core objective of this study was to determine what preferences cow-calf producers have for alternative voluntary traceability systems and system attributes. This core objective led to evaluating a key hypothesis of: "cow-calf producer preferences for voluntary traceability systems are homogeneous." This hypothesis was evaluated using a choice experiment designed to accomplish two main things: (1) identify "average" or representative preferences and (2) examine the extent of heterogeneity in these preferences. According to Ouma et al. (2007) the conceptual framework for choice experiments arises from the consumer theory developed by Lancaster (1966), which postulates that preferences for goods are a function of the traits or characteristics possessed by the good, rather than the good itself. Therefore, analyzing the reasoning for an observed choice can be done by examining the attributes/components of the chosen and not chosen alternatives. In turn, a value or preference for these attributes/components can be derived.

Another objective was to evaluate how sensitive producer preferences were to price adjustments (premiums/discounts). This led to a set of evaluations to examine if producers are price sensitive and if this price sensitivity varied across producers. This was accomplished by evaluating heterogeneity in producer preferences for premiums and discounts to examine if all producers are equally price-sensitive.

Another objective was to examine if producer preferences were sensitive to the entity in charge of data maintenance. Thus, answering the questions, do preferences for particular systems change if the entity maintaining the data switches from government to private and do preferences vary if the private entity is based within the cattle industry or not? An additional objective stemming from the choice experiment was to examine how the inclusion and composition of additional information (e.g., age verification vs. production practice information) of *Advanced Traceability* systems affected voluntary participation rate.

Continuing under the same umbrella of the core objective of this research, additional objectives were identified followed by hypotheses to test. An objective was to investigate how producers' welfare was affected if a certain level of traceability becomes mandatory (e.g., removal of *No Traceability* option). This may arise as mandatory traceability systems could be introduced to correct perceived market failures when firms fail to supply the socially optimal level of traceability (Hobbs et al., 2005). Market failure can occur because the credence nature of food safety and quality attributes may lead to markets being dominated by low-quality products if producers of high quality food are unable to offer credible assurances to consumers (Golan et al., 2003; Hobbs, 2004; Hobbs et al., 2005). Alternatively, traceability systems facilitate the traceback of products in the event of a food safety problem, reducing the impact on public health and protecting the reputation of all firms in the same industry, thus, net social benefits of a traceback system may outweigh the net private benefits, leading to underinvestment in traceability (Hobbs, 2003; Golan et al., 2003; Hobbs et al., 2005). Initially, the USDA stated that NAIS would start as a voluntary program and later become mandatory to achieve full participation with premises registration and animal ID to be required by January 2008 and the reporting of defined animal movements to be required by January 2009. However, in late 2006, the agency decided that NAIS would remain voluntary (United States Government Accountability Office, 2007). This leads to analyzing the cow-calf producer welfare impacts of having voluntary traceability as an option as opposed to mandatory traceability as the only option where the *No Traceability* option is prohibited. We also estimated the welfare effect producers would experience given the removal of both *No Traceability* and *Advanced Traceability* alternatives. This analysis will be beneficial as the U.S. Government Accountability Office (GAO) report indicated that industry association officials suggested that if NAIS became mandatory, producers who have voluntarily participated would lose the market advantage they currently enjoy through higher prices paid at market or slaughter for animals they identify for marketing or management purposes.

A final hypothesis under this core objective that was identified was: "producer preferences are sensitive to producer demographics, perceptions, and current production/technology practices." Then, if it was determined that producer preferences were sensitive to producer demographics, perceptions, and current production/technology practices it was determined how their choice of traceability systems and traceability system attributes was affected.

Overall, the evaluations listed above drive the objective of designing these voluntary traceability systems in order to maximize expected voluntary participation rate, dually, showing how these voluntary traceability programs should look given alternative goals for traceability systems. Overall, immediate guidance in how voluntary traceability programs should be designed stemmed from our choice experiment and associated models.

A second tier of objectives allowed for an alternative evaluation of individual perceptions of traceability systems. An outline of the tier 2 objectives is as follows:

- Tier 2: Evaluation of individual perceptions of traceability systems.
    - Objective 2.1: Identify cow-calf producer forecasts of voluntary participation in NAIS with the registration of premises and registration of premises with the use of RFID.
    - Objective 2.2: Determine what type of producer and/or operations have premises registered in NAIS.
    - Objective 2.3: Determine what type of producer is in favor of making NAIS mandatory.
    - Objective 2.4: Determine if certain concerns and issues were still of top apprehension to traceability system participation or have producers perceptions shifted within the industry.
    - Objective 2.5: Identify if producer preferences are sensitive to producer demographics, perceptions, and current production/technology practices.

Continuing with this second tier of objectives, two sets of producer' forecasts were then identified to acquire even more valuable information regarding U.S. cow-calf producers. Obtaining forecasts of voluntary participation in NAIS with the registration of premises and registration of premises with the use of approved animal identification devices (i.e., RFID) on cattle leaving the premises met the forecasting objective. By utilizing these forecasts, and the characteristics that describe the most optimistic and pessimistic forecasters, a better sense of how traceability systems should be designed and promoted in order to maximize voluntary participation rate was identified.

An evaluation of what type of cow-calf producer has their premises registered in NAIS was performed. Furthermore, what type of cow-calf operator is in-favor of making

NAIS mandatory was determined. These two objectives were investigated judiciously because it was important to determine if producers are in favor/not in favor of mandatory NAIS because their premises were already registered in NAIS, or alternatively, did their characteristics and/or perceptions lead to their decision concerning mandatory NAIS.

Previous studies (e.g., Kansas State University, 2006) identified cost to producer, reliability of technology, confidentiality of information, and liability to the producer as top concerns of cow-calf producers. Given this previous research, an objective of this work was to determine if these concerns, as well as additional concerns and issues, were still of top apprehension to participation, or have producers perceptions shifted within the industry. Producers reaffirming these factors or changes in attitudes will most surely affect the optimal design and voluntary participation rate. Once again, the typology of producers through the hypothesis, "concerns are sensitive to producer demographics, perceptions, and current production/technology practices," was revisited in order to determine if their previous concerns held certain.

Chapter five, Conceptual Framework and Models, introduces random utility theory which underlies objectives related to choice experiments (e.g., Tier 1 objectives) and was the basis for meeting the core objective. Also, unfolded within the conceptual framework chapter is theory based around the forecasting objectives. Chapter 6, Empirical Modeling, shows how each of the objectives was met econometrically utilizing Tobit, Probit, MNL, RPL, and LCM models.

CHAPTER 4: SURVEY AND DATA DESCRIPTION

4.1 Survey Design

A survey was designed to obtain information from U.S. cow-calf producers regarding demographics, production practices, and potential beef traceability systems (the original survey is provided in Appendix 1). The survey was conducted by Michigan State University faculty and graduate students in conjunction with *BEEF* Magazine who supplied the mailing list for the survey. The random selection of farms to receive the survey allowed equal opportunity for selection regardless of participation in various farm organizations; however, given that *BEEF* Magazine subscribers traditionally have herd sizes greater than one-hundred animals, the sample was not expected to be completely representative of the diverse population of U.S. cow-calf operations. Thus, conclusions are drawn only for the producers surveyed.

The comprehensive survey included questions regarding various aspects of cow-calf production, including demographics and current production/technology practices, perceptions concerning traceability, and a choice experiment focused on beef traceability. The survey data collected was used to parameterize the analysis of cow-calf producer characteristics, perceptions, and choices affecting the implementation of individual animal traceability systems.

Questions regarding gender, producer's age, state of residence (U.S. farm production region), farm organization(s) of membership, educational description, years raising beef cattle, expected years raising beef cattle, estimated annual pre-tax income, household income from off-farm sources, operation's labor supplied by non-family (paid employees), operation's feed/forage needs produced on farm, marketing claims, marketing methods, number beef cows that calved in 2007, operation's sales at particular production stages, and animal identification methods currently used were asked to better understand the characteristics of the cow-calf producers and their operations.

More in-depth questions concerning cow-calf producers' perceptions of important issues and concerns to the U.S. beef industry when designing a national, individual animal traceability system were then asked to capture the most important issues and concerns of cow-calf producers. Furthermore, respondents were allowed to indicate their level of agreement with statements involving economies of scale, liability, COOL, and mandatory traceability when implementing individual animal traceability systems. Appendix 2 provides a complete list of the variables elicited from these questions and complete definitions of each as they will be used throughout subsequent discussion of model specification, results, and conclusions.

A choice experiment was utilized to simulate real-life situations in which cow-calf producers choose between alternative traceability systems. Choice experiments permit multiple attributes to be evaluated, thereby allowing researchers to estimate trade-offs between different alternatives (Lusk, Roosen, and Fox, 2003). A reference page (see Appendix 1) describing *NAIS Traceability*, *Advanced Traceability*, *No Traceability*, the entities maintaining the data, the premium/discount (per animal sold), and additional advanced traceability information was included before the choice experiment scenarios for reference in interpreting the alternative traceability options.

In this choice experiment, cow-calf producers were presented with a set of four scenarios, each of which involved choosing a preferred alternative from three different traceability systems. The three traceability systems included: (a) *NAIS Traceability*, (b)

Advanced Traceability, and (c) *No Traceability*. *NAIS Traceability*, as the name suggests, refers to NAIS and is a voluntary state-federal-industry partnership, which is a modern, streamlined information system that helps producers and animal health officials respond quickly and effectively to animal health events in the U.S. The NAIS program consists of three components: (1) premises registration, (2) animal ID, and (3) animal tracing. Premise registration requires a producer to provide basic contact information. Animal ID (on an individual animal basis in cattle) provides the producer with a uniform numbering system for identifying their animals and a way of linking those animals to their birthplace or premises of origin. RFID ear tags was listed as the type of animal ID used. Animal tracing allows the producer to choose an animal tracking database (owned and operated by private industry groups or states) and report certain animal movements that might pose a significant risk of disease transmission. The USDA is left responsible for protecting individuals' private information from disclosure (USDA APHIS, 2008).

Advanced Traceability was considered in the choice experiment because advanced systems besides NAIS are becoming ever more popular and available to producers. These systems provide quality signals to consumers regarding experience or credence attributes (Hobbs, 2004). Furthermore, advanced traceability systems reflect demand-side incentives, including reducing information costs for consumers, implementing product differentiation strategies, and providing accurate economic signal to producers (Buhr, 2003; Meuwissen et al., 2003; Hobbs, 2004; Golan et al., 2004; Smith et al., 2005). Finally, these advanced systems provide proactive information and quality verification which is essentially an increase in production information available to producers. Thus, it can be seen that advanced traceability systems depend on the attribute(s) that drive their development. *Advanced Traceability* refers to a traceability system with the same basic participation requirements as *NAIS Traceability*, but also requires producers to record and provide additional information that is believed to be of particular interest to beef consumers and/or is believed to improve production management throughout the beef supply chain. This additional advanced traceability information includes: age verification, production practice information, performance/genetic information, and health certifications/vaccinations records. Age verification, performance/genetic information, and health certifications/vaccinations records were only listed in the survey. Production practice information was described as information that would include, but is not limited to, growth hormones used and/or grass-fed diets used. The additional information requirements were not presented as individual or group specific, which allowed respondents to interpret these as they seen fit. More generally, the additional information requirements were purposely not overly specific as doing so would have limited the scope of this study (e.g., required valuation of fewer attributes and/or levels). However, we do acknowledge that different perceptions of producers in the requirements of these traceability system attributes likely impacted their willingness to participate. As such, all of our conclusions are strictly based upon producer responses to the information provided to them. Furthermore, participation in this traceability system would require partaking in random verification audits to further validate consistency between on-farm practices and information maintained within the traceability system.

As recommended by Adamowicz et al. (1998), a no-choice option was also presented to participants, because this is an obvious element of choice behavior. *No*

Traceability refers to a scenario without participation in any individual animal traceability system. This alternative was never associated with a premium and, therefore, always presented with a discount greater or equal to $0.00 per animal sold. Accordingly, managing entity and additional information to provide were absent from this choice alternative.

Among the three choices for traceability systems, attributes were randomly varied (following orthogonal fractional design procedures; Kuthfeld, Tobias, and Garratt, 1994) in order to back out cow-calf producer's preferences for traceability system attributes. The attributes included were: (a) premium/discount per animal sold, (b) managing entity, and (c) additional information. Options differed in terms of the premium or discount (per animal sold) that a producer would receive by selecting each alternative. These price adjustments ranged from discounts of up to $15 per animal (indicating you receive $15/animal less than the market price) to premiums of up to $15 per head (indicating the producer would receive $15/animal more than the market price). Within the survey, negative numbers indicated discounts and positive numbers indicated premiums.

Alternatives for managing entities were included due to the growing concerns among many producers regarding the collection and use of what they view as their private production information (Becker, 2007). That is why some producers want a private third-party, rather than USDA, to collect and maintain animal data. When considering government (USDA) or private entity as the manager of traceability data, producers are often concerned with who has the best qualifications for consistency of data recording and management (including confidentiality assurances), ability to respond to technical problems in the field, and the speed of animal traceback. The entity maintaining the tracing data and managing each traceability system took one of three forms: Government, Private - Industry, and Private - Not Industry. A reference to government means a government entity (such as USDA) manages and maintains the traceability system. Private - Industry means a private entity manages and maintains the traceability system. This entity is based within and owned by the beef industry. Furthermore, this entity specializes in designing, managing, and maintaining traceability specifically for the beef industry. Private - Not Industry means a private entity manages and maintains the traceability system. This entity is not based within, and is owned outside of the beef industry. This entity specializes in designing, managing, and maintaining livestock traceability systems.

The additional information required to provide in the *Advanced Traceability* choice was presented in all possible combinations (e.g., $2^4 = 16$) to ensure proper survey design and exhaust all possibilities to allow for the identification of the most important and most desired combinations of additional information to provide. This also allowed for embedding of additional information combinations to be evaluated (e.g., does "WTA for age verification + WTA for health records = WTA for age verification + health records?"

A concern in most choice experiments is hypothetical bias. Typically, with hypothetical questions, respondents will be more willing to choose to participate or not participate in a voluntary traceability system than they would if real money and circumstances were involved. A cheap talk script was included before the scenarios which informed respondents of the hypothetical bias. This has been shown to reduce hypothetical bias in choice experiment research (Lusk, 2003).

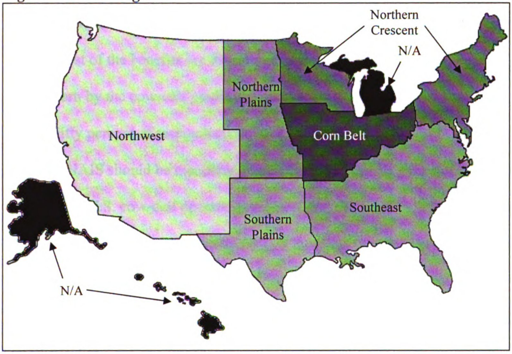
4.2 Survey Data

On November 26, 2007 a total of 2,000 (1,998 effective) surveys were mailed to cow-calf producers (selected on an "nth" name basis by *BEEF* Magazine) throughout the country. A one-dollar bill was included in the survey to potentially increase participation and response (Gregory, 2008). The respondent pool was expected to include cow-calf operations of greater than one-hundred animals due to the characteristics of *BEEF* Magazine subscribers. Michigan respondents (5) were not included in the final data set because of the mandatory nature of the state's individual, beef traceability system. Contrary to earlier expectations, 28.10% of producers indicated that their operation's had less than one-hundred cows that calved in 2007. The respondent pool provided 655 useable surveys (32.78% effective response rate). Consistent with Michigan State University research requirements when administering a survey, respondents were presented the option to decline to answer individual questions or portions of the survey at their discretion, if they chose to participate at all. Furthermore, the protocol for this survey and research was approved by Michigan State's University Committee on Research Involving Human Subjects (UCRIHS).[1] Summary statistics were computed for all questions. Appendix 3 provides a summary of responses to the entire set of survey questions. Throughout the presentation of the summary statistics, the "number reporting or N Valid" accompanies each set of summary statistics, which indicates the total number of usable responses to a given question. Many questions allowed a respondent to check all answers which were applicable to the operation from a multiple choice list, and such questions were analyzed by tabulating the total number of responses and computing frequencies.

[1] Institutional Review Board (IRB); number X07-1014 approved on October 23, 2007.

Approximately 92% of the respondents were male, with the average age of the sample being 58 years. Distribution of respondents across U.S. states and production regions followed the National Agriculture Statistics Service (NASS) numbers for cattle operations (NASS, 2008). The USDA Economic Research Service (ERS) farm production regions were subsequently adjusted to help eliminate over parameterization problems in estimation. This was accomplished by combining the Mountain and Pacific regions, Lake States and Northeast region, and Southeast region, Appalachia region, and Delta States. These new adjusted farm production regions still maintained geographical differences. Figure 4.1 provides a pictorial representation of these regions.

Figure 4.1. U.S. Regions



Appendix 2 provides a state by state categorization of these geographical regions. Based on the 2007 calendar year, producers indicated that 60.91% of the operations had less than two-hundred beef cows that calved. Plastic ear tags were the most commonly used form of animal ID (87.89%), with RFID being the least used at 9.18%. Forty-four percent indicated their operation's premises were currently registered with NAIS.

Contained in Appendix 3 (Tables 23-30) is a summary of ordered responses regarding cow-calf producer's perceptions of the importance of certain issues and concerns to the U.S. beef industry in designing a national, individual animal traceability system. Furthermore, this summary provides cow-calf producer's agreement with statements concerning economies of scale, liability, COOL, and mandatory traceability when implementing individual animal traceability systems. Also provided are results of producers' perceptions concerning the allocation of benefits and costs when implementing traceability systems and forecasts for NAIS premise registration and RFID use. If individual animal traceability systems were put in place, cow-calf producers believe most of the benefits are distributed rather evenly, whereas they believe costs are largely born by the cow-calf producers.

Fifty percent of respondents believe that NAIS should not be mandatory, 21% indicated NAIS should be mandatory, and 29% of producers were undecided. Finally, forecasts for U.S. cow-calf operations with premises registered in NAIS by December 31, 2008 averaged 40%, while forecasts for U.S. cow-calf operations with premises registered in NAIS and RFID used by December 31, 2008 averaged 31%.

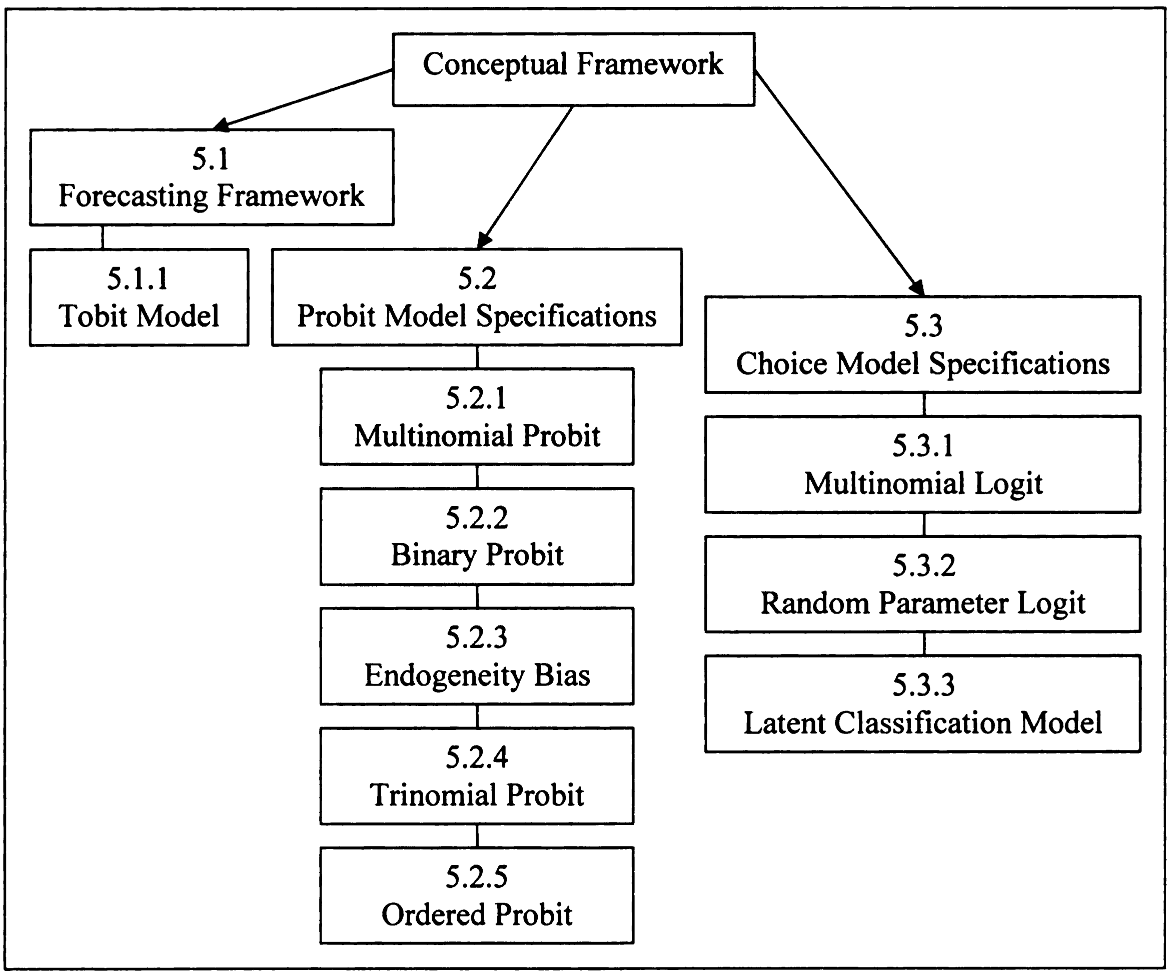
The last section of Appendix 3 (Tables 31-37) provides summary tables of the hypothetical choice experiment. Approximately 75% of the choice experiments were returned completed. The remaining 25% were either left blank or partially completed.

These survey findings will be discussed in subsequent chapters with regards to how they inform the underlying economic analysis of factors affecting which producers and/or operations currently participate or would choose to participate in certain traceability systems. Economic and management implications will then be parameterized using the results to better enable the designing of individual, voluntary beef traceability systems.

CHAPTER 5: CONCEPTUAL FRAMEWORK AND MODELS

In this chapter, the conceptual framework and models corresponding to the objectives outlined in chapter 3 and underlying the empirical models that will be estimated are developed. This involves describing the economic theory driving these model specifications. The model development discussion is followed by a discussion in the following empirical modeling chapter concerning evaluation procedures used in examining the appropriateness of the developed models and the techniques and variables employed. To further aid in following this progression, Figure 5.1 is provided as a guide.

Figure 5.1. Conceptual Model Progression Flow Chart



5.1 Forecasting Framework

When analyzing producer intentions, an important question is what factors cause intention development. The presumption is that beliefs are key elements in forming attitudes, intentions, and eventually influencing behavior (Han and Harrison, 2006). Beliefs represent the base set of information a producer has about an object or concept (Fishbein and Ajzen, 1975). Thus, these beliefs will describe all the thoughts a producer has about systems in association with various attributes, and beliefs play an important role in forming attitudes towards action.

When producers are asked to forecast participation and usage rates (e.g., NAIS registration and RFID use) concerning aspects of voluntary traceability systems their beliefs about the future may be based on their current attitudes and characteristics. Thus, providing insight into the characteristics of the most optimistic and pessimistic forecasters. Given that forecasts by design range from 0 to 100% (Appendix 1, survey question 24); to analyze producer stated forecasts of participation and usage rates, Tobit models were utilized where forecasts were modeled as zero for a fraction of the population but are roughly continuously distributed over positive values (Wooldridge, 2003).

5.1.1 Tobit Model

The Tobit model developed by Tobin (1958) supposes that the decision to participate in the market is the same as the decision about the quantity or extent of participation. This implies that any variable that increases the probability of nonzero value must also increase the conditional mean of the positive values.

Compared with the Probit model as described in a later section, which is based on the cumulative distribution and estimates the probability of the dependent variable lying inside at a 0-1 interval, the Tobit model was adopted, as it does not throw away any information on the value of the dependent variable (Gong et al., 2007). In situations when there is an upper or lower bound on an outcome variable, an appropriate statistical model to apply is a Tobit model with left (lower) and/or right (upper) censoring.

The censored regression or Tobit model is appropriate when the dependent variable is censored at some upper or lower bound as an artifact of how the data are collected or measured (Tobin, 1958). The general formulation that is typically presented is for censoring at a lower bound of zero and is usually given in terms of an index function (Greene, 2000):

$$\begin{aligned} & y_i^* = x_i'\beta + \varepsilon_i \qquad \varepsilon \sim N(0,\sigma^2) \\ (5.1) \quad & y_i = 0 \quad \text{if } y_i^* \le 0, \\ & y_i = y_i^* \quad \text{if } y_i^* > 0. \end{aligned}$$

where the index variable, sometimes called the latent variable, $E[y_i^* \mid x_i]$ is $x_i'\beta$, ε is the error, and β is a vector of coefficients to be estimated. For the *ith* observation, y_i^* is an unobserved latent continuous variable, y_i is the observed variable, x_i' is a vector of values on the independent variable or explanatory variables, and it is assumed that ε_i is uncorrelated with x_i' and is independently and identically distributed. This specification can also be written to encompass the more general double bounded range in which:

$$(5.2)\quad \begin{aligned} y_i^* &= x_i'\beta + \varepsilon_i \qquad \varepsilon \sim N(0,\sigma^2) \\ y_i &= y_i^* \quad \text{if } L < y_i^* < U, \\ y_i &= L \quad \text{if } y_i^* \leq L \\ y_i &= U \quad \text{if } y_i^* \geq U \end{aligned}$$

where *L* and *U* take on the values of the lower bound and upper bound, respectively.

The Tobit model has some important features that make it appealing for use with our data. In addition, the Tobit model is consistent and unbiased provided that there is no heteroscedasticity in the error terms.

5.2 Probit Model Specifications

A common behavioral assumption underlying economic theory and applied research in economics states that "agents" aim to maximize their expected utility. This research and analysis also relied upon these assumptions. The following specifications of random utility models allows for the elicitation of preferences for complex multidimensional systems, from which models of producer preferences may be estimated (Hall et al., 2004).

5.2.1 Multinomial Probit Model

Following Greene (2000) unordered-choice models can be motivated by a random utility model. Thus, for the *ith* individual faced with *j* choices, suppose that the utility of choice *j* is (Greene, 2000):

$$(5.3)\quad U_{ij} = z_{ij}'\beta + \varepsilon_{ij}.$$

Then if the individual makes choice *j* in particular, then we assume that U_{ij} is the maximum among the *j* utilities. Hence, the statistical model is driven by the probability that choice *j* is made, which is (Greene, 2000):

(5.4) $\text{Prob}(U_{ij} > U_{ik}) \quad \forall\, k \neq j.$

Probit models can be used to model any discrete choice/selection situation. The random utility framework was first utilized in Probit model specifications in analyzing producer behavior in discrete choice situations. The multinomial Probit model, which assumes that decision makers may be modeled as coming from a population of random utility maximizers, where the error component is in the (unobserved) utilities arise from a multivariate normal distribution (McFadden, 1981; Bunch and Kitamura, 1991). Now, the probability that individual *n* selects alternative *j* is given by:

(5.5) $\text{Prob}[U_{nj} > U_{ni}] \quad \forall\, i \neq j$

where this equation has a utility function in which alternative *j* is only chosen if it yields the highest utility across individuals *n*.

5.2.2 Binary Probit

In our application of binary Probit models it is assumed that producers attempt to maximize their utility when they face a binary choice. An example application in this work is the 'yes' or 'no' decision of registering premises within the NAIS system (e.g., question 22 of the survey in Appendix 1).

Following Wooldridge (2003) in a binary response model, interest lies primarily in the response probability:

(5.6) $\text{Prob}[Y = 1 \mid \mathbf{x}] = \text{Prob}[Y = 1 \mid x_1, x_2, \ldots, x_k],$

For specifying the Probit models consider a class of binary response models of the form:

$$(5.7)\quad \text{Prob}[Y = 1 \mid \mathbf{x}] = G[\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k] = G[\beta_0 + x\beta],$$

where G is a function taking on values strictly between zero and one: $0 < G(z) < 1$, for all real numbers z. This ensures that the estimated response probabilities are strictly between zero and one. This estimation and subsequent estimation of Probit choice models will be based on the method of maximum likelihood. The nonlinear Probit model for the function G ensures that the probabilities are between zero and one. G is a standard normal cumulative distribution function (CDF), which is expressed as an integral:

$$(5.8)\quad G(z) = \Phi(z) \equiv \int_{-\infty}^{z} \phi(v)dv,$$

where $\phi(z)$ is a standard normal density:

$$(5.9)\quad \phi(z) = (2\pi)^{-1/2} \exp(-z^2/2).$$

Wooldridge (2003) shows that Probit models can be derived from an underlying latent variable model where y^* is an unobserved, or latent, variable, determined by:

$$(5.10)\quad y_i^* = x_i'\beta + \varepsilon_i, \quad y_i = 1[y_i^* > 0], 0 \text{ Otherwise}$$

where the notion of $1[y_i^* > 0]$ is used to define a binary outcome. The function $y_i = 1[y_i^* > 0]$ is called the indicator function which takes on the value one if the event in the brackets is true, and zero otherwise. Therefore, y is one if $y^* > 0$, and y is zero if $y^* \leq 0$. It is further assumed that ε is independent of x, ε has a standard normal distribution, and ε is symmetrically distributed about zero implying that $1 - G(-z) = G(z)$ for all real numbers z. Given the assumptions presented above, the derived response probability for y is:

$$(5.11)\quad \text{Prob}(y = 1 \mid x) = \Pr\text{ob}(y^* > 0 \mid x) = \Pr\text{ob}[e > -(\beta_0 + x\beta) \mid x]$$
$$= 1 - G[(\beta_0 + x\beta)] = G(\beta_0 + x\beta),$$

which is exactly the same as the binary response model shown in equation (5.7) (Wooldridge, 2003). In this model the primary goal is to explain the effects of the x_j on the response probability $\text{Prob}(y = 1 \mid x)$. In the application of these Probit models sample selection bias and/or endogeneity bias may need to be dealt with, so depending on the question at hand, different techniques may need to be applied.

5.2.3 Endogeneity Bias

An example of potential endogeneity bias in this analysis arises when estimating whether producers believe that NAIS should be a mandatory system requiring all U.S. cattle producers to participate. The interest lies in how various factors, such as demographics and production/technology practices, affect producers' beliefs regarding mandatory traceability. Being currently registered in NAIS may be systematically correlated with unobservable factors that affect beliefs about mandatory NAIS, potentially producing biased estimators.

Endogeneity refers to the fact that an independent variable included in the model (e.g., having NAIS registered premises) is potentially a choice variable, correlated with unobservables relegated to the error term. In this situation, the dependent variable (beliefs regarding if NAIS should be mandatory), is observed for all observations in the data, so because the entire sample is used, there are no sample-selection issues (Millimet, 2001). Rather, this is an issue addressed in simultaneous-equation models considering the potentially endogenous variables (having NAIS registered premises) in an equation separate from the equation of original interest (beliefs regarding if NAIS should be mandatory). Unlike single-equation models, in the simultaneous-equations models one estimates the parameters of each equation while taking into account information provided by other equations in the system (Gujarati, 2003). Following Gujarati (2003), consider the following system of equations:

$$(5.12) \quad Y_{1i} = \beta_{10} + \gamma_{11} X_{1i} + u_{1i}$$

$$(5.13) \quad Y_{2i} = \beta_{20} + \beta_{21} Y_{1i} + \gamma_{21} X_{1i} + u_{2i}$$

where Y_1 and Y_2 are mutually dependent, or endogenous, stochastic variables, X_1 is an exogenous variable, and u_1 and u_2 are stochastic disturbances terms. Thus, for estimation purposes, it must be determined if the stochastic explanatory variable Y_1 in equation (5.13) is distributed independently of u_1. Referring to equation 5.12 and 5.13 for a procedure on how to remedy this issue, first equation 5.12 is estimated and the predicted values are obtained. Using the predicted values the Inverse Mills ratio is calculated. Then, including the Inverse Mills Ratio as an explanatory variable in the estimation of equation 5.13 (instead of Y_1 itself) can be done to test for endogeneity. If the Inverse Mills Ratio is found to be statistically significant, then evidence of endogeneity exists, justifying the bias correction procedure of including the Inverse Mills Ratio as an explanatory variable. If it is statistically insignificant, then we fail to reject the null hypothesis of exogeneity.

5.2.4 Trinomial Probit

Extending this discussion in analyzing trinomial situations with the Probit model we look to calculate the probability of choosing one of three alternatives. This can be shown by:

$$(5.14)\quad \mathrm{Prob}[U_3 \geq U_1 \text{ and } U_3 \geq U_2] = \mathrm{Prob}[U_1 - U_3 \leq 0 \text{ and } U_2 - U_3 \leq 0]$$

5.2.5 Order Probit

An extension of the Probit model applies to models in which there is an ordering to the categories associated with the dependent variable (Pindyck and Rubinfeld, 1996). That is, often the response variable can have more multiple outcomes and very often the outcomes are ordinal in nature; that is they cannot be expressed on an interval scale (Gujarati, 2003). An example in this research is that some responses are on a Likert-type scale, such that a respondent indicates "entirely unimportant," "unimportant," "neutral," "important," and "very important." Within an ordered Probit model the following specification was used:

$$(5.15)\quad y_i^* = x_i'\beta + \varepsilon_i$$

where y_i^* is the latent and continuous measure of interest faced by respondent *i*, x_i' is a vector of explanatory variables describing respondent *i*, β is a vector of parameters to be estimated, and ε_i is a random error term (assumed to follow a standard normal distribution). The observed and coded discrete continuous measure of interest, y_i^*, is determined from the model as follows where it is assumed that there is an underlying index *Z* for each respondent that measures the degree of their response. As shown in

Pindyck and Rubinfeld (1996) the ordered Probit model assumes that there are cut-off points Z^* and Z^{**} which define the relationship between the observed and unobserved dependent variables, specifically, $Z_i = \alpha + \beta X_i$, and

$$(5.16) \quad y_i \begin{cases} 3 \text{ if } Z_i \geq Z^{**} \\ 2 \text{ if } Z^* < Z_i < Z^{**} \\ 1 \text{ if } Z_i \leq Z^* \end{cases}$$

where the Z_i's represent thresholds to be estimated (along with the parameter vector β). This general specification may be extended to use in multiple size Likert-type response questions.

5.3 Choice Model Specifications

Random utility theory frequently underlies objectives related to choice experiments. Thus, models based on random utility, can be used to identify the set of feasible alternatives producers may choose among a set of choices. As shown in Nakosteen and Zimmer (1980) suppose that, an agent's utility of two choices, can be denoted U^a and U^b. The observed choice between the two reveals which one provides the greater utility, but not the unobservable utilities. Thus, the observed indicator equals 1 if $U^a > U^b$ and 0 if $U^a \leq U^b$. There are multiple approaches that may be employed to model random utility. To begin, a common formulation is the linear random utility model (Greene, 2000):

$$(5.17) \quad U^a = x'\beta_a + \varepsilon_a \quad \text{and} \quad U^b = x'\beta_b + \varepsilon_b$$

Then, if Y = 1 is denoted by the agent's choice of alternative *a*:

$$\begin{aligned}(5.18)\quad \text{Prob}[Y=1\,|\,X] &= \text{Prob}[U^a > U^b] \\ &= \text{Prob}[x'\beta_a + \varepsilon_a - x'\beta_b - \varepsilon_b > 0\,|\,x] \\ &= \text{Prob}[\mathbf{x}'(\beta_a - \beta_b) + \varepsilon_a - \varepsilon_b > 0\,|\,x] \\ &= \text{Prob}[x'\beta + \varepsilon > 0\,|\,x]\end{aligned}$$

5.3.1 Multinomial Logit

This random utility framework can be applied to the initial sets of models that will be estimated which are typically referred to as multinomial (or conditional) Logit models. The conditional logistic models estimate producer random utility [Adamowicz et al. (1998); Lusk, Roosen, and Fox (2003); and Schroeder et al. (2005)] which can be characterized by the following equation:

$$(5.19)\quad U_{jt} = v_{jt} + \varepsilon_{jt}$$

where U_{jt} is the utility associated with alternative *j* in choice scenario *t*, v_{jt} is the systematic, observable component of utility determined by attributes and their values, and ε_{jt}, is a random, unobservable component of Logit models, independently and identically distributed over all alternatives and choice situations. This random component of the producer's utility function is included to capture the variation in producers choices (i.e., a producer may not choose what seems to the analyst to be the "preferred" alternative or the analyst may simply fail to incorporate all relevant explanatory variables in *X*). A producer will choose alternative *j* if $U_j \geq U_k$ for all $j \neq k$. So, the probability that alternative *j* will be chosen is equal to the probability that the utility gained from its choice is greater than or equal to the utilities of choosing another alternative in the choice set. However since these utilities contain a stochastic component, researchers can only describe the probability of producers choosing alternative *j* as (Boxall and Adamowicz, 2002; Adamowicz et al, 1998):

$$(5.20)\quad \text{Prob}\{j \text{ chosen}\} = \text{prob}\{v_j + \varepsilon_j \geq v_k + \varepsilon_k;\quad j \neq k \quad \forall\, j \in C\}$$

where *C* is the choice set of all possible alternatives. Assuming the random errors in (5.19) are independently and identically distributed across the *j* alternatives and *N* individuals with a type I extreme value distribution, Adamowicz et al (1998), Boxall and Adamowicz (2002) and Lusk, Roosen, and Fox (2003) have shown that the probability of a producer choosing alternative *j* becomes:

$$(5.21)\quad \text{Prob}\{j \text{ chosen}\} = \frac{e^{\mu\beta X_i}}{\sum_{k \in C} e^{\mu\beta X_k}}$$

where μ is a scale parameter, which is inversely related to the variance of the error term. According to Lusk, Roosen, and Fox (2003) the scale parameter, μ, is typically assumed equal to one because it is unidentifiable within any particular data set. β is a vector of parameters. Assuming the systematic utility component v_j is linear in the parameters and follows the generalized regression specification leads to:

$$(5.22)\quad v_j = \beta_1 x_{j1} + \beta_2 x_{j2} + \ldots + \beta_n x_{jn}$$

where x_{jn} is the *n-th* attribute value for alternative *j* and β_n is a vector of preference parameters associated with the *n-th* attribute of the *j-th* alternative. The β's are utility parameters to be estimated, initially assumed to be constant across producers. That is utility levels are independent of characteristics and perceptions that may vary across producers. Multinomial Logit models assume that all respondents share the same coefficients for a given attributes. That is, all respondents are assumed to have the same preferences for attributes. This assumption may be unrealistic if producer's tastes are in fact heterogeneous. As such, the homogeneous producer tastes assumption is evaluated using random parameter Logit and latent class models as described below.

5.3.2 Random Parameter Logit

Utility parameters can be allowed to vary across the sampled observations (as random parameters) and therefore deviate from the surveyed population mean. A random parameters Logit model, as well as the previously discussed models, was used to determine producer willingness-to-accept (WTA) in alternative voluntary traceability systems relative to one another. The RPL model allows for random taste variation within the surveyed population, is free of the independence of irrelevant alternatives (IIA) assumption, and allows correlation in unobserved factors over time, thus eliminating three limitations of standard Logit models (Revelt and Train, 1998; Train, 2003; Tonsor et al., 2005). These three limitations are also avoided in the latent class model shown below. This aids in the ability to directly estimate heterogeneity in producer preferences. Specification of the random parameters Logit model is given by:

(5.23) $U_{ijt} = v_{ijt} + [u_{ij} + \varepsilon_{ijt}]$

where U_{ijt} is the utility producer *i* associates with attribute *j* in choice scenario *t*, v_{ijt} is the systematic portion of the utility function, u_{ij} is an error term distributed normally over producers and alternatives (but not choice situations), and ε_{ijt} is the stochastic error, independently and identically distributed over all producers, attributes, and choice scenarios. This describes a panel data model where the cross-sectional element is producer *i* and the time series component is the choice scenario *j* (Alfnes, 2004; Tonsor et al., 2005). The probability that producer *i* chooses alternative *j* in choice scenario *t* is given by:

$$(5.24)\ \text{Prob}(U_{ijt} \geq U_{ikt})$$

for all possible *k* attributes. Following Alfnes (2004) and Tonsor et al. (2005) and assuming v_{ijt} is linear in parameters, the utility function can be expressed as:

$$(5.25)\ v_{it} = \beta_{i1}x_{1it} + \beta_{i2}x_{2it} + \ldots + \beta_{ij}x_{ijt}$$

where x_{ijt} is the *j-th* attribute value for choice scenario *t* for producer *i* and β_j is a vector of preference parameters associated with the *j-th* attribute of the *t-th* choice to scenario of the *i-th* producer. We specify β to vary normally across producers.

The random parameters provide a rich array of preference information. They define the degree of preference heterogeneity through the standard deviation of the parameters and through interactions between the mean parameter estimate and the deterministic segmentation criteria, where the latter include other attributes of alternatives, socio-economic and contextual descriptors, and even descriptors of the data collection method and instrument. Random parameters are also the basis for accommodating correlation across alternatives and across choice situations (Hensher, Rose, and Greene, 2005).

RPL and latent class models examine heterogeneity differently and differ in their ability to explain the identified heterogeneity. RPL models explicitly account for heterogeneity by allowing parameters to vary randomly over individuals (Layton, 1996; Train, 1997, 1998). While these random parameter Logit procedures incorporate and account for heterogeneity, they are not well-suited to explaining the sources of heterogeneity (Boxall and Adamowicz, 2002). These sources often relate to the socioeconomic characteristics and tastes of the decision maker (Ouma et al., 2007).[2] Latent class models are better suited in explaining the sources of heterogeneity, because individuals are intrinsically sorted into a number of latent classes (Ouma et al., 2007). Each segment (or latent class) is characterized by homogeneous preferences though heterogeneous across classes (Boxall and Adamowicz, 2002).

5.3.3 Latent Classification Model

Boxall and Adamowicz (2002) describe the latent classification/segmentation approach to assume the existence of *s* segments in a population where individual *n* belongs to segment *s* (*s* = 1, ..., *s*). The latent classification approach assumes that *s* segments of producer preferences exist such that preferences are homogeneous for producers within each segment but heterogeneous across segments. The utility function can now be expressed:

$$(5.26) \quad v_{ni|s} = \beta_s X_{ni} + \varepsilon_{ni|s}$$

In this expression the utility parameters are now segment specific. The probability of a producer choosing alternative *j* is:

$$(5.27) \quad \mathrm{Prob}\{j \text{ chosen}|s\} = \frac{e^{\mu_s \beta_s X_i}}{\sum_{k \in C} e^{\mu_s \beta_s X_k}}$$

where the β's and μ's are segment-specific utility and scale parameters respectively.

---

[2] Though it is possible to account for the socioeconomic characteristics of the decision maker by interacting key individual characteristics with the traits, this requires a priori selection of key limited individual-specific variables (Ouma et al., 2007).

The paper applies this latent classification approach to a set of voluntary beef traceability system choice data. The behavioral components come from a choice experiment in which three attributes of voluntary traceability systems were varied. The analysis assesses simultaneously the influence of individual characteristics, motivational aspects, and the influence of choice-based attributes in the estimation of latent segments (Boxall and Adamowicz, 2002).

CHAPTER 6: EMPIRICAL MODELING

The survey data, which was summarized in chapter 4, was utilized to provide economic insight into why varying types of cow-calf operations choose alternative voluntary traceability systems and to identify those characteristics affecting producers' choices. Appendix 2, as explained in Chapter 4, provides a complete list of the variables elicited from these questions and complete definitions of each. This chapter follows a structured dialogue of theoretical and empirical evaluation procedures used in examining the appropriateness of the developed models. In particular, specific applications of Tobit, Probit, and Logit models uniquely specified to address the objectives of this research were presented.

The discussion of Tobit and Probit models will focus on the portion of the survey not involved with the choice experiment. Models throughout this discussion will take the following general form:

(6.1) Variable of interest = f(Demographics, Production Practices, Perceptions)

where Demographics, Production Practices, and Perceptions are vectors of multiple variables. Discussion of MNL, RPL, and LCM models involved estimation of models analyzing the choice experiment responses while also utilizing select variables from the previously discussed portion of the survey in the analysis.

Producer's demographics, production practices, and perceptions will likely have large impacts on their decisions concerning their beliefs, current practices, and choices regarding traceability systems. Controlling for demographics is necessary for examining the relative impacts of demographics to the impacts of other factors like perceptions and current production practices. Some production methods may decrease support because producers would not like to share that information with the rest of the production chain; while some production methods may increase support because producers can use these claims to increase marketability. Some marketing methods may decrease support because producers may not see the need when they are marketing directly to consumers because the beef is already "traceable." While other marketing methods may increase support because producers can use these claims to increase marketability. Producers' perceptions regarding important issues to the U.S. beef industry when designing a voluntary traceability system examined if producers are more concerned with issues such as disease implications or marketability. Perceptions regarding concerns to the U.S. beef industry when designing a voluntary traceability system may also impact support.

A factor analysis was performed on three sets of producer perception variables or eighteen statements (questions 17, 18, and 19 in the survey, Appendix 1) prior to estimation. The scores from the 18 statements were factor analyzed using principle component analysis with varimax rotation. Components were extracted until eigenvalues were less than or equal to 1.0 (Boxall and Adamowicz, 2002). The factor analysis identified three components across the given set of statements. However, these three components were not very informative as they simply consisted of each question (17, 18, and 19, respectively) within the survey. Therefore, the factors were not used as explanatory variables in subsequent models.

6.1 Tobit Models

The survey asked cow-calf producers to forecast future NAIS registration and RFID use rates among cow-calf producers in the U.S. beef industry. Examining the characteristics that describe the most optimistic and pessimistic forecasters may provide a better sense of how the NAIS traceability system and RFID technology could be promoted to enhance voluntary participation. This analysis helps in meeting the objective related to cow-calf producer forecasts in chapter 3.

More specifically, Tobit models will be used to evaluate responses to the two part question (question 24 of the survey, Appendix 1):

- *"If the NAIS system remains a system of voluntary participation, by December 31, 2008 what do you predict will be the percentage of U.S. cow-calf operations with premises registered in NAIS?"*
- *"If the NAIS system remains a system of voluntary participation, by December 31, 2008 what do you predict will be the percentage of U.S. cow-calf operations with premises registered in NAIS AND using NAIS approved RFID animal identification devices on the percentage of cattle leaving their premises."*

The forecasting questions will help give an indication of where producers believe the future (in this case specified as December 31, 2008) of the beef industry is going with the voluntary NAIS system. If a producer believes that NAIS registration and RFID use rates will be high in the future then arguably they may be more likely to accept and support such programs. Alternatively, if they believe traceability will not be implemented within the industry a lack of support may be more likely.

The bivariate empirical Tobit model for the forecast of NAIS participation and forecast of NAIS participation and RFID use took the form:

(6.2)

$$
\begin{aligned}
y_1^* &= \alpha_0 + \alpha_1 Age + \alpha_2 Member + \alpha_3 Years + \alpha_4 ExpYears + \alpha_5 Cows + \alpha_6 Auctions \\
&\quad + \alpha_7 RFID + \alpha_8 RegNAIS + \alpha_9 ManNAIS + \alpha_{10} CRetailers + \alpha_{11} CProcessors \\
&\quad + \alpha_{12} CFeedlots + \varepsilon_1
\end{aligned}
$$

$$
\begin{aligned}
y_2^* &= \beta_0 + \beta_1 Age + \beta_2 CB + \beta_3 NP + \beta_4 NW + \beta_5 SE + \beta_6 SP + \beta_7 cMember + \beta_8 Education \\
&\quad + \beta_9 Years + \beta_{10} ExpYears + \beta_{11} Income + \beta_{12} OIncome + \beta_{13} Labor + \beta_{14} OFeed \\
&\quad + \beta_{15} Cows + \beta_{16} Auctions + \beta_{17} PTags + \beta_{18} ENotches + \beta_{19} Brand + \beta_{20} Tattoo \\
&\quad + \beta_{21} MTags + \beta_{22} RFID + \beta_{23} NoID + \beta_{24} RegNAIS + \beta_{25} ManNAIS + \varepsilon_2
\end{aligned}
$$

where y_1 = producer forecast of NAIS premises registration, y_2 = producer forecast of NAIS premise registration and RFID use, α's and β's are coefficients to be estimated and the explanatory variables are defined as described in Appendix 2. If the model's error terms are correlated, joint estimation will allow for an increase in effiency, thereby leading to more consistent β's.

6.2 Probit Models

Probit models will be applied to these specific survey questions (22 and 23 in the survey, Appendix 1):

(1) "*Are your operation's premise(s) currently registered with USDA in the NAIS (National Animal Identification System)?*" and

(2) "*Do you believe that NAIS (as previously outlined) should be a mandatory system requiring all U.S. cattle producers to participate?*"

6.2.1 Binary Probit

Question (1) will follow a binary format as the question elicited a "yes or no" response. The empirical Probit model for the first question of whether producers' premises were currently registered in the NAIS system was:

(6.3)

$$\begin{aligned} y_1^* = {} & \beta_0 + \beta_1 Age + \beta_2 CB + \beta_3 NP + \beta_4 NW + \beta_5 SE + \beta_6 SP + \beta_7 Member + \beta_8 Education \\ & + \beta_9 Years + \beta_{10} ExpYears + \beta_{11} Income + \beta_{12} OIncome + \beta_{13} Labor + \beta_{14} OFeed \\ & + \beta_{15} Cows + \beta_{16} Auctions + \beta_{17} PTags + \beta_{18} ENotches + \beta_{19} Brand + \beta_{20} Tattoo \\ & + \beta_{21} MTags + \beta_{22} RFID + \beta_{23} NoID + \beta_{25} ManNAIS + \varepsilon_1 \end{aligned}$$

where $y_1 = 1(0)$ if a producer answered Yes(No), β's are coefficients to be estimated, and the explanatory variables are defined as described in Appendix 2.

6.2.2 Endogeneity Evaluation

Question (2), whether NAIS should be mandatory, followed a trinomial format as the question elicited a "yes or no or undecided" response. To examine if responses to question (2) were endogenously determined with question (1), a two-stage estimation was performed (Wooldridge, 2002). Significance of the Inverse Mills ratio coefficient led to reject exogeneity of question (2) from question (1).

6.2.3 Trinomial Probit

Estimating the trinomial Probit model was based upon producers' beliefs concerning mandatory NAIS; where producers chose between (i) NAIS should be mandatory, (ii) undecided whether NAIS should be mandatory, and (iii) NAIS should not be mandatory.

(6.4)

$$y_{it}^{1} = \alpha_0 + \alpha_1 Age_{it} + \alpha_2 CB_{it} + \alpha_3 NP_{it} + \alpha_4 NW_{it} + \alpha_5 SE_{it} + \alpha_6 SP_{it} + \alpha_7 Member_{it} + \alpha_8 ExpYears_{it} + \alpha_9 Years_{it} + \alpha_{10} Income_{it} + \alpha_{11} Cows_{it} + \alpha_{12} Auctions_{it} + \alpha_{13} BRetailers_{it} + \alpha_{14} BProcessors_{it} + \alpha_{15} BFeedlots_{it} + \alpha_{16} CRetailers_{it} + \alpha_{17} CProcessors_{it} + \alpha_{18} CFeedlots_{it} + \alpha_{19} InvMills_{it} + \varepsilon_{it}^{1}$$

$$y_{it}^{2} = \beta_0 + \beta_1 Age_{it} + \beta_2 CB_{it} + \beta_3 NP_{it} + \beta_4 NW_{it} + \beta_5 SE_{it} + \beta_6 SP_{it} + \beta_7 Member_{it} + \beta_8 ExpYears_{it} + \beta_9 Years_{it} + \beta_{10} Income_{it} + \beta_{11} Cows_{it} + \beta_{12} Auctions_{it} + \beta_{13} BRetailers_{it} + \beta_{14} BProcessors_{it} + \beta_{15} BFeedlots_{it} + \beta_{16} CRetailers_{it} + \beta_{17} CProcessors_{it} + \beta_{18} CFeedlots_{it} + \beta_{19} InvMills_{it} + \varepsilon_{it}^{2}$$

where $y_{it}^{1} = 1$ indicates a belief that NAIS should be mandatory (0 otherwise), and $y_{it}^{2} = 1$ indicates a producer being undecided about NAIS being mandatory (0 otherwise).[3] The Inverse Mills ratio (*InvMills*) is equal to the standardized predicted values from equation 6.3. β's are coefficients to be estimated, and the explanatory variables are defined in Appendix 2. Maximum Likelihood Estimation (MLE) to jointly estimate equations (6.3) and (6.4) would have been preferred; however, the PROC QLIM procedure in SAS (which was used on the previous models and some of the subsequent models) does not currently support multinomial Probit estimation. SAS does not provide an option to specify multinomial Probit models for this system (SAS, 2008). Multinomial Probit models are supported in the PROC MDC procedure in SAS; however, given the endogeneity issue with the registered NAIS equation it does not allow systems of equations to be estimated as would need to be done. Therefore, STATA was used in the estimation of this equation and a two-stage procedure using the Inverse Mills ratio was used to deal with the endogeneity issue.

[3] $y_{it}^{1} = 0$ and $y_{it}^{2} = 0$ implies a producer believes NAIS should not be mandatory.

6.2.4 Ordered Probit

Ordered Probits were used to estimate questions in which there was ranked responses as given in the following questions (17, 18, and 19 in the survey, Appendix 1):

(1) *"In designing a national, individual animal traceability system how important are the following issues in the U.S. beef industry (please circle your answers where 1 = Entirely Unimportant, 2 = Unimportant, 3 = Neutral, 4 = Important, 5 = Very Important)?"*

(2) *"In designing a national, individual animal traceability system how concerned are you regarding the following issues in the U.S. beef industry (where 1 = Entirely Unconcerned, 2 = Unconcerned, 3 = Neutral, 4 = Concerned, 5 = Very Concerned)?"*

(3) *"Indicate your level of agreement with each of the following statements (Where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). Implementing individual animal traceability systems: (i) "is more cost effective for larger cow-calf operations." (ii) "results in more liability for cow-calf producers than cattle owners at other stages of production" (iii) "is unnecessary if COOL (Country-of-Origin Labeling) was implemented nationally." (iv) "as a mandated system is exaggerated?"*

The empirical Probit model for these questions was:

(6.5)

$$
\begin{aligned}
y_1^* = {} & \beta_0 + \beta_1 \text{Age} + \beta_2 \text{CB} + \beta_3 \text{NP} + \beta_4 \text{NW} + \beta_5 \text{SE} + \beta_6 \text{SP} + \beta_7 \text{Member} + \beta_8 \text{Education} \\
& + \beta_9 \text{Years} + \beta_{10} \text{ExpYears} + \beta_{11} \text{Income} + \beta_{12} \text{OIncome} + \beta_{13} \text{Labor} + \beta_{14} \text{OFeed} \\
& + \beta_{15} \text{Cows} + \beta_{16} \text{Auctions} + \beta_{17} \text{RegNAIS} + \varepsilon_1
\end{aligned}
$$

where β's are coefficients to be estimated, and the explanatory variables are defined as described in Appendix 2.

6.3 Multinomial Logit Models

The choice experiment framework was designed to improve the understanding of traceability system choices and preferences by requiring cow-calf producers to choose between two traceability system options and a *No Traceability* system option (reference data/survey discussion and/or Appendix A showing the CE scenarios). Data obtained through choice experiments has traditionally been analyzed using multinomial Logit models (e.g., Lusk, Roosen, and Fox, 2003).

Because, producer-level support, or lack of support, for voluntary traceability systems in the U.S. will be based on the net benefits producer groups perceive they would receive from the system and their underlying utility functions, empirical modeling and subsequent examining of preferences for alternative systems should allow researchers to better determine optimal voluntary systems (Bailey and Slade, 2004).

Recall that multinomial logistic models estimate producer random utility as (Adamowicz et al., 1998; Lusk, Roosen, and Fox, 2003; and Schroeder et al., 2005):

$$(6.6)\quad U_{jt} = v_{jt} + \varepsilon_{jt}$$

where U_{jt} is the utility associated with alternative *j* in choice scenario *t*, v_{jt} is a systematic, observable (explainable) component of utility determined by attributes and their values, and ε_{jt}, is a random, unobservable (unexplainable) component of Logit models, independently and identically distributed over all alternatives and choice situations. Assuming v_{jt} is linear in parameters, v_{jt} is specified individually for each of the three available alternatives (two traceability system options and a *No Traceability* system option):

(6.7) $v_{jt} = \beta_1(PD_{jt}) + \beta_2(PvtI_{jt}) + \beta_3(PvtNI_{jt}) \quad \forall\ j = \text{NAIS Trace}$

(6.8)
$$\begin{aligned} v_{jt} = {} & \beta_{\text{Adv Trace}} + \beta_1(PD_{jt}) + \beta_2(PvtI_{jt}) + \beta_3(PvtNI_{jt}) + \beta_4(PP_{jt}) + \beta_5(PG_{jt}) \\ & + \beta_6(HR_{jt}) + \beta_7(AVPP_{jt}) + \beta_8(AVPG_{jt}) + \beta_9(AVHR_{jt}) + \beta_{10}(PPPG_{jt}) \\ & + \beta_{11}(PPHR_{jt}) + \beta_{12}(PGHR_{jt}) + \beta_{13}(AVPPPG_{jt}) + \beta_{14}(AVPPHR_{jt}) \\ & + \beta_{15}(PPPGHR_{jt}) + \beta_{16}(AVPPPGHR_{jt}) + \beta_{17}(AT\_Cows) + \beta_{18}(AT\_Member) \\ & + \beta_{19}(AT\_Auctions) + \beta_{20}(AT\_Years_{jt}) + \beta_{21}(AT\_IndID) \\ & + \beta_{22}(AT\_GrpID_{jt}) + \beta_{23}(AT\_NoID) + \beta_{24}(AT\_CB) + \beta_{25}(AT\_NP) \\ & + \beta_{26}(AT\_NW) + \beta_{27}(AT\_SE) + \beta_{28}(AT\_SP) \quad \forall\ j = \text{Adv Trace} \end{aligned}$$

(6.9)
$$\begin{aligned} v_{jt} = {} & \beta_{\text{No Trace}} + \beta_1(PD_{jt}) + \beta_{29}(NT\_Cows) + \beta_{30}(NT\_Member) \\ & + \beta_{31}(NT\_Auctions) + \beta_{32}(NT\_Years) + \beta_{33}(NT\_IndID) \\ & + \beta_{34}(NT\_GrpID) + \beta_{35}(NT\_NoID) + \beta_{36}(NT\_CB) \\ & + \beta_{37}(NT\_NP) + \beta_{38}(NT\_NW) + \beta_{39}(NT\_SE) + \beta_{40}(NT\_SP) \\ & \forall\ j = \text{No Trace} \end{aligned}$$

where $\beta_{\text{Adv Trace}}$ and $\beta_{\text{No Trace}}$ are constants (relative to *NAIS*) for *Advanced Traceability* and *No Traceability*, respectively. PD_{jt} is the premium/discount per head sold; $PvtI_{jt}$ and $PvtNI_{jt}$ are effects coded variables equal to one if the alternative lists the entity maintaining the data as Private - Industry or Private - Not Industry, respectively (-1 for Government (base) or 0 otherwise); PP_{jt}, PG_{jt}, HR_{jt}, $AVPP_{jt}$, $AVPG_{jt}$, $AVHR_{jt}$, $PPPG_{jt}$, $PPHR_{jt}$, $AVPPPG_{jt}$, $AVPPHR_{jt}$, $AVPGHR_{jt}$, $PPPGHR_{jt}$, $AVPPPGHR_{jt}$ denote effects coded variables equal to one if the alternative lists the additional information as Production Practices, Performance/Genetics, and Health Records and for combinations refer to Appendix B, respectively (-1 for Age Verification (base) or 0 otherwise). Interaction terms AT_Cows, NT_Cows, AT_Member, NT_Member, AT_Auctions, NT_Auctions, AT_Years, NT_Years, AT_IndID, NT_IndID, AT_GrpID, NT_GrpID, AT_NoID, NT_NoID, AT_CB, NT_CB, AT_NP, NT_NP, AT_NW, NT_NW, AT_SE, NT_SE, AT_SP, and NT_SP are explanatory variables, that incorporate producer demographic effects on preferences for *Advanced* and *No Traceability* systems, and are defined in Appendix 2.

As explained above the managing entity and additional information variables were effects coded. Following Beck and Gyrd-Hansen (2005), attributes with L qualitative levels are transformed into L-1 dummy variables in which each dummy is set equal to 1 when the qualitative level is present, and equal to -1 if the Lth (the arbitrary reference level) is present and equal to 0 otherwise. Thus, for our effects coding, the base case for managing entity will be government and for additional information the base case will be age verification. In effects coding, the reference point is defined as the negative sum of the estimated coefficients; the utility of the Lth level equals: $\beta_1 \times (-1) + \beta_2 \times (-1) + \cdots + \beta_{L-1} \times (-1)$. This means that the reference point is now internalized in the β estimates and cannot be carried over onto the $\beta_{\text{Adv Trace}}$ and $\beta_{\text{No Trace}}$ coefficients. Thus, when effects coding is applied the constant term can only reflect the utility associated with the fixed comparator and misinterpretation is not possible (Beck and Gyrd-Hansen, 2005).

Standard multinomial Logit models may be limiting because they do not allow for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors over time. Therefore, additional models were estimated including RPL and LCM models.

6.4 Random Parameter Models

Random parameters Logit models explicitly account for heterogeneity by allowing model parameters to vary randomly, and continuously, over individuals (Layton 1996; Train 1997, 1998). Although heterogeneity is accounted for in these models, difficulty arises in determining the sources of heterogeneity (Ouma, Abdulai, and Drucker, 2007). Assuming the observable portion of utility is linear in parameters, we specify v_{ijt} separately for each of the three available alternatives (two traceability system options and a *No Traceability* system option):

(6.10) $v_{ijt} = \beta_1(PD_{jt}) + \beta_2(PvtI_{jt}) + \beta_3(PvtNI_{jt}) \quad \forall\ j = \text{NAIS Trace}$

(6.11)

$$\begin{aligned} v_{ijt} = {} & \beta_{i\text{Adv Trace}} + \beta_1(PD_{jt}) + \beta_2(PvtI_{jt}) + \beta_3(PvtNI_{jt}) + \beta_4(PP_{jt}) + \beta_5(PG_{jt}) \\ & + \beta_6(HR_{jt}) + \beta_7(AVPP_{jt}) + \beta_8(AVPG_{jt}) + \beta_9(AVHR_{jt}) + \beta_{10}(PPPG_{jt}) \\ & + \beta_{11}(PPHR_{jt}) + \beta_{12}(PGHR_{jt}) + \beta_{13}(AVPPPG_{jt}) + \beta_{14}(AVPPHR_{jt}) \\ & + \beta_{15}(PPPGHR_{jt}) + \beta_{16}(AVPPPGHR_{jt}) + \beta_{17}(AT\_Cows_i) + \beta_{18}(AT\_Member_i) \\ & + \beta_{19}(AT\_Auctions_i) + \beta_{20}(AT\_Years_i) + \beta_{21}(AT\_IndID_i) + \beta_{22}(AT\_GrpID_i) \\ & + \beta_{23}(AT\_NoID_i) \quad \forall\ j = \text{Adv Trace} \end{aligned}$$

$$\begin{aligned} v_{ijt} = {} & \beta_{i\text{No Trace}} + \beta_1(PD_{jt}) + \beta_{24}(NT\_Cows_i) + \beta_{25}(NT\_Member_i) \\ & + \beta_{26}(NT\_Auctions_i) + \beta_{27}(AT\_Years_i) + \beta_{28}(NT\_Years_i) \\ & + \beta_{29}(AT\_IndID_i) + \beta_{30}(NT\_IndID_i) + \beta_{31}(AT\_GrpID_i) \\ & + \beta_{32}(NT\_Grp.ID_i) + \beta_{33}(AT\_NoID_i) + \beta_{34}(NT\_NoID_i) \\ & \forall\ j = \text{No Trace} \end{aligned} \tag{6.12}$$

where the variables in equations (6.10), (6.11), and (6.12) are defined as in equations (6.7), (6.8), (6.9). In addition, $\beta_{i\text{Adv Trace}}$ and $\beta_{i\text{No Trace}}$ are now assumed to be normally distributed $\left(\beta \sim N(\bar{\beta}, \Omega)\right)$, thus introducing preference heterogeneity across producers into the model. Revelt and Train (1998) define β_{ik} on these two constants as:

$$(6.13) \quad \beta_{ik} = \bar{\beta}_k + LM$$

where L is a lower-triangular Cholesky factor of Ω such that $LL' = \Omega$, and M is a vector of independent standard normal deviates (Revelt and Train, 1998). Schroeder et al. (2006) have shown that the RPL model estimates both the mean and standard deviation of the utility coefficients assumed to vary across producers. Conversely, the MNL model only estimates a mean coefficient across individuals and implicitly assumes this coefficient adequately reflects each individual's preferences. If the standard deviation parameters are significant, evidence is said to exist supporting preference heterogeneity for the evaluated attribute(s).

6.5 Latent Classification Models

A latent classification strategy assumes that producers can be separated into different segments such that producers within each segment have homogeneous preferences, but that preferences vary across producers from alternative segments. This process may help better identify marketing segments of producers likely to support alternative traceability systems. Observed variables (e.g., producer attitudes, perceptions, socio-demographic, and/or production practice factors) are integrated with information from the choice experiment such that some sources of heterogeneity can be identified while simultaneously modeling revealed preferences for the traceability system attributes in the choice experiment. The LCM model estimates a utility function unique to each producer segment. Thus, this process groups producers with relatively homogeneous preferences based on similarities in their utility functions, as revealed by a discrete set of different values of each β_k from the MNL models. As shown below, additional information variables were only included as singles and pairs due to convergence problems with larger combinations of these variables. Assuming the observable portion of utility is linear in parameters and that the traceability system attributes are additive above the pair combinations, we specify v_{ijt} separately for each of the three available alternatives (two traceability system options and a *No Traceability* system option):

(6.14) $v_{ijt|s} = \beta_{i1|s}(PD_{jt}) + \beta_{i2|s}(PvtI_{jt}) + \beta_{i3|s}(PvtNI_{jt}) \quad \forall\ j = \text{NAIS Trace}$

(6.15)

$$\begin{aligned} v_{ijt|s} = {} & \beta_{\text{Adv Trace}} + \beta_{i1|s}(PD_{jt}) + \beta_{i2|s}(PvtI_{jt}) + \beta_{i3|s}(PvtNI_{jt}) + \beta_{i4|s}(PP_{jt}) + \beta_{i5|s}(PG_{jt}) \\ & + \beta_{i6|s}(HR_{jt}) + \beta_{i7|s}(AVPP_{jt}) + \beta_{i8|s}(AVPG_{jt}) + \beta_{i9|s}(AVHR_{jt}) + \beta_{i10|s}(PPPG_{jt}) \\ & + \beta_{i11|s}(PPHR_{jt}) + \beta_{i12|s}(PGHR_{jt}) \quad \forall\ j = \text{Adv Trace} \end{aligned}$$

(6.16) $v_{ijt|s} = \beta_{\text{No Trace}} + \beta_{i1|s}(PD_{jt}) \quad \forall\ j = \text{No Trace}$

where the variables in equations (6.14), (6.15), and (6.16) are defined as in equations (6.7), (6.8), (6.9) above. Furthermore, membership in segment *s* is a function of *Cows*, *Auctions*, *Member*, *Years*, *IndID*, *GrpID*, and *NoID*. These variables are defined in Appendix 2.

6.6 Willingness-to-Accept Estimates

MNL, RPL, and LCM model estimated coefficients themselves have little interpretive value. However, in each model relative combinations of select coefficients used for WTA estimates provide economically meaningful insights on producer preferences. Following Nahuelhaul, Lourero, and Loomis (2004) and Rigby and Burton (2005) mean WTA for producers are calculated for each non-price traceability system attribute at the means of each model's explanatory variables. These calculations are generally given by.

$$(6.17)\ \text{Mean WTA} = \frac{\text{MU}}{\text{MUI}}\Big|_{\textit{mean independent variables}}$$

where *MU* is the mean marginal utility of traceability systems and system attributes and *MUI* is the marginal utility of income (proxied in our calculations with the premium/discount (PD) price coefficient).

In estimating our RPL model, not allowing the price coefficient to to vary randomly ensures a negative proice coefficient for all producers and ensures that WTA estimates are normally distributed (Lusk, Roosen, and Fox, 2003).

To determine if the estimated average WTA estimates in each model are statistically different from zero, a Krinsky-Robb (1986) bootstrapping procedure was employed to develop confidence intervals on the WTA estimates. Bockstael and Strand (1987) have emphasized that the parameter estimates used to calculate welfare measures are themselves random variables, thus the Krinsky-Robb technique used here to develop confidence intervals for the WTA measure accounts for the variability associated with all the estimated coefficients and is based directly on the Logit specification for the choices of respondents. The Krinsky and Robb approach uses the information on the distribution of $\hat{\beta}$ contained in the variance-covariance matrix to approximate the distribution of WTA (Park et al., 1991).

Following Park, Loomis, and Creel (1991), the Krinsky-Robb technique can be implemented using information readily available from the estimated Logit model: the estimates of the parameter vector, denoted by $\hat{\beta}$, and the estimated variance-covariance matrix, denoted by $\hat{V}$. Multiple random drawings to create a new parameter vector $\hat{\hat{\beta}}$ are made from a multivariate normal distribution with variance-covariance matrix $\hat{V}$ and mean $\hat{\beta}$. For each drawing of $\hat{\hat{\beta}}$, WTA is calculated. An empirical distribution for each WTA measure is then obtained using the complete set of replications (random drawings). A $(1-\alpha)$ confidence interval is obtained by ranking the vector of calculated WTA values and dropping the $\alpha/2$ values from each tail of the ranked vector (Park, Loomis, and Creel, 1991). Krinsky and Robb (1986) suggest that past experimentation has indicated that one-thousand drawings are sufficient to generate a sufficiently accurate empirical distribution. This simulation process makes more complete use of valuable information provided by each estimated model and results in much more complete mapping of producer preferences (Tonsor et al., 2008).

6.7 Welfare Measure

In meeting one of the previously stated tier 1 objectives the welfare effect producers would experience given two alternative changes were estimated: (1) removal of *No Traceability* and (2) removal of both *No Traceability* and *Advanced Traceability* from their choice set. The welfare measure accounted for the fact that producers are currently free to choose "*No Traceability*" and that producers' actual choices are uncertain. Small and Rosen (1978) and Morey (1999) show that expected maximum utility from making a choice from a particular choice set is given by: $CV = \ln\left(\sum e^{Vj}\right) + C$, where *C* is Euler's constant. Thus, the welfare change that occurs when moving from one situation given by CV^0 to a situation given by CV^1 is: 1/(Marginal utility of income) x [(CV^1)-(CV^0)]. This calculation represents the most producers would be willing to pay per choice occasion to face the choices in situation 1 versus situation 0 (Lusk, Norwood, and Pruitt, 2006). Alternatively, one can interpret this value as the amount necessary to make a producer equally well-off in the two situations. Chapter 7 will apply the modeling techniques described throughout this chapter to the data obtained from the survey.

CHAPER 7: RESULTS

7.1 Producers' Practices and Perceptions Regarding Traceability

The following chapter provides the econometric results and economic interpretation of the various models estimated meeting the research objectives as discussed in previous chapters. The end of this chapter includes parameter estimates and standard error values for the various models estimated throughout this section. F-tests were utilized to determine the preferred variable set for each model. F-tests allow for the testing of joint hypothesis that a number of coefficients were zero. In order to determine each preferred model, a complete set of producer specific variables were identified and used in estimation of each model. Then groups of coefficient estimates were tested to determine if the groups were statistically different than zero.[4] Significance of individual coefficients and mean marginal effects (ME) in each final model specification are discussed throughout the text in this section. ME represent the mean effect of a particular explanatory variable on the question/model at hand.

Additional models concerning producers' perceptions and concerns when implementing an individual animal traceability system were estimated, but not included in this chapter. These include models of how important producers feel an individual animal traceability system is for managing the supply chain, enhancing food safety, improving marketability, and improving on-farm management. Other additional models evaluated how producers perceived common issues in the beef industry when implementing individual animal traceability systems (i.e., economies of scale, liability

[4] The 10% significance level was used on all F-tests.

shifts, and the exaggeration in need of mandatory traceability). These results can be found in Appendix 4.

7.1.1 Producers' Forecast Analysis

Recall the two part question regarding producers' forecast of NAIS participation and both NAIS participation and RFID use (question 24 of the survey, Appendix 1).

(1) "*If the NAIS system remains a system of voluntary participation, by December 31, 2008 what do you predict will be the percentage of U.S. cow-calf operations with premises registered in NAIS?*"

(2) "*If the NAIS system remains a system of voluntary participation, by December 31, 2008 what do you predict will be the percentage of U.S. cow-calf operations with premises registered in NAIS?*"

The empirical equations to these questions were estimated jointly due to the possible correlation between them due to potentially omitted covariates in each model. Estimating a bivariate model identified significant correlation between the two equations. Therefore, joint estimation was preferred.

The following are the demographics that were included in the Tobit equation to evaluate producers' forecast for NAIS participation: age (*Age*), the number of memberships in various farm organizations (*Member*), years raising beef cattle (*Years*), expected future years raising beef cattle (*ExpYears*), number of beef cows that calved in 2007 (*Cows*), whether local auctions were used as a marketing outlet (*Auctions*), whether RFID was used for animal identification (*RFID*), whether the operation's premise(s) was currently registered in NAIS (*RegNAIS*), producer's belief on whether NAIS should be mandatory (*ManNAIS*), and the percentage of costs that retailers, processors, and feedlots born over cow-calf producers (*CRetailers*, *CProcessors*, and *CFeedlots*, respectively). Variables included in the Tobit equation to evaluate producers' forecast for NAIS participation and RFID use were: *Age*, U.S. production regions (*CB, NP, NW, SE, SP*), *Member*, education (*Education*), *Years*, *ExpYears*, pre-tax household income (*Income*), portion of household income from off-farm sources (*OIncome*), paid labor percentage (*Labor*), the proportion of feed produced on-farm (*OFeed*), *Cows*, *Auctions*, whether plastic ear tags (*PTags*), ear notches (*ENotches*), brands (*Brand*), tattoos (*Tattoo*), brucellosis/metal tags (*MTags*), *RFID*, or no identification (*NoID*) were used for animal identification, *RegNAIS*, and *ManNAIS.*

The mean response by respondents giving a forecast for future NAIS participation was 40.47% with a standard deviation of 18.87%, while the mean response by respondents giving a forecast for future NAIS participation and RFID use was 31.58% with a standard deviation of 20.11%. Table 7.1 presents the results of the significant ME joint estimates for future NAIS participation and both future NAIS participation and RFID use.[5] It is important to note that the ME are interpreted at the mean, thus for the representative (average) producer in each case. This follows for all subsequent interpretation of the ME coefficients.

[5] Table 7.1a shows the estimated coefficients and standard errors. The remainder of this chapter follows this format, where only the marginal effects of the covariates with statistically significant coefficients are explicitly discussed.

Table 7.1. Producers' Forecasts

Parameter	ME
Future NAIS Participation	
Years	-1.6511
RegNAIS	9.7144
CProcessors	-0.0821
CFeedlots	0.0864
Future NAIS Participation and RFID Use	
Age	0.3487
OFeed	-2.1543
Cows	-1.1635
RFID	-5.8898
ManNAIS	3.1342

• Source: Calculated from Survey Data Estimation

Producers that have premises currently registered in NAIS and believe that more of the costs from traceability systems are born by feedlot operations than by cow-calf operations forecast higher NAIS premises registrations. Alternatively, producers with more years of experience who believe that more of the cost from traceability systems are born by processors than by cow-calf producers forecast lower NAIS premises registrations.

Economic interpretation of the ME estimates reveals that producers with premises registered in NAIS forecast a 9.71% higher NAIS premises registrations. For every additional percentage of costs a producer perceives being born by processors they forecast 0.08% lower NAIS premises registrations. For every five years of additional experience producers forecast 1.65% lower premises registrations. For every additional percentage of costs a producer perceives being born by feedlots over those born by cow-calf producers, they forecast 0.09% higher NAIS premises registrations.

Older producers who believe NAIS should be a mandatory system forecast higher NAIS premises registrations and RFID use. While producers on larger operations whose feed needs are primarily from on-farm sources and who use RFID for animal ID forecast lower NAIS participation and RFID use. For every additional ten years of age producers forecast 3.94% higher NAIS premises registrations and RFID use. Operators who believe NAIS should be mandatory will forecast 3.13% higher NAIS premises registrations and use of RFID. Alternatively, for every level of beef cows that calved in 2007 increase (see question 14 in survey, Appendix 1) producers will forecast 1.16% lower NAIS participation and RFID use. Increasing the proportion of feed/forage needs that an operation produces on their own farm by 25% is associated with a 2.15% lower forecast for NAIS premises registrations and RFID use. Producers who use RFID for animal ID will forecast 5.89% lower NAIS participation and RFID use.

Although obtaining and identifying these two sets of producer forecasts was identified as one of the objectives; we do not place much value in these forecasts as presented above. There are two primary reasons that lead us to this conclusion. First, this question was the last question of the survey making answers more questionable. Moreover, 9.31% of the producers failed to answer either part of this question. Furthermore, of the completed questions, 9.47% of the answers were nonsensical as producer forecasts for NAIS participation and RFID use were higher than only NAIS participation. Thus, survey design and/or producer understanding (or survey completion fatigue) led to the problems estimating, evaluating, and meeting this objective.

7.1.2 Registration in NAIS

The specific question addressing whether or not producers have their premises registered in NAIS was: *"Are your operation's premise(s) currently registered with the USDA in the NAIS System?"* Variables included in the Probit model to analyze producers' premise registration in NAIS were: *Age*, *CB*, *NP*, *NW*, *SE*, *SP*, *Member*, *Education*, *Years*, *ExpYears*, *Income*, *OIncome*, *Labor*, *OFeed*, *Cows*, *Auctions*, *PTags*, *ENotches*, *Brand*, *Tattoo*, *MTags*, *RFID*, *NoID*, *RegNAIS*, and *ManNAIS*. Of the respondents who responded to this question, forty-four percent of producers indicated that their premises was currently registered in NAIS. Table 7.2 presents the ME estimates for NAIS premise registration.[6]

Table 7.2. NAIS Premise Registration

Parameter	ME
NW	-0.3084
Member	0.0570
RFID	0.4488
ManNAIS	0.0667

• Source: Calculated from Survey Data Estimation

Here, producers who are more active in farm organizations, use RFID on their premises, and believe NAIS should be mandatory are more likely to have their operation's premises registered in the NAIS system. However, producers from the Northwest (relative to the Northern Crescent) are less likely to have their premises registered with NAIS.

Each additional membership in a farm organization increases the likelihood of producers registering their premises by 5.70%. RFID use on a premise increases the likelihood of NAIS premise registration by 44.88%. Producers who believe NAIS should be mandatory are 6.67% more likely to have premises registered. Finally, cow-calf operators in the Northwest are 30.84% less likely than those in the Northern Crescent to have the premises registered with NAIS.

[6] Table 7.2a shows the estimated coefficients and standard errors.

7.1.3 Mandatory NAIS Beliefs

Next, we looked at the question: *"Do you believe that NAIS should be a mandatory system requiring all U.S. cattle producers to participate (please indicate yes, no, or undecided)."* Variables in this discrete multinomial Probit model were: *Age*, *CB*, *NP*, *NW*, *SE*, *SP*, *Member*, *Education*, *Years*, *ExpYears*, *Income*, *Cows*, *Auctions*, the percentage of benefits that retailers, processors, and feedlots receive over cow-calf producers (*BRetailers*, *BProcessors*, and *BFeedlots*, respectively), *CRetailers*, *CProcessors*, *CFeedlots*, and the inverse mills ratio (*InvMills*). Recall, the inverse mills ratio (*InvMills*) is a standardized value representing the prediction/probability of a producer having their premise registered with NAIS. Including this variable in the model allowed us to deal with the inherent endogeneity between whether or not a producer had the premises registered with NAIS and if they believe NAIS should be mandatory.

For the sample used in our model estimation, 21.22% of respondents believe NAIS should be mandatory, 50.32% believe NAIS should not be mandatory, and 28.46% of respondents are undecided concerning mandatory NAIS. Tables 7.3 presents the results of the ME estimates for beliefs concerning whether NAIS should be mandatory under the three possible outcomes (Yes, No, and Undecided).[7] Here, ME's of a given covariate will by definition sum to zero across the given number of responses.[8]

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[7] Table 7.3a presents the estimated coefficients and standard errors.

[8] While the MEs sum to zero (and hence can be inferred from Table 7.3) we have denoted MEs associated with statistically insignificant coefficients by N/A.

Table 7.3. Producers' Beliefs Concerning Mandatory NAIS

	ME		
Parameter	No	Yes	Undecided
Age	0.0015	N/A	-0.0072
CB	-0.3370	0.1549	0.1821
NP	-0.5465	0.2565	0.2900
NW	-0.6665	0.1801	0.4864
SE	-0.4554	0.2410	0.2144
SP	-0.4268	0.3267	0.1001
Member	0.1478	-0.0194	-0.1284
Years	-0.0131	N/A	0.0474
Income	0.0391	N/A	-0.0305
Auctions	-0.1565	N/A	0.2131
BRetailers	0.0020	-0.0015	N/A
CFeedlots	-0.0050	0.0011	0.0039
InvMills	1.3550	-0.5089	-0.8461

• Source: Calculated from Survey Data Estimation

Older producers that are more active in industry organizations, with higher levels of household income, and beliefs that retailers, as opposed to cow-calf producers, receive more of the benefits from traceability systems are more likely to believe NAIS should not be mandatory. While, producers from the Corn Belt, Northern Plains, Northwest, Southeast, and Southern Plains who are less active in industry organizations, and believe feedlots incur more of the costs from traceability systems than cow-calf operations are more likely to answer *Yes or Undecided* when asked if NAIS should be mandatory. Furthermore, producers believing retailers receive less of the benefits from traceability systems than cow-calf producers are more likely in favor of mandatory NAIS. Where as, younger, more experienced producers with a lower level of household income who use local auctions to market their cattle are more likely undecided concerning mandatory NAIS

For every ten years a producer's age increases they are 1.5% more likely to believe NAIS should not be mandatory and 7.2% less likely to be undecided. Producers from the Corn Belt, Northern Plains, Northwest, Southeast, and Southern Plains, as opposed to producers in the Northern Crescent are 33.70%, 54.65%, 66.65%, 45.54%, and 42.68%, respectively, less likely to believe NAIS should not be mandatory; and 15.49%, 25.65%, 18.01%, 24.10%, and 32.67%, respectively, more likely to believe NAIS should be mandatory. While these same producers are 18.21%, 29.00%, 48.64%, 21.44%, and 10.01%, respectively, more likely to be undecided concerning mandatory NAIS. Each addition membership in a farm organization causes producers to be 14.78% more likely to believe NAIS should not be mandatory, 1.94% less likely to believe NAIS should be mandatory, and 12.84% less likely to be undecided. For every additional five years of experience, producers are 1.31% less likely to be in favor of voluntary NAIS and 4.74% more likely to be undecided when asked if NAIS should be mandatory or not. For every $25,000 increase in household income producers are 3.91% more likely to believe NAIS should not be mandatory and 3.05% less likely to be undecided[9]. Producers who believe more of the benefits from traceability systems translate to retailers as opposed to cow-calf producers are 0.21% more likely to be in favor of no mandatory NAIS.

Producers using local auctions to market their cattle are 15.65% less likely to be in favor of voluntary NAIS and 21.31% more likely to be undecided concerning mandatory NAIS. For every additional percentage of benefits a producer believes is received by retailers over those received by cow-calf producers, they are 0.20% more likely to be in favor of voluntary NAIS and 0.15% less likely to be in favor of mandatory NAIS. Similarly, for every additional percentage of costs a producer perceives being

[9] These results and interpretations are not very informative, but do suggest that a continuous variable may have very small effects. In the future, it would be preferable to use a continuous variable to make interpretation more useful.

born by feedlots over those born by cow-calf producers, they are 0.50% less likely to be in favor of voluntary NAIS, 0.11% more likely to believe NAIS should be mandatory, and 0.39% more likely to be undecided.

7.1.4 Important Issues when Implementing Traceability Systems

In meeting our second tier of objectives, we evaluated important issues within the beef industry as they relate to traceability system implementation. As shown by summary statistics presented in Appendix 3, cow-calf producers vary widely in scale and production practices of their operations, so it is crucial to consider how producer specific demographics affect perceptions and concerns of cow-calf producers. Controlling for demographics and production practices is necessary for examining the relative impacts of different factors on perceptions and levels of concerns. The following are the demographics that were included in each model: *Age*, *CB, NP, NW, SE, SP*, *Member*, *Education*, *Years*, *ExpYears*, *Income*, *OIncome*, *Labor*, *OFeed*, *Cows*, *Auctions*, and *RegNAIS*.

A series of discrete ordered Probits were estimated to evaluate how cow-calf producer demographics and production practices influenced cow-calf producer's perceptions and concerns regarding a national, individual animal traceability system. It was important to recognized the possible correlation between various questions due to potentially omitted covariates in each model. As such, it would have been preferable if these equations would have been estimated in a system with all equations being included, however, convergence constraints and software limitations (note there were 18 ordered

Probit models) restricted our ability to do so.[10] Estimating bivariate models on pairs of equations, subjectively identified to be potentially related, regularly identified significant correlation between the two models. However, single-equation ordered Probit models were settled upon as conclusions were not substantially changed as compared to subjective bivariate specifications and convergence was feasible.

We examined responses to the following question, "*In designing a national, individual animal traceability system how important are the following issues in the U.S. beef industry (please circle your answers where 1 = Entirely Unimportant, 2 = Unimportant, 3 = Neutral, 4 = Important, 5 = Very Important).*" This question was asked with specific reference to the following issues: monitoring/managing disease, maintaining current foreign markets, accessing foreign markets, and increasing consumer confidence." Appendix 3 (Tables 23-23h) presents a summary of producer's answers to these questions.

This summary reveals that cow-calf producers believe that the most important issues to the U.S. beef industry in designing a national, individual animal traceability system were monitoring/managing disease and increasing consumer confidence, with over 78% of producers ranking these as *important* or *very important*. Maintaining current foreign markets and accessing foreign markets were seen as important (*important* or *very important*) as indicated by over 50% of producers. This shows that producers are dually concerned with disease implications and marketability of their beef cattle when considering the design of a traceability system.

[10] These eighteen ordered Probits involving the design of a national, individual animal traceability system in the U.S. beef industry included: Eight for important issues, six for producer concerns, and four for common industry statements.

Table 7.4 presents the ME estimates for how important producers feel traceability is for monitoring/managing disease.[11] The ME estimates were interpreted for the *very important* response. Once again given the nature of these particular models, ME's of a given covariate will by definition sum to zero across the given number of responses.

Table 7.4. ME to Monitoring/Managing Disease

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
Age	0.0012	0.0006	0.0013	0.0012	-0.0042
Member	-0.0086	-0.0044	-0.0090	-0.0084	0.0303
Education	-0.0067	-0.0034	-0.0071	-0.0066	0.0239
RegNAIS	-0.0329	-0.0168	-0.0345	-0.0322	0.1164

- Source: Calculated from Survey Data Estimation

Younger producers of higher education, with more active membership in farm organizations, and registered NAIS premises see greater importance (are more likely to respond *very important*) for monitoring/managing disease in designing a national, individual animal traceability system.

For every ten years a producer's age increases they are 4.20% less likely to respond that traceability is *very important* for monitoring/managing disease. Each additional membership in a farm organization causes producers to be 3.03% more likely to respond that traceability is *very important* for monitoring/managing disease. For every level of education increase (see question 5 in survey, Appendix 1) producers are 2.39% more likely to respond that traceability is *very important* for monitoring/managing disease. Producers with their premises registered in NAIS are 11.64% more likely to respond that traceability is *very important* for monitoring/managing disease.

Table 7.5 presents the ME estimates for how important producers feel traceability

[11] Table 7.4a shows the estimated coefficients and standard errors.

is for maintaining current foreign markets.[12]

Table 7.5. ME to Maintaining Current Foreign Markets

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
Age	0.0012	0.0006	0.0015	0.0004	-0.0038
Auctions	0.0337	0.0170	0.0415	0.0115	-0.1038
RegNAIS	-0.0231	-0.0117	-0.0284	-0.0079	0.0712

• Source: Calculated from Survey Data Estimation

Younger producers not using local auctions as their most frequent marketing outlet and with premises registered in NAIS see greater importance (are more likely to respond *very important*) for maintaining current foreign markets. For every ten years a producer's age increases they are 3.80% less likely to respond that traceability is *very important* for maintaining current foreign markets. Producers using local auctions as a marketing outlet are 10.38% less likely to respond that traceability is *very important* for maintaining current foreign markets. Producers with their operation's premises registered in NAIS are 7.12% more likely to respond that traceability is *very important* for maintaining current foreign markets.

Table 7.6 presents the ME estimates for how important producers feel traceability is for accessing foreign markets.[13]

Table 7.6. ME to Accessing Foreign Markets

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
Education	-0.0100	-0.0052	-0.0125	-0.0011	0.0288
Years	-0.0098	-0.0051	-0.0122	-0.0010	0.0281
Auctions	0.0369	0.0192	0.0459	0.0039	-0.1059

• Source: Calculated from Survey Data Estimation

[12] Table 7.5a shows the estimated coefficients and standard errors.
[13] Table 7.6a shows the estimated coefficients and standard errors.

Producers with higher education, more years of experience, not using local auctions as a marketing outlet see greater importance (are more likely to respond *very important*) for accessing foreign markets.

For every level of education increase (question 5 in survey, Appendix 1) producers are 2.88% more likely to respond that traceability is *very important* for accessing foreign markets. For every five years of additional experience, producers are 2.81% more likely to respond that traceability is *very important* for accessing foreign markets. Producers marketing through local auctions are 10.59% less likely to respond that traceability is *very important* for accessing foreign markets.

Table 7.7 presents the ME estimates for how important producers feel traceability is for increasing consumer confidence.[14]

Table 7.7. ME to Increasing Consumer Confidence

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
Age	0.0013	0.0009	0.0014	0.0010	-0.0046
SE	-0.0695	-0.0456	-0.0718	-0.0552	0.2421
Auctions	0.0320	0.0210	0.0331	0.0255	-0.1117
RegNAIS	-0.0224	-0.0147	-0.0232	-0.0178	0.0781

• Source: Calculated from Survey Data Estimation

Younger producers from the Southeast, not using local auctions, with registered NAIS premises see greater importance (are more likely to respond *very important*) for increasing consumer confidence.

For every ten years a producer's age increases they are 4.60% less likely to respond that traceability is *very important* for increasing consumer confidence. Producers in the Southeast are 24.21% more likely than producers in the base region to

[14] Table 7.7a shows the estimated coefficients and standard errors.

respond that traceability is *very important* for increasing consumer confidence.[15] Producers using local auctions are 11.17% less likely to respond that traceability is *very important* for increasing consumer confidence. Producers with their premises registered in NAIS are 7.81% more likely to respond that traceability is *very important* for increasing consumer confidence.

7.1.5 Producer Concerns When Implementing Traceability Systems

Continuing with the second tier of objectives, this thesis evaluated if previously identified concerns regarding traceability within the beef industry were still of top apprehension to participation or have producers perceptions shifted. The second core question for these objectives examined responses to the question: *"In designing a national, individual animal traceability system how concerned are you regarding the following issues in the U.S. beef industry.*" This question was asked with specific reference to the following concerns: cost to participating producer, liability to participating producer, confidentiality of information, reliability of technology, non-participating firms benefiting, and failure of system to meet stated goals. Appendix 3 (Tables 24-24f) provides a summary of producer's answers to this question.

When it came to concerns of implementation of traceability systems producers were concerned (responded as either *concerned* or *very concerned*) with cost (81.43%), liability (78.01%), reliability of technology (75.04%), failure of system to meet stated goals (73.92%), confidentiality of information (71.42%), and non-participating firms benefiting (60.45%).

[15] Base region consists of the following states in the Northern Crescent region of the U.S.: MN, WI, CT, ME, MD, MA, NH, NJ, NY, PA, RI, and VT. This region comprises 3.70% of the survey population.

Table 7.8 presents the ME estimates for how concerned producers are with the costs associated with traceability systems.[16]

Table 7.8. ME to Concerns Regarding System Cost

	ME				
Parameter	Entirely Unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
Age	0.0013	0.0010	0.0022	0.0022	-0.0066
Years	-0.0086	-0.0065	-0.0151	-0.0147	0.0449
OFeed	-0.0103	-0.0078	-0.0182	-0.0176	0.0539
Cows	-0.0099	-0.0075	-0.0175	-0.0169	0.0518

- Source: Calculated from Survey Data Estimation

We found younger producers are more likely to be *very concerned* with the entire list of issues in designing a national, individual animal traceability system. Producers with more years of experience in larger operations that produce a larger proportion of their own feed are more likely to view cost to the participating producer as a main concern (are more likely to respond *very concerned*). For every ten years a producer's age increases they are 6.60% less likely to respond being *very concerned* with cost to the participating producers. For every five years of additional experience producers are 4.49% more likely to respond being *very concerned* with cost to the participating producers. Increasing the proportion of feed/forage needs that an operation produces on their own farm by 25% is associated with a 5.39% increase in odds of being *very concerned* with cost of a traceability system. For every level of beef cows that calved in 2007 increase (see question 14 in survey, Appendix 1) producers are 5.18% more likely to respond to being *very concerned* with cost.

Table 7.9 presents the ME estimates for how concerned producers are with

[16] Table 7.8a shows the estimated coefficients and standard errors.

increased liability from traceability systems.[17]

Table 7.9. ME to Concerns Regarding System Liability

	ME				
Parameter	Entirely Unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
Age	0.0014	0.0016	0.0037	0.0022	-0.0089
NP	-0.0252	-0.0289	-0.0647	-0.0391	0.1579
SE	-0.0413	-0.0474	-0.1062	-0.0642	0.2591
SP	-0.0300	-0.0344	-0.0770	-0.0466	0.1879
Years	-0.0080	-0.0091	-0.0204	-0.0124	0.0498
OFeed	-0.0057	-0.0065	-0.0147	-0.0089	0.0358
Cows	-0.0056	-0.0064	-0.0143	-0.0087	0.0349

- Source: Calculated from Survey Data Estimation

Producers in the Northern Plains, Southeast, and Southern Plains, as opposed to producers in the Northern Crescent, with more years of experience, larger operations that produce a large proportion of their own feed revealed heightened concern (are more likely to respond *very concerned*) over the liability to the participating producer a traceability system brings.

For every ten years a producer's age increases they are 8.90% less likely to respond being *very concerned* with liability to the participating producer. Producers in the Northern Plains, Southeast, and Southern Plains are 15.79%, 25.91%, and 18.79%, respectively, more likely than producers in the base region to respond to being *very concerned* with the liability to the participating producer.[18] For every five years of additional experience producers are 4.98% more likely to respond to being *very concerned* with liability. Increasing the proportion of feed/forage needs that an operation produces on their own farm by 25% is associated with a 3.58% increase in odds of being *very concerned* with liability. Furthermore, for every level of beef cows that calved in

[17] Table 7.9a shows the estimated coefficients and standard errors.
[18] Base region consists of the following states in the Northern Crescent region of the U.S.: MN, WI, CT, ME, MD, MA, NH, NJ, NY, PA, RI, and VT. This region comprises 3.70% of the survey population.

2007 increase (see survey) producers are 3.49% more likely to respond to being *very concerned* with liability to the participating producer.

Table 7.10 presents the ME estimates for how concerned producers are with confidentiality of information.[19]

Table 7.10. ME to Concerns Regarding Confidentiality

	ME				
Parameter	Entirely Unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
Age	0.0020	0.0013	0.0023	0.0009	-0.0064
Years	-0.0204	-0.0135	-0.0239	-0.0090	0.0668
OIncome	0.0076	0.0051	0.0089	0.0034	-0.0250
Labor	0.0121	0.0080	0.0142	0.0054	-0.0397

• Source: Calculated from Survey Data Estimation

Producers with more years of experience, whose primary source of income is from the farm operation, and hire a low proportion of labor are more likely to view confidentiality of information as a top concern (are more likely to respond *very concerned*) in program design. For every ten years a producer's age increases they are 6.40% less likely to respond being *very concerned* with confidentiality of information. For every five years of additional experience producers are 6.68% more likely to respond to being *very concerned* with confidentiality of information. Increasing the proportion off-farm income by 20% is associated with a 2.50% decrease in odds of being *very concerned* with the confidentiality of traceability information. Similarly, increasing the proportion of hired (non-family) labor on an operation by 25% is associated with a 3.97% decrease in the probability of being *very concerned* with confidentiality.

Table 7.11 presents the ME estimates for how concerned producers are with the

[19] Table 7.10a shows the estimated coefficients and standard errors.

reliability of traceability technology.[20]

Table 7.11. ME to Concerns Regarding Reliability

	ME				
Parameter	Entirely Unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
Age	0.0008	0.0008	0.0020	0.0008	-0.0045
NP	-0.0364	-0.0361	-0.0893	-0.0377	0.1995
NW	-0.0391	-0.0387	-0.0958	-0.0405	0.2141
SE	-0.0450	-0.0446	-0.1105	-0.0467	0.2469
SP	-0.0408	-0.0404	-0.1001	-0.0423	0.2236
Years	-0.0081	-0.0080	-0.0198	-0.0084	0.0443
Income	-0.0047	-0.0047	-0.0116	-0.0049	0.0259
OFeed	-0.0068	-0.0067	-0.0167	-0.0071	0.0373
Cows	-0.0049	-0.0048	-0.0119	-0.0050	0.0266

• Source: Calculated from Survey Data Estimation

Operators outside the Northern Crescent and the Corn Belt, with more years of experience, a higher level of household income, on larger operations that produce a larger proportion of their own feed are more likely to indicate reliability of technology is a major concern (are more likely to respond *very concerned*) in designing a national, individual animal traceability system. For every ten years a producer's age increases they are 4.50% less likely to respond being *very concerned* with the reliability of traceability technology. Producers in the Northern Plains, Northwest, Southeast, and Southern Plains are 19.95%, 21.41%, 24.69%, and 22.36%, respectively, more likely than producers in the base region to respond to being *very concerned* with the reliability of traceability technology.[21] For every five years of additional experience producers are 4.43% more likely to respond to being *very concerned* with reliability of technology. For every level $25,000 increase in household income producers are 2.59% more likely to indicate being

[20] Table 7.11a shows the estimated coefficients and standard errors.

[21] Base region consists of the following states in the Northern Crescent region of the U.S.: MN, WI, CT, ME, MD, MA, NH, NJ, NY, PA, RI, and VT. This region comprises 3.70% of the survey population.

very concerned with technology reliability. Increasing the proportion of feed/forage needs that an operation produces on their own farm by 25% is associated with a 3.73% increase in odds of being *very concerned* with reliability. Furthermore, for every level of beef cows that calved in 2007 increase (see survey question 14) producers are 2.66% more likely to respond to being *very concerned* with reliability of the technology of an implemented traceability system.

Table 7.12 presents the ME estimates for how concerned producers are with non-participating firms benefiting.[22]

Table 7.12. ME to Concerns Regarding Non-Participating Firms Benefiting

	ME				
Parameter	Entirely Unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
Age	0.0013	0.0011	0.0020	-0.0003	-0.0041
Years	-0.0118	-0.0098	-0.0175	0.0025	0.0364
OFeed	-0.0102	-0.0085	-0.0152	0.0022	0.0316
Cows	-0.0071	-0.0059	-0.0106	0.0015	0.0221

- Source: Calculated from Survey Data Estimation

Producers with more years of experience with larger operations that produce a large proportion of their own feed are more likely to view non-participating firms benefiting as a key concern (are more likely to respond *very concerned*). For every ten years a producer's age increases they are 4.10% less likely to respond being *very concerned* with non-participating firms benefiting from implemented traceability systems. For every five years of additional experience producers are 3.64% more likely to respond to being *very concerned* with non-participating firms benefiting. Increasing the proportion of feed/forage needs that an operation produces on their own farm by 25% is associated with a 3.16% increase in odds of being *very concerned* with non-

[22] Table 7.12a shows the estimated coefficients and standard errors.

participating firms benefiting. Furthermore, for every level of beef cows that calved in 2007 increase (see survey question 14) producers are 2.21% more likely to respond to being *very concerned* with non-participating firms benefiting.

Table 7.13 presents the ME estimates for how concerned producers are with the failure of a traceability system to meet stated goals.[23]

Table 7.13. ME to Concerns Regarding System Failures

	ME				
Parameter	Entirely Unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
Age	0.0008	0.0007	0.0017	0.0006	-0.0037
NP	-0.0398	-0.0333	-0.0807	-0.0286	0.1825
NW	-0.0396	-0.0332	-0.0804	-0.0285	0.1817
SE	-0.0441	-0.0370	-0.0895	-0.0317	0.2023
SP	-0.0500	-0.0419	-0.1014	-0.0359	0.2291
Years	-0.0083	-0.0070	-0.0169	-0.0060	0.0383
OFeed	-0.0100	-0.0084	-0.0203	-0.0072	0.0459

• Source: Calculated from Survey Data Estimation

Cow-calf producers in the Northern Plains, Northwest, Southeast, and Southern Plains, as opposed to producers in the Northern Crescent, with more years of experience in operations that produce a large proportion of their own feed are more likely to be *very concerned* with the failure of a traceability system to meet stated goals.

For every ten years a producer's age increases they are 3.70% less likely to respond being *very concerned* with non-participating firms benefiting from implemented traceability systems. Producers in the Northern Plains, Northwest, Southeast, and Southern Plains are 18.25%, 18.17%, 20.23%, and 22.91%, respectively, more likely than producers in the base region[24] to respond to being *very concerned* with the failure of a system to meet stated goals. For every five years of additional experience producers are

[23] Table 7.13a shows the estimated coefficients and standard errors.
[24] Base region consists of the following states in the Northern Crescent region of the U.S.: MN, WI, CT, ME, MD, MA, NH, NJ, NY, PA, RI, and VT. This region comprises 3.70% of the survey population.

3.83% more likely to respond being *very concerned* with the failure of a traceability system to meet stated goals. Increasing the proportion of feed/forage needs that an operation produces on their own farm by 25% is associated with a 4.59% greater likelihood of producers being *very concerned* with the failure of a traceability system to meet stated goals.

7.1.6 Issues in the Beef Industry when Implementing Traceability Systems

In the third and final set of producer perceptions we evaluated the question, *"Please circle your level of agreement with each of the following statements concerning implementing individual animal traceability systems: Is more cost effective for larger cow-calf operations, results in more liability for cow-calf producers than cattle owners at other stages of production, is unnecessary if COOL (Country-of-Origin Labeling) was implemented nationally, and as a mandated system is exaggerated in need."* Appendix 3 (Tables 25-25d) provides a summary of producer's answers to this question.

This sample summary reveals that 47.50% of cow-calf producers believe COOL is more important than a proposed traceability system. Table 7.14 presents the ME estimates of producers' perceptions concerning COOL implementation[25].

Table 7.14. ME to Implementation of COOL

	ME				
Parameter	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Education	0.0118	0.0111	0.0053	-0.0062	-0.0221
Years	-0.0151	-0.0143	-0.0068	0.0079	0.0283
OIncome	0.0139	0.0131	0.0063	-0.0073	-0.0260
Auctions	-0.0373	-0.0352	-0.0168	0.0195	0.0697
RegNAIS	0.0468	0.0442	0.0211	-0.0245	-0.0876

• Source: Calculated from Survey Data Estimation

[25] Table 7.14a shows the estimated coefficients and standard errors.

Cow-calf operators with more years of experience, lower education, with a large percentage of income from the farm, who use local auctions as a marketing outlet, and do not have their premises registered with NAIS are more likely to agree that implementing individual traceability systems is unnecessary if COOL was implemented nationally. For every ten years a producer's age increases they are 2.21% less likely to agree that traceability is unneeded if COOL was implemented. For every five years of additional experience, producers are 2.83% more likely to agree that traceability is unneeded if COOL was implemented. Every education level increase (see survey question 5) causes producers to be 2.21% less likely to agree that COOL could replace traceability. Producers who use local auctions to market their cattle are 6.97% more likely, while producers with registered premises in NAIS are 8.76% less likely to agree that implementing individual traceability systems is unnecessary if COOL was implemented nationally. Results concerning the remaining statements in this question can be found in Appendix 4.

7.2 Choice Experiment Analysis

The following set of estimates reveals the results from the MNL, RPL, and LCM (3-segment) model estimations. The RPL and LCM models were both preferred (via Log-likelihood ratio (LR) tests) to the MNL model. This suggests significant preference heterogeneity exists among our sample of producers.

7.2.1 Multinomial Logit Model

Table 7.15 presents the MNL point estimates as well as standard errors.

Table 7.15. Multinomial Logit Estimates

Parameter	Coefficient	Standard Error
PD	0.0340***	0.0073
No Trace	-0.0485	0.4532
Advanced Trace	-0.2518	0.4472
PvtI	-0.0159	0.1043
PvtNI	0.1013	0.1032
PP	0.6369***	0.2345
PG	0.5227**	0.2309
HR	-0.1135	0.2456
AVPP	-0.1508	0.1577
AVPG	-0.1945	0.2452
AVHR	0.3881**	0.1682
PPPG	-0.2067	0.2430
PPHR	-0.2383	0.1584
PG & HR	0.0029	0.2275
AVPPPG	-0.0508	0.2331
AVPPHR	0.4818***	0.1694
PPPGHR	-0.2124	0.1621
AVPPPGHR	-0.9330***	0.2416
Adv Trace * Cows	0.0620	0.0406
No Trace * Cows	0.0973***	0.0440
Adv Trace * Auctions	-0.1186	0.1232
No Trace * Auctions	0.4527***	0.1343
Adv Trace * Member	0.1011**	0.0496
No Trace * Member	-0.1980***	0.0538
Adv Trace * Years	-0.1099***	0.0390
No Trace * Years	0.0129	0.0422
Adv Trace * IndvID	0.9874*	0.2583
No Trace * IndvID	0.0965	0.2130
Adv Trace * GrpID	0.0345	0.1595
No Trace * GrpID	-0.2513	0.1689
Adv Trace * NotID	0.7568*	0.3886
No Trace * NotID	1.0421***	0.3543
Adv Trace * CB	-0.3336	0.3091
No Trace * CB	-0.2952	0.3370
Adv Trace * NP	-0.1149	0.3051
No Trace * NP	-0.0363	0.3353
Adv Trace * NW	-0.4340	0.3102
No Trace * NW	0.0807	0.3398
Adv Trace * SE	-0.8857***	0.3133
No Trace * SE	-0.5664*	0.3412
Adv Trace * SP	-0.9271***	0.3210
No Trace * SP	-0.2818	0.3457

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

The MNL model results (Table 7.15) show that, when comparing alternative traceability programs, cow-calf producers are sensitive to price adjustments. This suggests voluntary participation in traceability programs deemed undesirable to the representative cow-calf producer may be accomplished by offering premiums for participation, it also suggests participation may be enhanced by markets penalizing non-participants. As previously noted, this evaluation of *Advanced Traceability* systems considered multiple pieces (and combinations) of required information to be provided. The MNL model suggests producers would prefer to provide production practice (PP) or performance/genetic (PG) information rather than provide age verification (AV). However, for programs characterized with AV as a requirement, producers appear to prefer providing both AV and health certification/vaccination records (HR) instead of solely AV. Similarly, producers prefer to provide the combination of AV, PP, and HR information, rather than solely provide AV. This suggests producers may see value in providing this additional information once AV is required. However, producers do have a strong preference against programs requiring all four evaluated information components of AV, PP, PG, and HR. This evaluation allowed us to rank the preferred information content components of *Advanced Traceability* systems. Implied rankings are as followed: (1) AV, PP, and HR, (2) PG, (3) PP, (4) AV and HR, (5-13) AV and the insignificant (relative to AV) combinations, and (14) AV, PP, PG, and HR.

The inclusion of demographics (via interaction terms) in the MNL model allowed for further examination of the types of producers valuing *NAIS, Advanced Traceability,* and *No Traceability* options differently. Producers who are active in industry associations, have less years of experience, use individual or no/other animal identification, and do not operate in the Southern Plains are more likely to prefer *Advanced Traceability* systems over *NAIS.* Alternatively, producers who have larger operations, use local auctions to market their cattle, are less active in industry associations, use no/other animal identification, and are not from the Southeast are more likely to prefer *No Traceability* to *NAIS.*

Individual coefficients are generally of limited value with more insights being ascertained from combinations of multiple coefficients. Of particular interest are estimates of producers' willingness-to-accept (WTA) estimates. Table 7.16 provides WTA estimates for the MNL model. The *No Traceability* (No Trace) and *Advanced Traceability* (Adv Trace) WTA values were calculated at the mean values of each producer demographic variable (*Cows, Auctions, Member, Years, IndvID, GrpID, NotID, CB, NP, NW, SE, and SP*) included in the model.

Table 7.16. Multinomial Logit Willingness-to-Accept

Parameter	WTA	95% Confidence Interval
No Trace (vs. NAIS)	$2.17	[$14.28, -$13.36]
Adv Trace (vs. NAIS)	-$1.78	[$6.76, -$7.70]
PvtI (vs. Gov't)	-$0.93	[$12.19, -$14.34]
PvtNI (vs. Gov't)	$5.96	[$19.56, -$6.27]
PP (vs. AV)	$37.43	[$70.30, $11.28]
PG (vs. AV)	$30.72	[$65.24, $5.42]
HR (vs. AV)	-$6.67	[$23.67,-$37.97]
AVPP (vs. AV)	-$8.86	[$10.47, -$31.32]
AVPG (vs. AV)	-$11.43	[$22.28, -$42.24]
AVHR (vs. AV)	$22.81	[$47.75, $3.78]
PPPG (vs. AV)	-$12.15	[$16.01, -$43.48]
PPHR (vs. AV)	-$14.01	[$6.25, -$36.58]
PGHR (vs. AV)	$0.17	[$29.32, -$28.43]
AVPPPG (vs. AV)	-$2.98	[$28.04, -$34.48]
AVPPHR (vs. AV)	$28.32	[$51.45, $10.13]
PPPGHR (vs. AV)	-$12.49	[$4.87, -$35.96]
AVPPPGHR (vs. AV)	-$54.84	[-$30.25, -$91.15]

- Source: Calculated from Survey Data Estimation
- All presented values are in $/animal.

It is worth noting that the results of the MNL model imply the representative producer is indifferent between the three evaluated programs (*NAIS, Advanced Traceability*, and *No Traceability*) as well as to the managing entity of the evaluated programs (insignificant WTA estimates). However, producers appear to be sensitive to the information required for participation. In comparing two traceability systems requiring only one piece of additional information, producers must be paid $37.43/animal in a system seeking AV to make them indifferent between providing AV and providing PP information in an alternative system. Similarly, producers will accept discounts (relative to alternative traceability systems) up to $30.72/animal before they will participate in a system requiring AV rather than a system solely requiring PG information. However, as noted above, in evaluating multiple traceability systems that each require the provision of AV, producers appear to prefer providing additional information. In particular, table 7.16 suggests that a traceability system requiring both AV and HR or requiring in combination AV, PP, and HR are preferred to those solely requiring AV. The estimates of $22.81/animal and $28.32/animal imply producers would actually accept discounts of these two amounts for providing these information combinations, rather than simply providing AV.

While this result may seem counter-intuitive, a potential explanation would be producers are anticipating some reward (beyond immediate price/head adjustments) for providing this information and hence are readily willing to provide it in systems characterized by age verification requirements. That is, AV may be a "threshold attribute" that once required results in other attributes (PP and HR) being easily provided as well. However, producers maintain a preference to not be required to provide too much information. This is evident from the estimate that producers would accept a discount of $54.84/animal before they would provide all four information components (AV, PP, PG, and HR) rather than simply provide AV.

As previously noted, standard MNL models may be limiting because they do not allow for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors over time. Therefore, additional models, including RPL and LCM models, were estimated and results shown below.

7.2.2 Random Parameter Logit Model

As previously mention a LR test lead to rejection of the MNL model for the RPL model. Table 7.17 presents point estimates and standard errors for the RPL model.

Table 7.17. Random Parameter Logit Estimates

Parameter	Coefficient	Standard Error
	Random parameters in utility functions	
No Trace	-1.0278	2.3343
Adv Trace	-1.8904	1.6992
	Nonrandom parameters in utility functions	
PD	0.1226***	0.0174
PvtI	0.2909	0.2016
PvtNI	-0.0363	0.2322
PP	2.0239***	0.5233
PG	1.3677***	0.5027
HR	-1.0858*	0.6112
AVPP	0.0821	0.3799
AVPG	-1.5800**	0.6474
AVHR	0.7959**	0.3504
PPPG	-1.0351*	0.5525
PPHR	-0.5817	0.3606
PGHR	0.1060	0.5631
AVPPPG	0.2580	0.5641
AVPPHR	1.6073***	0.5066
PPPGHR	-0.2458	0.3308
AVPPPGHR	-1.8135***	0.5322
Adv Trace * Cows	0.2581	0.1990
No Trace * Cows	0.4687*	0.2666

Table 7.17 (cont'd)

Parameter	Coefficient	Standard Error
Adv Trace * Auctions	-0.0833	0.5649
No Trace * Auctions	1.5573*	0.8051
Adv Trace * Member	0.0506	0.2438
No Trace * Member	-0.8179**	0.3298
Adv Trace * Years	-0.3062	0.1883
No Trace * Years	-0.0056	0.2693
Adv Trace * IndvID	2.7739**	1.0833
No Trace * IndvID	0.0494	1.4130
Adv Trace * GrpID	0.2023	0.6674
No Trace * GrpID	-0.5046	0.9526
Adv Trace * NotID	2.4064	1.6834
No Trace * NotID	3.2783	2.0482
Diagonal values in Cholesky matrix, L.		
No Trace	6.6582***	0.6847
Adv Trace	3.5514***	0.3106
Below diagonal values in L matrix.		
Adv Trace: No Trace	2.66525***	0.5517
Standard deviations of parameter distributions		
Stand. Dev. of No Trace	6.6582***	0.6847
Stand. Dev. of Adv Trace	4.4402***	0.4233

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

The RPL model results (Table 7.17) show that, when comparing alternative traceability programs, cow-calf producers are sensitive to price adjustments. As noted in the previous model, these RPL model results suggest that participation in traceability programs deemed undesirable to the representative cow-calf producer may be accomplished by offering premiums for participation or participation may be influenced by markets penalizing non-participation. The evaluation of *Advanced Traceability* systems through the RPL model considered the same multiple pieces (and combinations) of required information to be provided to producers as was the case in the MNL model. As in the MNL model, the RPL model suggests producers would prefer to provide PP or PG information rather than provide AV. On the other hand, the RPL model implies that producers would prefer to provide HR as opposed to providing AV. For programs characterized with AV, as a requirement, producers appear to prefer providing both AV and PP, as well as, AV and HR instead of solely AV. Similarly, producers prefer to provide the combination of AV, PP, and HR information, rather than solely provide AV. As previously explained, this suggests producers may see value in providing this additional information once AV is required. However, producers do have a strong preference against programs requiring all four evaluated information components of AV, PP, PG, and HR. Further evaluation reveals that producers would prefer to provide AV individually to AV and PG or PP and PG. An implied ranking of the preferred information content components of advanced traceability systems was: (1) PP, (2) AV, PP, and HR, (3) PG, (4) AV and HR, (5) AV and PP, (6 -10) AV and the insignificant (relative to AV) combinations, and (11) PP and PG, (12) HR, (13) AV and PG, and (14) AV, PP, PG, and HR.

The inclusion of demographics (via interaction terms) in the RPL model allowed for further examination of the types of producers valuing *NAIS, Advanced Traceability, and No Traceability* options differently. Producers who use individual animal identification are more likely to prefer *Advanced Traceability* systems over *NAIS.* Producers who have larger operations, use auctions, and are less active in industry associations are more likely to prefer *No Traceability* to *NAIS.*

To further evaluate preference heterogeneity in the RPL model the estimated Cholesky matrix was examined. The diagnol values of the Cholesky matrix represent the true value of variance for each random parameter once the cross-correlated parameters terms have be uncofounded (Hensher, Rose, and Green, 2006). Both random parameters, *No Trace* and *Adv Trace*, were estimated to have statistically significant diagnol

Cholesky elements. This provides evidence of preference heterogeneity persisting for each traceability system, even after incorporating producer characteristics.

Examination of the off-diagnol elements (*Adv Trace: No Trace*) of the Cholesky matrix reveals a statistically significant (0.001) estimate. This suggests a significant cross-correlation among the random parameter estimates would have been inappropriatel confused within standard deviation estimates of each random parameter without Cholesky matrix decomposition and evaluation (Tonsor et al., 2008). Evaluation of the correlation term reveals the *No Trace* and *Adv Trace* variables to generally be positively correlated within the population. This suggests *Advanced Traceability* and *No Traceability* are closer substitutes than suggested by the non-stochastic portion of the model (Alfines, 2004).

Interpretation of individual coefficients must be made with caution and is generally discouraged in random utility models (Scarpa and Del Giudice, 2004). Caution is particularily warranted in these models given differences in scales and the number of interaction terms between producer characteristics and traceability system attributes (Tonsor et al., 2008). Table 7.18 provides WTA estimates for the RPL model.

Table 7.18. Random Parameter Logit Willingness-to-Accept

Parameter	WTA	95% Confidence Interval
No Trace (vs. NAIS)	$0.51	[$11.90, -$12.16]
Adv Trace (vs. NAIS)	$1.10	[$7.98, -$5.57]
PvtI (vs. Gov't)	$4.75	[$11.97, -$1.86]
PvtNI (vs. Gov't)	-$0.59	[$7.23, -$7.91]
PP (vs. AV)	$33.03	[$51.58, $16.29]
PG (vs. AV)	$22.32	[$39.86, $6.11]
HR (vs. AV)	-$17.72	[$3.19, -$38.46]
AVPP (vs. AV)	$1.34	[$13.19, -$10.91]
AVPG (vs. AV)	-$25.79	[-$4.21, -$50.67]
AVHR (vs. AV)	$12.99	[$24.82, $1.40]
PPPG (vs. AV)	-$16.89	[$0.46, -$35.46]
PPHR (vs. AV)	-$9.49	[42.45, -$20.93]
PGHR (vs. AV)	$1.73	[$21.28, -$18.61]
AVPPPG (vs. AV)	$4.21	[$21.70, -$15.17]
AVPPHR (vs. AV)	$26.23	[$42.54, $9.49]
PPPGHR (vs. AV)	-$4.01	[$6.25, -$15.34]
AVPPPGHR (vs. AV)	-$29.60	[-$11.96, -$48.54]

- Source: Calculated from Survey Data Estimation
- All presented values are in $/animal.

As was the case in the MNL model, these results imply producers are indifferent between the three evaluated programs (*NAIS, Advanced Traceability*, and *No Traceability*) as well as to the managing entity of the evaluated programs. However, producers appear to be sensitive to the information required for participation. Producers must be compensated $33.03/animal in a system seeking AV to make them indifferent to participating in an alternative system solely requiring PP information. Similarly, producers will accept discounts up to $22.32/animal before they will provide AV rather than PG information. In evaluating multiple traceability systems that each require the provision of AV, producers appear to prefer providing some combinations of additional information. In particular, Table 7.18 suggests that a traceability system requiring both AV and HR or requiring in combination AV, PP, and HR are preferred to those solely requiring age verification. The estimates of $12.99/animal and $26.23/animal imply producers would actually accept discounts of these two amounts for providing these information combinations, rather than simply providing AV. As explained previously, producers could be anticipating some reward for providing this information and hence are readily willing to provide it in systems characterized by age verification requirements. However, producers maintain a preference to not be required to provide too much information. This is evident from the estimate that producers would accept a discount of \$25.79/animal before they would provide AV and PG rather than provide AV solely. Similarly, producers would accept a discount of \$29.60/animal before they would provide all four information components (AV, PP, PG, and HR) rather than simply provide AV.

Although RPL models do account for heterogeneity, a LCM strategy may be more suited for capturing this heterogeneity as it assumes that producers can be separated into different segments such that producers within each segment have homogeneous preferences, but that preferences vary across producers from alternative segments. Thereby identifing marketing segments of producers likely to support alternative traceability systems. Furthermore, LCM models have been found to be better suited for identifying individuals with heterogeneous preferences thanRPL models (Ouma et al., 2007).

7.2.3 Latent Classification Model

The LCM model was determined to be preferred to the RPL model because the LCM model accounted for producer heterogeneity and allowed for the identification of marketing segments. Furthermore, utilizing a LR test determined the LCM model was preferred to the MNL model. The segmentation of producers into marketing segments will help better identify how traceability systems should be designed and promoted in order to improve voluntary participation rate.

Following Boxall and Adamowicz (2002) allowed for identification of the number of segments minimizing the Bayesian Information Criterion (BIC), with three segments being preferable.[26] This LCM 3-segment model evaluates producer's preferences across three very distinct segments. For the purposes of interpretation segment one is named the *Advanced Traceability Preferring* segment (37.1% of producers), segment two the *No Traceability Preferring* segment (27.4%), and segment three the *NAIS Traceability Preferring* segment (35.5% of producers). These segment names are only used for ease in interpretation, with each segment being comprised of many more distinct characteristics that will be discussed in the following interpretation. Table 7.19 shows the coefficient and standard errors for the 3-segment LCM Model.

[26] Alternative models, for instance containing different covariates, in some cases produced models where 4-segments were preferred. However, in certain cases these 4-segment models had convergence issues, therefore a 3-segment model was selected.

Table 7.19. Latent Class Model Estimates

	Advanced Traceability Preferring		No Traceability Preferring		NAIS Traceability Preferring	
Parameter	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err
PD	0.0707***	0.0215	0.0667**	0.0327	0.0887***	0.0117
No Trace	0.0704	0.3509	4.6459***	0.5991	-2.2121***	0.1963
Adv Trace	1.8530***	0.3621	0.3488	0.6591	-3.0429***	0.2233
PvtI	-0.1030	0.2455	1.0780***	0.4038	0.4159***	0.1575
PvtNI	0.5003	0.3196	-0.1010	0.3956	0.2538	0.1643
PP	0.4558	0.7943	3.1588***	0.7521	1.2545***	0.3185
PG	-0.6730	0.7102	2.6228***	0.6179	1.1112***	0.2962
HR	-0.3344	0.7238	0.1829	0.8623	-1.8159***	0.5961
AVPP	0.7713	0.6458	1.0717*	0.5877	-0.1700	0.2856
AVPG	-1.0177**	0.4678	-3.9381	3.9887	-1.6913***	0.6392
AVHR	-0.4046	0.4350	-0.0289	0.8684	0.3256	0.2730
PPPG	-1.1796***	0.4438	-1.8622	3.9656	1.2823***	0.4321
PPHR	0.0836	0.6106	-0.2602	0.7805	-0.4239	0.3019
PGHR	2.1897	1.3511	-2.2191	4.0670	0.6836	0.4732
		-----Demographics------				
	THETA(1) in Class Model		*THETA(2) in Class model*		Base	
	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err
Constant	-0.6557	0.7791	-0.1864	0.7148	N/A	N/A
Cows	0.0553	0.0815	0.1178	0.0884	N/A	N/A
Auctions	-0.1560	0.2424	0.4719*	0.2666	N/A	N/A
Member	0.0814	0.0985	-0.2628**	0.1107	N/A	N/A
Years	-0.0787	0.0731	-0.0831	0.0731	N/A	N/A
IndvID	1.0116*	0.5550	0.0740	0.4334	N/A	N/A
GrpID	-0.0346	0.2923	-0.0616	0.3051	N/A	N/A
NotID	1.0265	0.8799	1.2244	0.7565	N/A	N/A

- Source: Calculated from Survey Data Estimation
- ***1% significance level, ** 5% significance level, * 10% significance level

The LCM results (Table 7.19) show that, when comparing alternative traceability programs, cow-calf producers in each segment are sensitive to price adjustments. Suggesting, consistent with the MNL and RPL model results, that participation in traceability programs deemed undesirable to the representative cow-calf producer may be accomplished by offering premiums for participation or participation may be influenced by markets penalizing non-participation. The evaluation of *Advanced Traceability* systems through the LCM considered the single pieces and pairs of required information to be provided to producers.[27]

In evaluating the *Advanced Traceability Preferring* class (segment 1), the LCM suggests producers would prefer *Advanced Traceability* systems. Results show that producers would prefer to solely provide AV over providing AV and PG information or providing PP and PG information. Producers in the *No Traceability Preferring* class (segment 2) prefer *No Traceability* as the name suggests, as well as prefer a system that has a private-Industry managing entity. These producers would prefer to provide PP or PG information to providing AV solely. However, for programs characterized with AV, as a requirement, producers appear to prefer providing both AV and PP information instead of individually AV. The final class, *NAIS Traceability Preferring* (segment 3), producers prefer *NAIS Traceability* to *No Traceability* and *Advanced Traceability*. Note that these producers also prefer *No Traceability* to *Advanced Traceability*. Within a traceability system they would prefer a system with a private-industry managing entity. For this *NAIS Preferring* class the LCM suggests producers would prefer to provide PP or PG information or PP and PG information rather than provide just AV. On the other

[27] Due to convergence issues with the LCM model only single and pairs of additional information were included, as opposed to the full set of additional information combinations that were included in the MNL and RPL models.

hand, this model shows that producers would prefer to provide AV as opposed to providing HR. As shown with previous models producers do have a preference against programs requiring too much information, as producers would rather provide AV than AV and PG information.

Inclusion of demographics in the LCM allows further examination of the types of producers valuing *NAIS, Advanced Traceability, and No Traceability* options differently. Producers using individual animal identification are more likely to be in segment 1 and prefer *Advanced Traceability* to *NAIS Traceability*. Producers who are less active amongst industry associations and use local auctions are more likely to be in segment 2 and prefer *No Traceability* to *NAIS Traceability*.

As previously mentioned, individual coefficients are generally of limited value with more insights being ascertained from combinations of multiple coefficients. Of particular interest are estimates of producers' WTA estimates. Table 7.20 provides the WTA estimates for the LCM model.

Table 7.20. Latent Class Model Willingness-to-Accept

	Advanced Traceability Preferring	No Traceability Preferring	NAIS Traceability Preferring
Parameter	WTA	WTA	WTA
No Trace	-$4.63	$55.00	-$32.49
(vs. NAIS)	[$11.40, -$28.43]	[$259.07, $21.34]	[-$21.59, -$46.55]
Adv Trace	$26.22	$5.23	-$34.30
(vs. NAIS)	[$77.13, $11.69]	[$60.07, -$18.06]	[-$27.23, -$43.42]
PvtI	-$2.91	$32.32	$9.38
(vs. Gov't)	[$11.69, -$21.35]	[$119.71, $10.04]	[$17.88, $2.67]
PvtNI	$14.16	-$3.03	$5.72
(vs. Gov't)	[$40.20, -$4.36]	[$48.07, -$35.53]	[$13.17, -$1.69]
PP	$12.90	$94.71	$28.28
(vs. AV)	[$69.55, -$36.19]	[$407.71, $44.57]	[$44.45, $14.15]
PG	-$19.05	$78.64	$25.05
(vs. AV)	[$24.89, -$65.98]	[$428.55, $23.03]	[$43.24, $11.93]
HR	-$9.46	$5.48	-$40.94
(vs. AV)	[$49.39, -$45.56]	[$212.86, -$33.28]	[-$17.23, -$69.04]
AVPP	$21.83	$32.13	-$3.83
(vs. AV)	[$76.76, -$16.47]	[$153.90, -$8.44]	[$9.83, -$15.34]
AVPG	-$28.80	-$118.07	-$38.13
(vs. AV)	[-$2.23, -$82.74]	[$193.71, -$739.35]	[-$10.58, -$73.26]
AVHR	-$11.45	-$0.87	$7.34
(vs. AV)	[$12.97, -49.45]	[$157.23, -$43.71]	[$23.82, -$4.68]
PPPG	-$33.39	-$55.83	$28.91
(vs. AV)	[-$6.41, -$108.96]	[$293.13, -$625.22]	[$47.41, $9.90]
PPHR	$2.37	-$7.80	-$9.56
(vs. AV)	[$44.80, -$36.97]	[$70.48, -$111.33]	[$4.46, -$24.01]
PGHR	$61.98	-$66.54	$15.41
(vs. AV)	[$184.17, -$12.72]	[$272.99, -$692.21]	[$37.10, -$5.25]

- Source: Calculated from Survey Data Estimation
- All presented values are in $/animal.

The WTA estimates are explained class by class. Beginning with the *Advanced Traceability Preferring* class, producers in an *Advanced Traceability* system must be compensated $26.22/animal to participate in NAIS and be indifferent to *Advanced Traceability* without a premium. However, insignificance of the *No Traceability* WTA estimate suggests producers in this class would not require significant compensation to participate in *NAIS* rather than in a *No Traceability* system. Furthermore, producers will accept discounts up to $28.80/animal before they will provide AV and PG information rather than solely provide AV. Similarly, these producers will accept discount up to $33.39/animal before they provide PP and PG information as opposed to only providing AV.

Producers in the *No Traceability Preferring* class, as they prefer *No Traceability*, would need a premium of $55.00/animal to be indifferent between *No Traceability* and *NAIS*. These producers prefer traceability system managing entities to be private and within the industry and would need a premium of $32.32/animal to be indifferent to a traceability system that is managed by the government. Furthermore, producers in this class would require a $94.71/animal and $78.64/animal premium to provide AV as opposed to PP or PG information, respectively.

The final set of producers, the *NAIS Preferring* class, would accept a discount of up to $32.49/animal before they are indifferent between *NAIS* and *No Traceability* and would accept a discount of up to $34.30/animal before they are indifferent between *NAIS* and *Advanced Traceability*. While revealing a preference for NAIS, these producers would prefer the managing entity to be private and within the industry. They would require a premium of $9.38/animal premium to be indifferent between private-industry and government as a managing entity. Producers in this class would require a $28.28/animal and $25.05/animal premium to provide AV as opposed to PP or PG information, respectively. However, to provide HR over AV these same producers would need a premium of $40.94/animal. Considering pairs of information attributes, this class would need a premium of $38.13/animal to provide AV and PG information as opposed to just AV. In contrast, the NAIS preferring producers would need a premium of $28.91/animal to provide AV over PP and PG information in combination.

7.3 Producer Welfare Effects

As discussed in the previous chapter (section 6.7), producer welfare effects, reflecting the amount necessary to make a producer equally well-off in two alternative situations that cow-calf producers may face in the future were estimated. More specifically, this thesis considered situations in which producers face all three traceability options (i.e., *NAIS*, *Advanced*, and *No Traceability*) versus situations in which the *No Traceability* option is removed or both *No Traceability* and *Advanced Traceability* are removed. The latter case would be a situation of mandatory *NAIS Traceability*. These remain realistic possibilities, making them valid scenarios to consider. Table 7.21 presents the welfare effect estimates for the MNL, RPL, and LCM models.

Table 7.21. Welfare Effects

	MNL	RPL	LCM		
Effect			Advanced Traceability Preferring	No Traceability Preferring	NAIS Traceability Preferring
Removal of No Traceabilty Option	-$14.76 [-$11.19, -$22.54]	-$1.59 [-$1.89, -$8.76]	-$2.20 [-$0.98, -$5.15]	-$73.61 [-$38.44, -$304.19]	-$2.35 [-$1.50, -$2.39]
Mandatory NAIS Traceability	-$34.51 [-$23.74, -$64.52]	-$3.84 [-$6.71, -$20.25]	-$34.07 [-$18.04, -$98.20]	-$84.41 [-$40.81, -$388.45]	-$4.52 [-$2.43, -$6.56]

- Source: Calculated from Survey Data Estimation
- All presented values are in $/animal.

Welfare estimates utilizing the MNL model show that a situation, in which the *No Traceability* option is prohibited, would cause a welfare loss of $14.76 per animal. Along these same lines, imposing mandatory *NAIS Traceability* suggests a welfare loss of $34.51/animal. These valuations are estimates of the amount the representative producer would require making them equally well-off as they were given the option of selecting any of the three traceability alternatives.

The RPL model suggests removal of the *No Traceability* option results in an estimated welfare loss of $1.59/animal. While imposing mandatory *NAIS Traceability* suggests a welfare loss of $3.84/animal.

Utilizing our LCM model, the welfare estimates involved calculating the effects for the three distinct producer segments. The *Advanced Traceability Preferring* producers would have a welfare loss of $2.20/animal if the *No Traceability* option was removed and face a welfare loss of $34.07/animal if *NAIS Traceability* was the only option available. The *No Traceability Preferring* producers are far more negatively impacted by reduced choice sets. These producers face a welfare loss of $73.61/animal for the removal of *No Traceability* and a welfare loss of $84.41/animal for a situation in which only mandatory *NAIS* is available. Calculations suggest that the *NAIS Preferring* producers would have a welfare loss of $2.35/animal if the *No Traceability* option was removed and a welfare loss of $4.52/animal if the *No Traceability* and *Advanced Traceability* options were removed.

Comparison of welfare effect estimates across the three models shows notable differences. For example welfare estimates for the MNL model are notably higher than the same estimates in the RPL model. While the segmentation of the LCM model show varying degrees of the welfare effects, as the *Advanced Traceability Preferring* class has a relatively small estimate when only removing the No Traceability option, but becomes considerably larger once the *No* and *Advanced Traceability* options are both removed. Within the *NAIS Preferring* class, producer's welfare effects are relatively small for both situations. Conversely, producers within the *No Traceability Preferring* class experience relatively large welfare effects for both situations that exceed those of the other two LCM model segments and those suggested by the MNL and RPL models. Collectively, these results provide further evidence for the importance of model specification and consideration of producer preference heterogeneity.

7.4 Implications

The above mentioned WTA estimates, and associated inferences regarding producer preferences, provide a clearer understanding of how traceability systems should be designed and promoted in order to improve voluntary participation rates. To summarize the implications of the WTA findings, two specific cases that may benefit from this research are discussed. The first case would be a scenario of developing a voluntary traceability system that is fairly similar to NAIS in that there are limited "additional information pieces" required for producer participation. The purpose of a heavily structured (e.g., little to no variability in the trade-off between participation requirements and per animal compensation) traceability system could be to enhance the entire industry's ability to quickly identify and contact animal premises, promote animal identification, and develop animal movement and tracing capabilities. These goals would be consistent with those of animal health management and response objectives held by USDA in developing and promoting NAIS.

Alternatively, more advanced systems that enable producers or firms further down the supply chain to use traceability information could be designed as marketing tools. For instance, a traceability system could be designed to capture the production practice information most desired by a select consumer group. Provision of this information would require cooperation and compensation of all players in the supply chain, with benefits reflecting the perceived final market value of the information to consumers. For a producer this traceability information would give added value to the cattle they maket, in exchange for their willing participation. While for a retailer this traceability information provides value as consumers may be willing to pay for these added attributes.

The discussion of implications will be focused on the three traceability preferring segments as identified by the Latent Class Model. First, let's consider the implications of selecting different managing entities of a traceability system on producer participation. Our results suggest developers of a system who are primarily interested in achieving participation rate goals (e.g., as opposed to alternative national herd health goals held by USDA) can expect systems with managing entities being private and within the industry to enhance participation by producers. Furthermore, given that the structure of NAIS has the managing entity being government; these results suggest that producer participation may have been higher with private management. However, care should be taken in this assessment as the USDA, in managing NAIS, certainly has objectives beyond simply maximizing voluntary participation rates (e.g., animal herd health surveillance and response ability enhancement. Nonetheless, the results indicate a trade-off of participation rate and managing entity does exist for cow-calf producers.

In designing a private traceability system, altering the composition of the additional information required for participation is found to significantly impact voluntary participation interest. Advanced systems that only require production practice information or performance/genetic information, as opposed to age verification, would be supported within the *No Traceability Preferring* Class *and the NAIS Traceability Preferring* class. Producers in the *No Traceability Preferring* class would require a \$94.71/animal and \$78.64/animal premium to provide age verification as opposed to production practice information and performance/genetic information, respectively. As such, the cost of requiring producers possessing these preferences (estimated to be 27.4% of producers) to provide age verification likely outweighs the benefits of increasing the participation in such a system. As such, traceability system designers need to carefully outweigh the anticipated benefits of this age verification information (e.g., enhanced value of marketing verified younger animals) with the compensation that may be required to obtain participation of producers who may belong to the *No Traceability Preferring* class.

Conversely, the estimated premiums for producers in the *Advanced Traceability Preferring* class to provide age verification as opposed to production practice, performance/genetic information, and heath records, respectively, are not different from \$0. This suggests that small premiums could be paid to easily (and more affordably) entice producers to increase participation rate. Combined, this suggests that private traceability systems requiring age verification should first seek out producers belonging to the *Advanced Traceability Preferring* segment (e.g., those known to use individual identification methods) and initially avoid expending resources targeting those in th *No Traceability Preferring* (e.g., those known to typically market through auctions) class.

Producers in the *Advanced Traceability Preferring* and *No Traceability Preferring* segments are found to be indifferent to systems requiring health verification records and systems requiring age verification. Conversely, producers in the *NAIS Preferring* group hold a preference for providing age verification. Combined, this suggests that for systems considering verification of animal health throughout the supply chain to be a higher priority than age verification, target marketing should initially avoid producers in the *NAIS Preferring* group.

As a general statement, producers reduce participation in traceability systems as additional information requirements are added. Furthermore, considering the implications of requiring pairs of additional information becomes a challenge because different values may be placed on pairs of attributes (e.g., WTA age verification + production practice information ≠ WTA age verification + WTA production practice information). Therefore target marketing of systems that are characterized by the pairs of additional information to provide should be based on the benefits and costs of each proposed system because results indicate a trade-off of participation rate and additional information does exist for cow-calf producers.

The above mentioned welfare effect estimates, and associated inferences regarding implications of producer's realizing a reduced set of voluntary system options (e.g., being forced to participate in either Advanced Traceability and/or NAIS

Traceability), provides an improved understanding of how requiring traceability or imposing mandatory NAIS affects producers differently.

As expected, results show that producers in the *Advanced Traceability Preferring* segment would have the smallest negative welfare effect if traceability (e.g., *Advanced Traceability* or *NAIS Traceability)* became mandatory. However, if NAIS were to become mandatory requiring all cow-calf producers to participate, producers in the *Advanced Traceability Preferring* segment would be considerably more negatively affected. This shows that forcing producers to participate in a rather structured, national traceability system (e.g., NAIS) when they prefer private, advanced traceability system will likely decrease support.

Producers in the NAIS Preferring segment would experience a relatively small welfare effect of imposing mandatory traceability, either *Advanced Traceability* or *NAIS Traceability*. This is likely do to their ability to still choose *NAIS Traceability* which they prefer. When imposing mandatory *NAIS Traceability* on these producers there negative welfare impact becomes slightly larger. This is a result of restricting their choice set.

As one would expect, the results show that imposing mandatory traceability or mandatory *NAIS* on producers who prefer *No Traceability* will have the largest welfare effect. The implications of these finding require further discussion because producers in this segment have a strong preference for *No Traceability* and would be the type of producers most adversely affected by mandated traceability. The welfare effect estimates of \$73.61/animal and \$84.41/animal for removing the *No Traceability* option and imposing mandatory traceabily, respectively, may be large enough that increasing support for traceabilty or mandatory traceability would not be feasible in this segment. Stated differently, these large estimates suggest that these producers will likely not be willing to voluntarily participate in any traceability system. A prerequisite of their participation may well be a market characterized by mandated traceability, either by the government of the private sector that simply chooses to no longer accept "un-traced animals."

Table 7.1a. Producers' Forecasts

Parameter	*Future NAIS Participation* Estimate	Standard Error	*Future NAIS Participation and RFID Use* Estimate	Standard Error
Intercept	42.1771***	6.0054	26.1481***	9.0690
Age	0.0675	0.0930	0.3729***	0.1068
CB	N/A	N/A	-0.7427	4.7071
NP	N/A	N/A	-1.9082	4.8144
NW	N/A	N/A	-5.5572	5.0542
SE	N/A	N/A	-0.0020	4.8765
SP	N/A	N/A	-5.8327	5.1530
Member	1.2363	0.7724	0.2839	0.8949
Education	N/A	N/A	-0.1945	0.6185
Years	-1.6772**	0.6996	-1.2011	0.7939
ExpYears	0.3241	0.4701	0.3647	0.5353
Income	N/A	N/A	0.7795	0.5237
OIncome	N/A	N/A	-0.8439	0.6090
Labor	N/A	N/A	0.9138	0.9739
OFeed	N/A	N/A	-2.3037***	0.8929
Cows	-0.5654	0.6076	-1.2442*	0.7390
Auctions	0.1342	1.8112	-0.8945	2.1168
PTags	N/A	N/A	2.6699	3.2275
ENotches	N/A	N/A	-2.2580	2.0966
Brand	N/A	N/A	0.2855	2.2782
Tattoo	N/A	N/A	-0.9769	2.1039
MTags	N/A	N/A	2.3780	1.9142
RFID	-4.5168	3.1866	-6.2983*	3.6132
NoID	N/A	N/A	3.3593	6.0893
RegNAIS	9.8683***	1.8799	-1.0590	2.1269
ManNAIS	0.8588	1.0591	3.3516***	1.1843
CRetailers	0.0269	0.0389	N/A	N/A
CProcessors	-0.0834*	0.0491	N/A	N/A
CFeedlots	0.0877**	0.0439	N/A	N/A
Sigma	17.6699***	0.6130	19.7337***	0.6941
Rho	0.5674***	0.0335		

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.2a. NAIS Premise Registration Estimates

Parameter	Estimate	Standard Error
Intercept	-0.7491	0.5984
Age	-0.0006	0.0063
CB	-0.3904	0.3416
NP	-0.5257	0.3480
NW	-0.9237**	0.3678
SE	-0.2961	0.3525
SP	-0.3297	0.3688
Member	0.1707***	0.0532
Education	0.0539	0.0428
Years	-0.0233	0.0497
ExpYears	0.0160	0.0323
Income	0.0262	0.0375
OIncome	0.0280	0.0448
Labor	0.0654	0.0699
OFeed	0.0524	0.0631
Cows	-0.0153	0.0468
Auctions	-0.2092	0.1301
PTags	0.3305	0.2286
ENotches	-0.0123	0.1499
Brand	0.0183	0.1589
Tattoo	-0.0572	0.1605
MTags	-0.0473	0.1398
RFID	1.3439***	0.2669
NoID	-0.1599	0.4660
ManNAIS	0.1997***	0.0694

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.3a. Producers' Beliefs Concerning Mandatory NAIS Estimates

	Outcome=Yes		Outcome=Undecided	
Parameter	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.0162	0.0119	-0.0238**	0.0121
CB	1.1410*	0.6424	1.1594*	0.6437
NP	2.0026***	0.6413	2.0076***	0.6408
NW	2.5673***	0.7119	3.1515***	0.7088
SE	1.7576***	0.6606	1.6500**	0.6649
SP	1.8062***	0.6541	1.2624*	0.6680
Member	-0.3157***	0.1220	-0.6289***	0.1230
Years	-0.0918	0.0876	0.1619*	0.0903
ExpYears	-0.0491	0.0595	-0.0338	0.0598
Income	-0.0950	0.0726	-0.1562**	0.0708
Cows	-0.1095	0.0796	-0.0967	0.0800
Auctions	0.0770	0.2593	0.9363***	0.2629
BRetailers	-0.0082**	0.0039	-0.0048	0.0037
BProcessors	-0.0045	0.0049	-0.0051	0.0046
BFeedlots	0.0068	0.0061	0.0013	0.0059
CRetailers	0.0021	0.0060	-0.0019	0.0070
CProcessors	-0.0048	0.0077	-0.0143	0.0088
CFeedlots	0.0123*	0.0066	0.0201***	0.0068
InvMills	-3.9950***	0.5200	-4.7925***	0.5140
Constant	2.8262***	0.9958	4.1158***	1.0059

- Source: Calculated from Survey Data Estimation
- Outcome = No is the base outcome
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.4a. Monitoring/Managing Disease Estimates

Parameter	Estimate	Standard Error
Intercept	1.7272***	0.4772
Age	-0.0112**	0.0052
CB	-0.1375	0.2724
NP	0.1556	0.2697
NW	0.1826	0.2780
SE	0.3863	0.2907
SP	0.0308	0.2855
Member	0.0802*	0.0449
Education	0.0632*	0.0361
Years	-0.0022	0.0423
ExpYears	0.0050	0.0268
Income	0.0002	0.0314
OIncome	0.0271	0.0374
Labor	-0.0422	0.0594
OFeed	-0.0053	0.0531
Cows	0.0207	0.0377
Auctions	-0.0913	0.1105
RegNAIS	0.3085***	0.1056
Limit 2	0.2999***	0.0629
Limit 3	0.8274***	0.0855
Limit 4	1.7192***	0.0983

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.5a. Maintaining Current Foreign Markets Estimates

Parameter	Estimate	Standard Error
Intercept	1.2923***	0.4517
Age	-0.0105**	0.0052
CB	0.0250	0.2611
NP	0.3451	0.2579
NW	0.2158	0.2676
SE	0.3494	0.2755
SP	0.2756	0.2753
Member	0.0445	0.0434
Education	0.0422	0.0352
Years	0.0613	0.0403
ExpYears	0.0129	0.0267
Income	-0.0016	0.0309
OIncome	0.0506	0.0364
Labor	0.0009	0.0580
OFeed	0.0036	0.0512
Cows	-0.0004	0.0373
Auctions	-0.2832***	0.1084
RegNAIS	0.1942*	0.1027
Limit 2	0.3099***	0.0606
Limit 3	1.0052***	0.0851
Limit 4	1.8927***	0.0964

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.6a. Accessing Foreign Markets Estimates

Parameter	Estimate	Standard Error
Intercept	1.1488**	0.4631
Age	-0.0079	0.0052
CB	-0.4193	0.2730
NP	-0.2871	0.2682
NW	-0.2834	0.2787
SE	-0.0550	0.2861
SP	-0.1939	0.2858
Member	0.0479	0.0431
Education	0.0821**	0.0348
Years	0.0801**	0.0402
ExpYears	0.0272	0.0266
Income	-0.0001	0.0309
OIncome	0.0456	0.0362
Labor	0.0072	0.0580
OFeed	0.0225	0.0512
Cows	0.0325	0.0372
Auctions	-0.3022***	0.1079
RegNAIS	0.1532	0.1017
Limit 2	0.3288***	0.0616
Limit 3	1.0888***	0.0862
Limit 4	1.9926***	0.0975

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.7a. Increasing Consumer Confidence Estimates

Parameter	Estimate	Standard Error
Intercept	1.5097***	0.4570
Age	-0.0123**	0.0052
CB	0.2151	0.2616
NP	0.3998	0.2575
NW	0.2601	0.2675
SE	0.6477**	0.2800
SP	0.3597	0.2765
Member	0.0654	0.0433
Education	0.0239	0.0358
Years	0.0260	0.0411
ExpYears	0.0031	0.0272
Income	0.0274	0.0314
OIncome	0.0278	0.0372
Labor	-0.0222	0.0593
OFeed	-0.0354	0.0525
Cows	0.0550	0.0375
Auctions	-0.2988***	0.1109
RegNAIS	0.2089**	0.1040
Limit 2	0.3783***	0.0681
Limit 3	0.9007***	0.0867
Limit 4	1.8124***	0.0989

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.8a. Concerns Regarding System Cost Estimates

Parameter	Estimate	Standard Error
Intercept	1.3577***	0.4666
Age	-0.0177***	0.0052
CB	-0.2443	0.2710
NP	-0.1284	0.2675
NW	-0.0270	0.2772
SE	0.2777	0.2865
SP	0.1047	0.2846
Member	-0.0300	0.0436
Education	-0.0430	0.0357
Years	0.1195***	0.0410
ExpYears	-0.0147	0.0265
Income	0.0157	0.0314
OIncome	0.0225	0.0366
Labor	-0.0668	0.0585
OFeed	0.1435***	0.0515
Cows	0.1380***	0.0373
Auctions	0.1630	0.1084
RegNAIS	-0.1579	0.1038
Limit 2	0.3637***	0.0803
Limit 3	0.9879***	0.1034
Limit 4	1.9788***	0.1143

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.9a. Concerns Regarding System Liability Estimates

Parameter	Estimate	Standard Error
Intercept	1.5339***	0.4600
Age	-0.0238***	0.0052
CB	0.2575	0.2588
NP	0.4208*	0.2546
NW	0.4099	0.2643
SE	0.6905**	0.2735
SP	0.5006*	0.2726
Member	0.0463	0.0438
Education	-0.0084	0.0357
Years	0.1328***	0.0407
ExpYears	-0.0294	0.0266
Income	0.0348	0.0314
OIncome	-0.0320	0.0366
Labor	-0.0192	0.0589
OFeed	0.0953*	0.0520
Cows	0.0931**	0.0376
Auctions	-0.0244	0.1084
RegNAIS	-0.0962	0.1035
Limit 2	0.4819***	0.0965
Limit 3	1.2359***	0.1169
Limit 4	2.0984***	0.1243

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.10a. Concerns Regarding Confidentiality Estimates

Parameter	Estimate	Standard Error
Intercept	1.0775**	0.4523
Age	-0.0171***	0.0051
CB	0.0935	0.2586
NP	0.2412	0.2554
NW	0.3143	0.2661
SE	0.3161	0.2722
SP	0.2215	0.2729
Member	0.0497	0.0428
Education	0.0137	0.0352
Years	0.1788***	0.0401
ExpYears	0.0083	0.0264
Income	-0.0013	0.0309
OIncome	-0.0670*	0.0360
Labor	-0.1063*	0.0575
OFeed	0.0421	0.0514
Cows	0.0449	0.0366
Auctions	0.1217	0.1063
RegNAIS	-0.0998	0.1019
Limit 2	0.3971***	0.0667
Limit 3	1.0472***	0.0868
Limit 4	1.8063***	0.0962

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.11a. Concerns Regarding System Reliability Estimates

Parameter	Estimate	Standard Error
Intercept	0.7583*	0.4572
Age	-0.0121**	0.0050
CB	0.2580	0.2649
NP	0.5420**	0.2622
NW	0.5815**	0.2713
SE	0.6705**	0.2785
SP	0.6074**	0.2794
Member	0.0478	0.0428
Education	-0.0409	0.0349
Years	0.1203***	0.0400
ExpYears	-0.0205	0.0261
Income	0.0703**	0.0309
OIncome	-0.0311	0.0359
Labor	-0.0192	0.0573
OFeed	0.1013**	0.0512
Cows	0.0722**	0.0364
Auctions	-0.0657	0.1059
RegNAIS	-0.0204	0.1015
Limit 2	0.4431***	0.0884
Limit 3	1.2418***	0.1104
Limit 4	2.2128***	0.1190

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.12a. Concerns Regarding Free-Riding Estimates

Parameter	Estimate	Standard Error
Intercept	0.9534**	0.4402
Age	-0.0117**	0.0049
CB	0.0303	0.2571
NP	0.3629	0.2530
NW	0.0907	0.2620
SE	0.4036	0.2707
SP	0.1657	0.2691
Member	-0.0123	0.0419
Education	-0.0139	0.0342
Years	0.1043***	0.0395
ExpYears	-0.0206	0.0255
Income	0.0044	0.0301
OIncome	0.0021	0.0354
Labor	0.0032	0.0567
OFeed	0.0905**	0.0496
Cows	0.0631**	0.0352
Auctions	0.0343	0.1036
RegNAIS	0.0450	0.0991
Limit 2	0.4650***	0.0704
Limit 3	1.3574***	0.0907
Limit 4	2.0850***	0.0986

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.13a. Concerns Regarding System Failures Estimates

Parameter	Estimate	Standard Error
Intercept	0.4841	0.4466
Age	-0.0101**	0.0050
CB	0.2382	0.2557
NP	0.4932*	0.2520
NW	0.4913*	0.2624
SE	0.5469**	0.2698
SP	0.6192**	0.2706
Member	0.0238	0.0424
Education	0.0373	0.0350
Years	0.1034***	0.0397
ExpYears	-0.0101	0.0262
Income	0.0268	0.0305
OIncome	0.0134	0.0360
Labor	0.0283	0.0580
OFeed	0.1242**	0.0505
Cows	0.0362	0.0362
Auctions	0.0788	0.1051
RegNAIS	-0.1479	0.1010
Limit 2	0.4027***	0.0788
Limit 3	1.1646***	0.1009
Limit 4	2.1296***	0.1101

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

Table 7.14a. Implementation of COOL Estimates

Parameter	Estimate	Standard Error
Intercept	1.6611***	0.4426
Age	-0.0044	0.0049
CB	-0.2619	0.2611
NP	-0.2461	0.2572
NW	-0.0887	0.2665
SE	0.0258	0.2737
SP	-0.1818	0.2719
Member	-0.0656	0.0408
Education	-0.0749**	0.0340
Years	0.0959**	0.0387
ExpYears	0.0006	0.0253
Income	-0.0160	0.0296
OIncome	-0.0883**	0.0348
Labor	0.0641	0.0559
OFeed	0.0101	0.0497
Cows	0.0027	0.0349
Auctions	0.2366**	0.1027
RegNAIS	-0.2973***	0.0985
Limit 2	0.7123***	0.0695
Limit 3	1.4754***	0.0832
Limit 4	2.1433***	0.0926

- Source: Calculated from Survey Data Estimation
- *** 1% significance level, ** 5% significance level, * 10% significance level

CHAPTER 8: CONCLUSIONS

With traceability becoming ever more important within the beef industry for verification of animal health as well as marketing purposes, the need for traceability systems that are attractive to producers as well as meet the goals that they were designed for is evident. Traceability systems that are most aligned with the preferences of cow-calf producers have the potential to experience higher voluntary participation.

Subsequently, a majority of the past research has sought to analyze consumer's perceptions towards voluntary traceability systems; however, there has been little research on producer's perceptions towards these same traceability systems. The research presented within this thesis has illustrated the need for taking producers' preferences into account when designing and imposing traceability systems. Examinations of a mandatory versus voluntary National Animal Identification System (NAIS) preference, self-revelation of current NAIS participation, and the most current concerns and important issues to cow-calf producers regarding traceability provided information that was useful in determining strategies that may enhance participation rates and targeted marketing efforts of existing or potential live animal traceability systems.

Results indicate that producers from the Northwest (AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY), relative to the Northern Crescent (MN, WI, CT, ME, MD MA, NH, NJ, NY, PA, RI, VT), are less likely to have their premises registered with NAIS. As such, this identifies an area that the United States Department of Agriculture (USDA) may target to help increase voluntary premises registration in NAIS. Results concerning mandatory versus voluntary NAIS preferences revealed that producers who use local auctions to market their cattle are more likely undecided concerning mandatory NAIS.

This conclusion reveals that support for mandatory NAIS could be achieved by promoting within or working with auction markets. Furthermore, cow-calf operators with more years of experience are generally more concerned with issues related to animal traceability implementation.

This thesis also utilized models that examined cow-calf producers' preferences for traceability systems and attributes which were characterized by heterogeneity. Thereby, allowing us to better identify the success of alternative voluntary traceability systems that could potentially exist in the beef industry. This "potential success" was measured by producers' preferences for certain traceability systems and system attributes.

As was implied by the latent classification (LCM) and random parameter Logit (RPL) models, heterogeneity does exist between cow-calf producers and their preferences for traceability systems and system attributes. Producers were found to be sensitive to both price and information requirements in comparing voluntary traceability systems. This implies that voluntary participation in traceability programs deemed undesirable to the representative cow-calf producer may be accomplished by offering premiums for participation; it also suggests participation may be enhanced by markets penalizing non-participants. Furthermore, removal of traceability options contributes negatively to the economic welfare of producers. Especially, for those producers who prefer *No Traceability*. Welfare effects of imposing mandatory *NAIS* vary widely across producers and model specifications. The LCM model suggests a large range for these welfare effects of imposing mandatory traceability, where welfare estimates from the MNL and RPL models fell in between this range. This provides strong evidence for the priority of correct model specification.

Given cow-calf producers are sensitive to price adjustments and this thesis only considered price adjustments as a single factor, further research could determine if marginal utilities of discounts (penalties for nonparticipation) were the same as marginal utilities of premiums (incentives to participate), answering the question is "price/head" symmetrical across premiums and discounts. Another issue that could be addressed would investigate if and how preferences concerning traceability systems change if producer's choice set changes. This would involve mapping traceability system choice probabilities under different scenarios. These scenarios may include mandatory NAIS or voluntary market scenarios in which producers may chose discounts for non-participation.

Because model specification was found to be very important for the significance of point estimates, WTA estimates, and welfare effects, an out-of-sample exercise determining which model performed the highest across the sample would be beneficial. Thereby, allowing for more validation to be given to the various estimates.

APPENDICES

APPENDIX 1: COW-CALF PRODUCER SURVEY

Confidential Survey – For Research Purposes Only

Survey – Production Practices and Potential Beef Traceability Systems. Conducted by Michigan State University in Collaboration with *BEEF* Magazine

1. I am: Male _____ Female _____

2. I am _____ years old.

3. My state of residence is: ____________________.

4. Please check any farm organizations in which you are a member:
   - ☐ State or local cattlemen's group
   - ☐ Breed association
   - ☐ National Farm Bureau
   - ☐ National Cattlemen's Beef Association (NCBA)
   - ☐ Ranchers and Cattlemen's Action Legal Fund (R-Calf)
   - ☐ National Farmers Union
   - ☐ National Livestock Association
   - ☐ National Farmers Organization
   - ☐ Other (please list) __________

5. The best description of my educational background is:
   - ☐ Did not attend college
   - ☐ Technical training (Certification or Associates Degree)
   - ☐ Attended College, No Bachelor's (B.S. or B.A.) Degree
   - ☐ Bachelor's (B.S. or B.A.) College Degree
   - ☐ Graduate or Professional Degree (M.S., Ph.D., D.V.M., Law School)
   - ☐ Other (please describe) ____________________________________

6. How many years have you been raising beef cattle?
   - ☐ Less than 5 years
   - ☐ 6-10 years
   - ☐ 11-15 years
   - ☐ 16-20 years
   - ☐ 21-25 years
   - ☐ 26-30 years
   - ☐ Over 30 years
   - ☐ I don't raise beef cattle

7. How many more years do you expect your operation to be raising beef cattle?
   - ☐ Less than 5 years
   - ☐ 6-10 years
   - ☐ 11-15 years
   - ☐ 16-20 years
   - ☐ 21-25 years
   - ☐ 26-30 years
   - ☐ Over 30 years

8. Please estimate your annual pre-tax household income:
   - ☐ Less than $25,000
   - ☐ $25,000-$49,999
   - ☐ $50,000-$74,999
   - ☐ $75,000-$99,999
   - ☐ $100,000-$124,999
   - ☐ $125,000 or more

9. Approximately what portion of your household income is from off-farm sources?
   - ☐ Less than 20%
   - ☐ 20%-39%
   - ☐ 40%-59%
   - ☐ 60%-79%
   - ☐ 80% or more

10. What portion of your operation's labor is supplied by non-family, paid employees?
    ☐ Less than 25% ☐ 26%-50% ☐ 51%-75% ☐ Over 75%

11. What portion of your operation's feed/forage needs is produced by your own farm?
    ☐ Less than 25% ☐ 26%-50% ☐ 51%-75% ☐ Over 75%

12. Do you market cattle/beef based upon the following claims (Check Yes or No)?

Implant free	Yes ☐	No ☐	100% grass-fed diets	Yes ☐	No ☐
Antibiotic free	Yes ☐	No ☐	Humanely raised	Yes ☐	No ☐
Natural	Yes ☐	No ☐	Other (please list)____________		
Organic	Yes ☐	No ☐			

13. Which one of the following methods do you <u>most frequently</u> use in marketing your operations output (please check only one)?
    - ☐ Direct to traders
    - ☐ Direct to consumers
    - ☐ Local auction
    - ☐ Direct to backgrounding systems
    - ☐ Direct to feedlots
    - ☐ Local butcher
    - ☐ Packing Plant
    - ☐ Special auctions (clubs, associations, etc.)
    - ☐ Video/Internet auctions

14. How many beef cows that calved were on hand in your operation on January 1, 2007:
    - ☐ None
    - ☐ Less than 50
    - ☐ 50-99
    - ☐ 100-199
    - ☐ 200-299
    - ☐ 300-499
    - ☐ 500-999
    - ☐ 1,000 or more

15. How many head of cattle did your operation sell at the following production stages in 2007?

    Calves _____ (# head) Yearlings _____ (# head) Finished Cattle _____ (# head)

    If you market finished cattle do you have your own Yes ☐ No ☐ feedlot?

16. Which of the following animal identification methods do you currently use (check all that apply)?
    - ☐ Plastic ear tag
    - ☐ Ear notches
    - ☐ Brand
    - ☐ Tattoo
    - ☐ Brucellosis or any other metal tag
    - ☐ Electronic ear tag (RFID)
    - ☐ None
    - ☐ Other (please list) ___________

17. In designing a national, individual animal traceability system how important are the following issues to the U.S. beef industry (please circle your answers where 1 = Entirely Unimportant, 2 = Unimportant, 3 = Neutral, 4 = Important, 5 = Very Important):

Monitoring/managing disease:	1	2	3	4	5
Increasing consumer confidence:	1	2	3	4	5
Enhancing marketability:	1	2	3	4	5
Maintaining current foreign markets:	1	2	3	4	5
Accessing foreign markets:	1	2	3	4	5
Improving on-farm management:	1	2	3	4	5
Managing the supply chain:	1	2	3	4	5
Enhancing food safety:	1	2	3	4	5

18. In designing a national, individual animal traceability system how concerned are you regarding the following issues in the U.S. beef industry (where 1 = Entirely Unconcerned, 2 = Unconcerned, 3 = Neutral, 4 = Concerned, 5 = Very Concerned):

Cost to participating producer:	1	2	3	4	5
Confidentiality of information:	1	2	3	4	5
Reliability of technology:	1	2	3	4	5
Liability to participating producer:	1	2	3	4	5
Non-participating firms benefiting:	1	2	3	4	5
Failure of system to meet stated goals:	1	2	3	4	5

19. Please circle your level of agreement with each of the following statements (Where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree):

Implementing individual animal traceability systems:

"is more cost effective for larger cow-calf operations."	1	2	3	4	5
"results in more liability for cow-calf producers than cattle owners at other stages of production."	1	2	3	4	5
"is unnecessary if COOL (Country-of-Origin Labeling) was implemented nationally."	1	2	3	4	5
"as a mandated system is exaggerated in need."	1	2	3	4	5

Following are 4 scenarios, each containing 3 different options for you to select from where 2 options are voluntary traceability systems you could participate in. These two systems would require you to: a) provide basic contact information on your farm/premises and b) individually identify your livestock (prior to any sales transactions or movement to other premises) using approved radio frequency identification devices (RFID). The 3rd option (*No Traceability*) is an alternative where you choose not to participate in either of the 2 presented traceability systems. **For your information in interpreting the alternative traceability options please carefully read the following descriptions:**

NAIS Traceability: refers to the National Animal Identification System (NAIS).

- The NAIS program consists of three components:
  - ***Premise registration*** requires you to provide basic contact information.
  - ***Animal identification*** provides you with a uniform numbering system for identifying your animals and linking them to a birthplace/premises of origin.
  - ***Animal tracing*** allows you to choose an animal tracking database (owned and operated by private industry groups or States) and report certain animal movements that might pose a significant risk of disease transmission.
- USDA ensures producers that it will protect private information from disclosure.

Advanced Traceability: Same basic participation requirements as *NAIS Traceability* but also requires additional information which may include:

- **Age Verification**
- **Production Practice Information** (e.g., growth hormones, grass-fed diets, etc.)
- **Performance/Genetic Information**
- **Health Certifications/Vaccinations Records**

- Random verification audits would be required to further validate consistency between on-farm practices and information maintained within the traceability system.

The entity managing each traceability system may take one of three forms:

- **Government:** Entity such as the USDA.
- **Private - Industry:** Entity specializes in traceability specifically for the beef industry.
- **Private - Not Industry:** Entity specializes in traceability for multiple livestock species.

In addition to differences in requirements and goals of these alternatives, these options differ in terms of the **premium** or **discount** (per head sold) you would receive by selecting that alternative. These price adjustments to the market price range from discounts of up to $15 per head to premiums of up to $15 per head. Negative numbers indicate discounts and positive numbers indicate premiums.

Research studies have found people to overstate their willingness to participate (or accept discounts) in hypothetical situations. It is important that you make your selections as if you were actually facing these choices. **Place an "X" in the "I choose" box, below the option that you would choose from each of the following 4 scenarios.**

Scenario 1

Attribute	NAIS Traceability	Advanced Traceability	No Traceability
Premium/Discount ($/head)	$0.00	$0.00	-$7.50
Managing Entity	Government	Private - Not Industry	
Additional Information		Age Verification, Production Practices, and Health/Vaccinations	
I choose ...	☐	☐	☐

Scenario 2

Attribute	NAIS Traceability	Advanced Traceability	No Traceability
Premium/Discount ($/head)	$0.00	$15.00	$0.00
Managing Entity	Government	Private - Industry	
Additional Information		Age Verification, Production Practices, and Health/Vaccinations	
I choose ...	☐	☐	☐

Scenario 3

Attribute	NAIS Traceability	Advanced Traceability	No Traceability
Premium/Discount ($/head)	$0.00	$7.50	-$7.50
Managing Entity	Government	Government	
Additional Information		Age Verification, Production Practices, and Performance/Genetics	
I choose ...	☐	☐	☐

Scenario 4

Attribute	NAIS Traceability	Advanced Traceability	No Traceability
Premium/Discount ($/head)	$0.00	$15.00	-$15.00
Managing Entity	Government	Private - Not Industry	
Additional Information		Age Verification and Health/Vaccinations	
I choose ...	☐	☐	☐

20. If given the opportunity involving real money and binding decisions, how certain are you that you would make the selections you indicated in the previous scenarios? Please circle one number on this certainty scale:

    Very Uncertain 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 Very Certain

21. If individual animal traceability systems were put in place, how do you think the resulting benefits and costs would be distributed through the beef industry's supply chain? Please allocate the *percentages* each of the following sectors captures:

Benefits:		Costs:	
Retailers	________	Retailers	________
Processors	________	Processors	________
Feedlot Producers	________	Feedlot Producers	________
Cow-calf Producers	________	Cow-calf Producers	________
Sum	100%	Sum	100%

22. Are your operation's premise(s) currently registered with USDA in the NAIS (National Animal Identification System)?

    ☐ Yes ☐ No

23. Do you believe that NAIS (as previously outlined) should be a mandatory system requiring all U.S. cattle producers to participate?

    ☐ Yes ☐ No ☐ Undecided

24. If the NAIS system remains a system of voluntary participation, by December 31, 2008 what do you predict will be (please circle your answers):

    The percentage of U.S. cow-calf operations with premises registered in NAIS.

    0% - 10% - 20% - 30% - 40% - 50% - 60% - 70% - 80% - 90% - 100%

    The percentage of U.S. cow-calf operations with premises registered in NAIS AND using NAIS approved RFID animal identification devices on the percentage of cattle leaving their premises.

    0% - 10% - 20% - 30% - 40% - 50% - 60% - 70% - 80% - 90% - 100%

Thank you for your time in completing this survey. Your input will strengthen our research and help us obtain more accurate conclusions. If you wish to add any comments that might be useful in our research please feel free to do so here:

____

____

____

____

APPENDIX 2: VARIABLES USED IN REGRESIONS AND DIAGNOSTICS

Abbreviation	Definition
Age	Producer's Age
CB	Corn Belt Region (IL, IN, IA, MO, OH)
NC	Northern Crescent (MN, WI, CT, ME, MD MA, NH, NJ, NY, PA, RI, VT)
NP	Northern Plains (KS, NE, ND, SD)
NW	Northwest (AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY)
SE	Southeast (AL, FL, GA, SC, KY, NC, TN, VA, WV, AK, LA, MS)
SP	Southern Plains Region (OK, TX)
Member	Number of Memberships in industry Organizations
Education	Educational Background
Years	Years Raising Beef Cattle
ExpYears	Expected Future Years Raising Beef Cattle
Income	Annual Pre-tax Household Income
OIncome	Proportion of Off-farm Household Income
Labor	Proportion of Operation's Labor Supplied by, Paid Employees
OFeed	Feed/Forage Produced On-Farm
Cows	Marketing Through a Local Auction
Auctions	Beef Cows that Calved in 2007
PTags	Plastic Ear Tag Animal Identification
ENotches	Ear Notches Animal Identification
Brand	Brand Animal Identification
Tattoo	Tattoo Animal ID Identification
MTag	Brucellosis or Any Other Metal Tag Animal Identification
RFID	Electronic Ear Tag (RFID) Identification
NoID	None Animal Identification
RegNAIS	Operation's Premise(s) Currently Registered in NAIS
ManNAIS	Belief NAIS Should be Mandatory
BRetailers	Benefits to Retailers over Cow-Calf producers
BProcessors	Benefits to Processors over Cow-Calf producers
BFeedlots	Benefits to Feedlot Producers over Cow-Calf producers
CRetailers	Costs to Retailers over Cow-Calf producers
CProcessors	Costs to Processors over Cow-Calf producers
CFeedlots	Costs to Feedlot Producers over Cow-Calf producers
IndvID	Individual Animal Identification (PTags, RFID)
GrpID	Group Animal Identification (ENotches, Brand, Tattoo, MTags)
NotID	No/Other Animal Identification
PD	Premium or Discount per head sold
No Trace	No Traceability
Adv Trace	Advanced Traceability
PvtI	Private - Industry Managing Entity
PvtNI	Private – Not Industry Managing Entity

VARIABLES USED IN REGRESIONS AND DIAGNOSTICS (cont'd)

Abbreviation	Definition
PP	Production Practice Information
PG	Performance/Genetic Information
HR	Health Certification/Vaccination Records
AVPP	Age Verification & Production Practice Information
AVPG	Age Verification & Performance/Genetic Information
AVHR	Age Verification & Health Certification/Vaccination Records
PPPG	Production Practice & Performance/Genetic Information
PPHR	Production Practice Information & Health Records
PGHR	Performance/Genetic Information & Health Records
AVPPPG	Age Verification & Production Practice & Performance/Genetic Information
AVPPHR	Age Verification & Production Practice Information & Health Certification/Vaccination Records
PPPGHR	Production Practice & Performance/Genetic Information & Health Certification/Vaccination Records
AVPPPGHR	Age Verification & Production Practice & Performance/Genetic Information & Health Records
AT_Cows	Interaction of Advanced Traceability and number of beef cows
NT_Cows	Interaction of No Traceability and number of beef cows
AT_Member	Interaction of Advanced Traceability and number of industry memberships
NT_Member	Interaction of No Traceability and number of industry memberships
AT_Auctions	Interaction of Advanced Traceability and local auction use
NT_Auctions	Interaction of No Traceability and local auction use
AT_Years	Interaction of Advanced Traceability and years raising beef cattle
NT_Years	Interaction of No Traceability and years raising beef cattle
AT_IndID	Interaction of Advanced Traceability and individual ID use
NT_IndID	Interaction of No Traceability and individual ID use
AT_GrpID	Interaction of Advanced Traceability and group ID use
NT_GrpID	Interaction of No Traceability and group ID use
AT_NoID	Interaction of Advanced Traceability and no/other ID use
NT_NoID	Interaction of No Traceability and no/other ID use
AT_CB	Interaction of Advanced Traceability and Corn Belt
NT_CB	Interaction of No Traceability and Corn Belt
AT_NP	Interaction of Advanced Traceability and Northern Plains
NT_NP	Interaction of No Traceability and Northern Plains
AT_NW	Interaction of Advanced Traceability and Northwest
NT_NW	Interaction of No Traceability and Northwest
AT_SE	Interaction of Advanced Traceability and Southeast
NT_SE	Interaction of No Traceability and Southeast
AT_SP	Interaction of Advanced Traceability and Southern Plains
NT_SP	Interaction of No Traceability and Southern Plains

APPENDIX 3: COW-CALF PRODUCER SURVEY DEMOGRAPHIC, PERCEPTION, AND CHOICE EXPERIMENT SUMMARY TABLES

3.1 Demographics

Table A.3.1. Producers' Gender (Survey Question 1)

	Number Reporting	Percent Reporting
Male	602	92.47%
Female	49	7.53%
Total	651	100.00%

Source: Calculated from Data

Table A.3.2. Producers' Age (Survey Question 2)

N Valid	N Missing	Mean	Median	Standard Deviation	Minimum	Maximum
646	9	57.51	58	13.46	17	90

Source: Calculated from Data

Table A.3.3. Producers' State of Residence (Survey Question 3)

	Number Reporting	Percent Reporting		Number Reporting	Percent Reporting
Alabama	19	2.93%	Nebraska	51	7.86%
Arizona	3	0.46%	Nevada	7	1.08%
Arkansas	6	0.92%	New Mexico	5	0.77%
California	19	2.93%	New York	3	0.46%
Colorado	20	3.08%	North Carolina	7	1.08%
Florida	3	0.46%	North Dakota	34	5.24%
Georgia	9	1.39%	Ohio	8	1.23%
Hawaii	1	0.15%	Oklahoma	36	5.55%
Idaho	9	1.39%	Oregon	10	1.54%
Illinois	12	1.85%	South Carolina	2	0.31%
Indiana	3	0.46%	South Dakota	50	7.70%
Iowa	44	6.78%	Tennessee	14	2.16%
Kansas	45	6.93%	Texas	62	9.55%
Kentucky	10	1.54%	Utah	10	1.54%
Louisiana	3	0.46%	Virginia	13	2.00%
Maryland	1	0.15%	Washington	6	0.92%
Minnesota	10	1.54%	West Virginia	2	0.31%
Mississippi	4	0.62%	Wisconsin	10	1.54%
Missouri	42	6.47%	Wyoming	23	3.54%
Montana	33	5.08%	Total	649	100.00%

Source: Calculated from Data[28]

[28] Michigan was removed from the data due to the mandatory nature of their beef traceability system.

Table A.3.4. States within the ERS Farm Production Regions

Appalachia	Corn Belt	Delta States	Northern Plains	Southern Plains
Kentucky	Illinois	Arkansas	Kansas	Oklahoma
North Carolina	Indiana	Louisiana	Nebraska	Texas
Tennessee	Iowa	Mississippi	North Dakota	
Virginia	Missouri		South Dakota	
West Virginia	Ohio			
Mountain	**Northeast**	**Pacific**	**Southeast**	**Lake States**
Arizona	Connecticut	California	Alabama	Minnesota
Colorado	Delaware	Oregon	Florida	Wisconsin
Idaho	Maine	Washington	Georgia	
Montana	Maryland		South Carolina	
Nevada	Massachusetts			
New Mexico	New Hampshire			
Utah	New Jersey			
Wyoming	New York			
	Pennsylvania			
	Rhode Island			
	Vermont			

Table A.3.5. ERS Farm Production Regions

	Number Reporting	Percent Reporting
Appalachia	46	7.10%
Corn Belt	109	16.82%
Delta States	13	2.01%
Lake States	20	3.09%
Mountain	110	16.98%
Northeast	4	0.62%
Northern Plains	180	27.78%
Pacific	35	5.40%
Southeast	34	5.25%
Southern Plains	97	14.97%
Total	648	100.00%

Source: Calculated from Data[29]

[29] Base is equal to N-1 because Hawaii was not assigned a production region.

Table A.3.6. States within the U.S. Regions

Northwest	Northern Crescent	Southeast	Northern Plains
Arizona	Minnesota	Alabama	Kansas
Colorado	Wisconsin	Florida	Nebraska
Idaho	Connecticut	Georgia	North Dakota
Montana	Delaware	South Carolina	South Dakota
Nevada	Maine	Kentucky	
New Mexico	Maryland	North Carolina	Southern Plains
Utah	Massachusetts	Tennessee	Oklahoma
Wyoming	New Hampshire	Virginia	Texas
California	New Jersey	West Virginia	
Oregon	New York	Arkansas	Corn Belt
Washington	Pennsylvania	Louisiana	Illinois
	Rhode Island	Mississippi	Indiana
	Vermont		Iowa
			Missouri
			Ohio

U.S. Regions reflect ERS Farm Resource Regions and ERS Production Regions[30]

Table A.3.7. U.S. Regions

	Number Reporting	Percent Reporting
Southeast Area (Appalachia, Southeast, Delta States)	93	14.35%
Northern Crescent (Lake States, Northeast)	24	3.70%
Northwest Area (Pacific, Mountain)	145	22.38%
Corn Belt	109	16.82%
Northern Plains	180	27.78%
Southern Plains	97	14.97%
Total	648	100.00%

Source: Calculated from Data[31]

Table A.3.8. Farm Organizations of Membership (Survey Question 4)

	Number Reporting			Percent Reporting	
	Yes	No	Total	Yes	No
State or local cattlemen's group	338	317	655	51.60%	48.40%
Breed association	131	524	655	20.00%	80.00%
National Farm Bureau	225	430	655	34.35%	65.65%
National Cattlemen's Beef Association	145	510	655	22.14%	77.86%
Rancher's and Cattlemen's Action Legal Fund	79	576	655	12.06%	87.94%
National Farmers Union	41	614	655	6.26%	93.74%
National Livestock Association	17	638	655	2.60%	97.40%
National Farmers Organization	12	643	655	1.83%	98.17%
Other	51	604	655	7.79%	92.21%
Total	1039	4856	5895		

Source: Calculated from Data; Percents may reflect multiple answers

[30] The initial set was condensed for ease in estimation and interpretation.
[31] Base is equal to N-1 because Hawaii was not assigned a production region.

Table A.3.8. Farm Organizations of Membership (cont'd)

Others listed:

- Alabama Farmer's Federation
- American Cattlemen's Association
- American Soybean Association
- National Corn Growers Association
- American Quarter Horse Association
- American Sheep Industry
- Beef Quality Assurance
- Cattle Women
- Colorado Holistic Management
- Conservation District
- County Natural Beef
- Dekalb County Cattlemen's Assoc.
- Family Farms for the Future
- FFA Alumni
- Georgia Farm Bureau
- I-Cow
- Independent Cattlemen's Association.
- Local Fair Board
- Local Las Animas Company Livestock
- Mercy for Animals
- Montana Association of Conservation Districts
- Natural Resources Conservation Service
- Montana Organic Organization
- Big Horn Company Livestock Association
- Nebraska Cattlemen
- Concordia Institute
- Northern Plains Sustainable Agriculture Society
- Organic Grassfed Beef Association
- Organic Farmers Agency for Relationship Marketing
- Weston A Price Foundation
- State Farm Bureau
- Texas Southwest Cattle Raisers
- Texas Cattle Feeders Association
- Texas and Southwestern Cattle Raisers Association
- United States Cattlemen's Association

Table A.3.9. Educational Description (Survey Question 5)

	Number Reporting	Percent Reporting
Did not attend college	204	31.34%
Technical training (Certification or Associates Degree)	49	7.53%
Attended College, No Bachelor's (B.S. or B.A.) Degree	118	18.13%
Bachelor's (B.S. or B.A.) College Degree	194	29.80%
Graduate or Professional Degree (M.S., Ph.D., D.V.M., Law School)	80	12.29%
Other	6	0.92%
Total	651	100.00%

Source: Calculated from Data

Others listed:

- U.S. Army Training
- Farm Management (8 week course)
- Military
- U.S. Navy Training

Table A.3.10. Years Raising Cattle (Survey Question 6)

	Number Reporting	Percent Reporting
Less than 5 years	7	1.08%
6-10 years	23	3.53%
11-15 years	29	4.45%
16-20 years	34	5.22%
21-25 years	56	8.60%
26-30 years	65	9.98%
Over 30 years	427	65.59%
I don't raise beef cattle	10	1.54%
Total	651	100.00%

Source: Calculated from Data

Table A.3.11. Expected Future Years Raising Cattle (Survey Question 7)

	Number Reporting	Percent Reporting
Less than 5 years	74	11.56%
6-10 years	109	17.03%
11-15 years	75	11.72%
16-20 years	95	14.84%
21-25 years	45	7.03%
26-30 years	23	3.59%
Over 30 years	219	34.22%
Total	640	100.00%

Source: Calculated from Data

Table A.3.12. Estimated Annual Pre-tax Household Income (Survey Question 8)

	Number Reporting	Percent Reporting
Less than $25,000	30	4.96%
$25,000-$49,999	106	17.52%
$50,000-$74,999	134	22.15%
$75,000-$99,999	96	15.87%
$100,000-$124,999	62	10.25%
$125,000 or more	177	29.26%
Total	605	100.00%

Source: Calculated from Data

Table A.3.13. Off-Farm Household Income (Survey Question 9)

	Number Reporting	Percent Reporting
Less than 20%	288	45.50%
20%-39%	95	15.01%
40%-59%	119	18.80%
60%-79%	54	8.53%
80% or more	77	12.16%
Total	633	100.00%

Source: Calculated from Data

Table A.3.14. Labor Supplied by Paid Employees (Survey Question 10)

	Number Reporting	Percent Reporting
Less than 25%	480	75.00%
26%-50%	73	11.41%
51%-75%	43	6.72%
Over 75%	44	6.88%
Total	640	100.00%

Source: Calculated from Data

Table A.3.15. Feed Needs Produced by Own Farm (Survey Question 11)

	Number Reporting	Percent Reporting
Less than 25%	55	8.59%
26%-50%	57	8.91%
51%-75%	104	16.25%
Over 75%	424	66.25%
Total	640	100.00%

Source: Calculated from Data

Table A.3.16. Production Claims (Survey Question 12)

	Number Reporting			Percent Reporting	
	Yes	No	Total	Yes	No
Implant free	260	303	563	46.18%	53.82%
Antibiotic free	139	387	526	26.43%	73.57%
Natural	135	366	501	26.95%	73.05%
Organic	17	432	449	3.79%	96.21%
100% grass-fed diets	95	402	497	19.11%	80.89%
Humanely raised	283	237	520	54.42%	45.58%
Other	33	0	33	100.00%	0.00%
Total	962	2127	3089		

Source: Calculated from Data; Percents may reflect multiple answers

Others listed:

- Age & Source Verified
- Angus Breeding Cattle
- Backgrounded
- Beef Quality Assurance
- Boostered
- Calves right off summer grass
- Calves sold off cows, no weaning
- Dewormed
- Feeders direct, not from auction
- FVO Certified Organic
- Genetics
- Grain fed
- Johne's Disease Negative
- Marketing Co-op
- Never sick
- Non-hormone
- Pets
- Preconditioned
- Predator friendly
- Rangeland
- Seed stock
- Some creep feeding
- They are delicious (Local Slaughter)
- Vaccinated
- Vaccinated 9 way
- Vaccinated PR3
- Vaccinated against calf hood diseases
- Weaned
- Winter Hay & Supplements

Table A.3.17. Marketing Methods (Survey Question 13)

	Number Reporting	Percent Reporting
Direct to traders	77	9.73%
Direct to consumers	34	4.30%
Local auction	384	48.55%
Direct to backgrounding systems	23	2.91%
Direct to feedlots	70	8.85%
Local slaughter house	13	1.64%
Packing Plant	79	9.99%
Special auctions (clubs, associations, etc.)	39	4.93%
Video/Internet auctions	72	9.10%
Total	791	100.00%

Source: Calculated from Data; Percents may reflect multiple answers

Table A.3.18. Beef Cows that Calved (Survey Question 14)

	Number Reporting	Percent Reporting
None	27	4.24%
Less than 50	37	5.81%
50-99	115	18.05%
100-199	209	32.81%
200-299	116	18.21%
300-499	65	10.20%
500-999	48	7.54%
1,000 or more	20	3.14%
Total	637	100.00%

Source: Calculated from Data

Table A.3.19. Operation's Sales at Production Stages (Survey Question 15)

	N Valid	N Missing	Mean	Median	Standard Deviation	Minimum	Maximum
Calves	457	198	172.53	100	336.60	0	5000
Yearlings	315	340	216.01	60	514.22	0	5000
Finished Cattle	237	418	440.95	60	1437.33	0	15000

Source: Calculated from Data

Table A.3.20. Market Finished Cattle and Own Feedlot[32] (Survey Question 15)

Number Reporting			Percent Reporting	
Yes	No	Total	Yes	No
129	283	412	31.31%	68.69%

Source: Calculated from Data

[32] These results are not actually accurate because many producers indicated that they didn't own there own feedlot even if they did not market finished cattle in 2007.

Table A.3.21. Current Animal Identification Methods (Survey Question 16)

	Number Reporting			Percent Reporting	
	Yes	No	Total	Yes	No
Plastic ear tag	566	78	644	87.89%	12.11%
Ear notches	162	482	644	25.16%	74.84%
Brand	377	266	643	58.63%	41.37%
Tattoo	128	515	643	19.91%	80.09%
Brucellosis or any other metal tag	244	399	643	37.95%	62.05%
Electronic ear tag (RFID)	59	584	643	9.18%	90.82%
None	18	625	643	2.80%	97.20%
Other	8	635	643	1.24%	98.76%

Source: Calculated from Data

Others listed:

- Bangs
- Brisket tags
- FVO Certification Records
- Green tag
- Registration Number
- Sure Health Tags
- Wattle tag

Table A.3.22. Current Premise Registration in NAIS (Survey Question 22)

Number Reporting			Percent Reporting	
Yes	No	Total	Yes	No
275	350	625	44.00%	56.00%

Source: Calculated from Data

3.2 Perceptions

Table A.3.23. Issues in Designing a Traceability System (Survey Question 17)

	N Valid	N Missing	Mean	Median	Standard Deviation
Monitoring/managing disease	618	37	4.10	4	1.13
Increasing consumer confidence	608	47	4.03	4	1.16
Enhancing marketability	608	47	3.82	4	1.17
Maintaining current foreign markets	607	48	3.89	4	1.17
Accessing foreign markets	606	49	3.83	4	1.18
Improving on-farm management	605	50	3.49	4	1.29
Managing the supply chain	606	49	3.44	4	1.24
Enhancing food safety	617	38	3.95	4	1.21

Source: Calculated from Data

Table A.3.23a. Monitoring/Managing Disease (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	36	5.83%
Unimportant	27	4.37%
Neutral	70	11.33%
Important	192	31.07%
Very Important	293	47.41%
Total	618	100.00%

Source: Calculated from Data

Table A.3.23b. Increasing Consumer Confidence (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	36	5.92%
Unimportant	35	5.76%
Neutral	75	12.34%
Important	190	31.25%
Very Important	272	44.74%
Total	608	100.00%

Source: Calculated from Data

Table A.3.23c. Enhancing Marketability (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	44	7.24%
Unimportant	36	5.92%
Neutral	105	17.27%
Important	222	36.51%
Very Important	201	33.06%
Total	608	100.00%

Source: Calculated from Data

Table A.3.23d. Maintaining Current Foreign Markets (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	42	6.92%
Unimportant	32	5.27%
Neutral	107	17.63%
Important	196	32.29%
Very Important	230	37.89%
Total	607	100.00%

Source: Calculated from Data

Table A.3.23e. Accessing Foreign Markets (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	44	7.26%
Unimportant	32	5.28%
Neutral	120	19.80%
Important	197	32.51%
Very Important	213	35.15%
Total	606	100.00%

Source: Calculated from Data

Table A.3.23f. Improving On-Farm Management (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	71	11.74%
Unimportant	58	9.59%
Neutral	140	23.14%
Important	178	29.42%
Very Important	158	26.12%
Total	605	100.00%

Source: Calculated from Data

Table A.3.23g. Managing the Supply Chain (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	66	10.89%
Unimportant	56	9.24%
Neutral	166	27.39%
Important	182	30.03%
Very Important	136	22.44%
Total	606	100.00%

Source: Calculated from Data

Table A.3.23h. Enhancing Food Safety (Survey Question 17)

	Number Reporting	Percent Reporting
Entirely Unimportant	46	7.46%
Unimportant	32	5.19%
Neutral	96	15.56%
Important	174	28.20%
Very Important	269	43.60%
Total	617	100.00%

Source: Calculated from Data

Table A.3.24. Concerns in Designing a Traceability System (Survey Question 18)

	N Valid	N Missing	Mean	Median	Standard Deviation
Cost to participating producer	630	25	4.19	4	1.02
Confidentiality of information	623	32	3.97	4	1.20
Reliability of technology	625	30	4.05	4	1.03
Liability to participating producer	623	32	4.16	4	1.03
Non-participating firms benefiting	622	33	3.73	4	1.18
Failure of system to meet stated goals	619	36	3.99	4	1.06

Source: Calculated from Data

Table A.3.24a. Cost to Participating Producer

	Number Reporting	Percent Reporting
Entirely Unconcerned	24	3.81%
Unconcerned	20	3.17%
Neutral	73	11.59%
Concerned	207	32.86%
Very Concerned	306	48.57%
Total	630	100.00%

Source: Calculated from Data

Table A.3.24b. Confidentiality of Information

	Number Reporting	Percent Reporting
Entirely Unconcerned	42	6.74%
Unconcerned	35	5.62%
Neutral	101	16.21%
Concerned	164	26.32%
Very Concerned	281	45.10%
Total	623	100.00%

Source: Calculated from Data

Table A.3.24c. Reliability of Technology

	Number Reporting	Percent Reporting
Entirely Unconcerned	22	3.52%
Unconcerned	24	3.84%
Neutral	110	17.60%
Concerned	213	34.08%
Very Concerned	256	40.96%
Total	625	100.00%

Source: Calculated from Data

Table A.3.24d. Liability to Participating Producer

	Number Reporting	Percent Reporting
Entirely Unconcerned	20	3.21%
Unconcerned	25	4.01%
Neutral	92	14.77%
Concerned	183	29.37%
Very Concerned	303	48.64%
Total	623	100.00%

Source: Calculated from Data

Table A.3.24e. Non-Participating Firms Benefiting

	Number Reporting	Percent Reporting
Entirely Unconcerned	41	6.59%
Unconcerned	43	6.91%
Neutral	162	26.05%
Concerned	171	27.49%
Very Concerned	205	32.96%
Total	622	100.00%

Source: Calculated from Data

Table A.3.24f. Failure of System to Meet Stated Goals

	Number Reporting	Percent Reporting
Entirely Unconcerned	27	4.36%
Unconcerned	26	4.20%
Neutral	109	17.61%
Concerned	219	35.38%
Very Concerned	238	38.45%
Total	619	100.00%

Source: Calculated from Data

Table A.3.25. Common Traceability Statements (Survey Question 19)

	N Valid	N Missing	Mean	Median	Standard Deviation
"is more cost effective for larger cow-calf operations."	619	36	3.28	3	1.19
"results in more liability for cow-calf producers than cattle owners at other stages of production."	619	36	3.73	4	1.14
"is unnecessary if COOL (Country-of-Origin Labeling) was implemented nationally."	619	36	3.37	3	1.28
"as a mandated system is exaggerated in need."	618	37	3.38	3	1.23

Source: Calculated from Data

Table A.3.25a. "Is More Cost Effective for Larger Cow-Calf Operations"

	Number Reporting	Percent Reporting
Strongly Disagree	61	9.85%
Disagree	87	14.05%
Neutral	192	31.02%
Agree	173	27.95%
Strongly Agree	106	17.12%
Total	619	100.00%

Source: Calculated from Data

Table A.3.25b. "Results in More Liability for Cow-Calf Producers"

	Number Reporting	Percent Reporting
Strongly Disagree	27	4.36%
Disagree	69	11.15%
Neutral	136	21.97%
Agree	198	31.99%
Strongly Agree	189	30.53%
Total	619	100.00%

Source: Calculated from Data

Table A.3.25c. "Is Unnecessary if COOL was Implemented Nationally"

	Number Reporting	Percent Reporting
Strongly Disagree	61	9.85%
Disagree	97	15.67%
Neutral	167	26.98%
Agree	141	22.78%
Strongly Agree	153	24.72%
Total	619	100.00%

Source: Calculated from Data

Table A.3.25d. "As a Mandated System is Exaggerated"

	Number Reporting	Percent Reporting
Strongly Disagree	54	8.74%
Disagree	87	14.08%
Neutral	191	30.91%
Agree	143	23.14%
Strongly Agree	143	23.14%
Total	618	100.00%

Source: Calculated from Data

Table A.3.26. Allocation of Benefits with Traceability (Survey Question 21)

Benefits to:	N Valid	N Missing	Mean	Median	Standard Deviation
Retailers	514	141	34.38	30	24.93
Processors	513	142	26.56	25	20.52
Feedlot Producers	512	143	18.92	20	15.67
Cow-calf Producers	515	140	19.80	10	22.28

Source: Calculated from Data

Table A.3.27. Allocation of Costs with Traceability (Survey Question 21)

Costs to:	N Valid	N Missing	Mean	Median	Standard Deviation
Retailers	511	144	11.22	5	17.21
Processors	511	144	12.40	10	14.10
Feedlot Producers	511	144	18.71	20	15.00
Cow-calf Producers	518	137	58.36	60	29.22

Source: Calculated from Data

Table A.3.28. Should NAIS be Mandatory (Survey Question 23)

Number Reporting				Percent Reporting		
Yes	No	Undecided	Total	Yes	No	Undecided
132	313	177	622	21.22%	50.32%	28.46%

Source: Calculated from Data

Table A.3.29. Forecast of Premises Registered (Survey Question 24)

N Valid	N Missing	Mean	Median	Standard Deviation
593	62	40.47	40	18.87

Source: Calculated from Data

Table A.3.30. Forecast of Premises Registered and RFID Use (Survey Question 24)

N Valid	N Missing	Mean	Median	Standard Deviation
577	78	31.58	30	20.11

Source: Calculated from Data

3.3 Choice Experiment

Table A.3.31. General Choice Experiment Statistics

	Returned	Not Returned	complete	Complete %
Block A	136	264	91	66.91%
Block B	123	277	97	78.86%
Block C	127	273	97	76.38%
Block D	135	265	109	80.74%
Block E	134	266	100	74.63%
Total	655	1345	494	75.42%

Source: Calculated from Data

Table A.3.32. Complete Choice Experiments

	NAIS Trace	NAIS Trace %	Adv Trace	Adv Trace %	No Trace	No Trace %	Total
Block A	92	25.27%	183	50.27%	89	24.45%	364
Block B	124	31.96%	141	36.34%	123	31.70%	388
Block C	90	23.20%	154	39.69%	144	37.11%	388
Block D	152	34.86%	138	31.65%	146	33.49%	436
Block E	128	32.00%	175	43.75%	97	24.25%	400
Total	586	29.66%	791	40.03%	599	30.31%	1976

Source: Calculated from Data

Table A.3.33. Traceability Scenarios Block A

Traceability Scenarios Block A		Number Reporting	Percent Reporting
Scenario 1			
NAIS Traceability ($0.00, Government)		26	25.24%
Advanced Traceability ($0.00; Private - Not Industry; Age Verification, Production Practices, and Health/Vaccinations)		55	53.40%
No Traceability (-$7.50)		22	21.36%
	Total	103	100.00%
Scenario 2			
NAIS Traceability ($0.00, Government)		20	19.23%
Advanced Traceability ($15.00; Private - Industry; Age Verification, Production Practices, and Health/Vaccinations)		55	52.88%
No Traceability ($0.00)		29	27.88%
	Total	104	100.00%
Scenario 3			
NAIS Traceability ($0.00, Government)		29	30.53%
Advanced Traceability ($7.50; Government; Age Verification, Production Practices, and Performance/Genetics)		36	37.89%
No Traceability ($-7.50)		30	31.58%
	Total	95	100.00%
Scenario 4			
NAIS Traceability ($0.00, Government)		22	22.45%
Advanced Traceability ($15.00; Private - Not Industry; Age Verification and Health/Vaccinations)		61	62.24%
No Traceability ($-7.50)		15	15.31%
	Total	98	100.00%

Source: Calculated from Data

Table A.3.34. Traceability Scenarios Block B

Traceability Scenarios Block B	Number Reporting	Percent Reporting
Scenario 1		
NAIS Traceability ($0.00, Government)	36	33.96%
Advanced Traceability ($7.50; Private - Not Industry; Age Verification and Performance/Genetics)	39	36.79%
No Traceability (-$7.50)	31	29.25%
Total	106	100.00%
Scenario 2		
NAIS Traceability ($0.00, Government)	26	24.53%
Advanced Traceability ($0.00; Private - Industry; Age Verification and Health/Vaccinations)	47	44.34%
No Traceability ($0.00)	33	31.13%
Total	106	100.00%
Scenario 3		
NAIS Traceability ($0.00, Government)	36	36.36%
Advanced Traceability ($0.00; Government; Production Practices and Performance/Genetics)	29	29.29%
No Traceability (-$15.00)	34	34.34%
Total	99	100.00%
Scenario 4		
NAIS Traceability ($0.00, Government)	29	28.43%
Advanced Traceability ($7.50; Private - Industry; Production Practices and Health/Vaccinations)	49	48.04%
No Traceability (-$15.00)	24	23.53%
Total	102	100.00%

Source: Calculated from Data

Table A.3.35. Traceability Scenarios Block C

Traceability Scenarios Block C		
Scenario 1	Number Reporting	Percent Reporting
NAIS Traceability ($0.00, Government)	28	27.18%
Advanced Traceability ($0.00; Private - Not Industry; Age Verification)	32	31.07%
No Traceability ($0.00)	43	41.75%
Total	103	100.00%
Scenario 2		
NAIS Traceability ($0.00, Government)	20	20.00%
Advanced Traceability ($7.50; Government; Age Verification and Production Practices)	37	37.00%
No Traceability ($0.00)	43	43.00%
Total	100	100.00%
Scenario 3		
NAIS Traceability ($0.00, Government)	21	21.21%
Advanced Traceability ($7.50; Government; Age Verification)	42	42.42%
No Traceability (-$7.50)	36	36.36%
Total	99	100.00%
Scenario 4		
NAIS Traceability ($0.00, Government)	25	25.25%
Advanced Traceability ($7.50; Private - Not Industry; Health/Vaccinations)	48	48.48%
No Traceability (-$15.00)	26	26.26%
Total	99	100.00%

Source: Calculated from Data

Table A.3.36. Traceability Scenarios Block D

Traceability Scenarios Block D		
Scenario 1	Number Reporting	Percent Reporting
NAIS Traceability ($0.00, Government)	34	30.09%
Advanced Traceability ($15.00; Government; Production Practices and Health/Vaccinations)	34	30.09%
No Traceability ($0.00)	45	39.82%
Total	113	100.00%
Scenario 2		
NAIS Traceability ($0.00, Government)	48	42.86%
Advanced Traceability ($15.00; Government; Age Verification, Production Practices, Performance/Genetics, and Health/Vaccinations)	28	25.00%
No Traceability (-$7.50)	36	32.14%
Total	112	100.00%
Scenario 3		
NAIS Traceability ($0.00, Government)	37	32.46%
Advanced Traceability ($7.50; Private - Not Industry; Production Practices, Performance/Genetics, and Health/Vaccinations)	35	30.70%
No Traceability ($0.00)	42	36.84%
Total	114	100.00%
Scenario 4		
NAIS Traceability ($0.00, Government)	35	31.25%
Advanced Traceability ($15.00; Private - Industry; Age Verification and Production Practices)	48	42.86%
No Traceability (-$7.50)	29	25.89%
Total	112	100.00%

Source: Calculated from Data

Table A.3.37. Traceability Scenarios Block E

Traceability Scenarios Block E		Number Reporting	Percent Reporting
Scenario 1			
NAIS Traceability ($0.00, Government)		41	39.42%
Advanced Traceability ($0.00; Government; Production Practices, Performance/Genetics, and Health/Vaccinations)		35	33.65%
No Traceability (-$15.00)		28	26.92%
	Total	104	100.00%
Scenario 2			
NAIS Traceability ($0.00, Government)		36	34.95%
Advanced Traceability ($0.00; Government; Performance/Genetics and Health/Vaccinations)		38	36.89%
No Traceability (-$15.00)		29	28.16%
	Total	103	100.00%
Scenario 3			
NAIS Traceability ($0.00, Government)		27	25.71%
Advanced Traceability ($0.00; Private - Industry; Production Practices)		54	51.43%
No Traceability (-$7.50)		24	22.86%
	Total	105	100.00%
Scenario 4			
NAIS Traceability ($0.00, Government)		27	26.47%
Advanced Traceability ($7.50; Private - Industry; Performance/Genetics)		59	57.84%
No Traceability (-$15.00)		16	15.69%
	Total	102	100.00%

Source: Calculated from Data

APPENDIX 4: SUPPLEMENTAL REGRESSIONS AND DIAGNOSTICS

"In designing a national, individual animal traceability system how important managing the supply chain to the U.S. beef industry?"

Table A.4.1. Managing the Supply Chain Estimates

Parameter	Estimate	Standard Error
Intercept	1.6491***	0.4573
Age	-0.0055	0.0049
CB	-0.1182	0.2716
NP	0.2950	0.2680
NW	0.0002	0.2764
SE	0.4013	0.2852
SP	0.1373	0.2836
Member	0.0176	0.0418
Education	-0.0443	0.0340
Years	0.0286	0.0392
ExpYears	0.0025	0.0255
Income	-0.0218	0.0298
OIncome	0.0075	0.0352
Labor	-0.0091	0.0558
OFeed	-0.1227**	0.0506
Cows	0.0659*	0.0355
Auctions	-0.0402	0.1038
RegNAIS	0.0960	0.0988
Limit 2	0.4603***	0.0606
Limit 3	1.2744***	0.0796
Limit 4	2.1598***	0.0925

• *** 1% significance level, ** 5% significance level, * 10% significance level

Table A.4.2. ME to Managing the Supply Chain

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
OFeed	0.0199	0.0125	0.0148	-0.0120	-0.0352
Cows	-0.0107	-0.0067	-0.0080	0.0064	0.0189

"In designing a national, individual animal traceability system how important is enhancing food safety to the U.S. beef industry?"

Table A.4.3. Enhancing Food Safety Estimates

Parameter	Estimate	Standard Error
Intercept	1.8386***	0.4632
Age	-0.0017	0.0051
CB	-0.4302	0.2759
NP	0.0314	0.2727
NW	-0.1327	0.2809
SE	0.0387	0.2905
SP	-0.1502	0.2883
Member	-0.0072	0.0432
Education	-0.0390	0.0351
Years	0.0077	0.0407
ExpYears	0.0136	0.0264
Income	-0.0112	0.0311
OIncome	0.0145	0.0361
Labor	-0.0503	0.0574
OFeed	-0.0622	0.0517
Cows	0.0431	0.0365
Auctions	-0.1025	0.1082
RegNAIS	0.3008***	0.1034
Limit 2	0.3188***	0.0599
Limit 3	0.9589***	0.0825
Limit 4	1.7308***	0.0926

• *** 1% significance level, ** 5% significance level, * 10% significance level

Table A.4.4. ME to Enhancing Food Safety

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
RegNAIS	-0.0366	-0.0191	-0.0417	-0.0174	0.1148

"In designing a national, individual animal traceability system how important is improving marketability to the U.S. beef industry?"

Table A.4.5. Improving Marketability Estimates

Parameter	Estimate	Standard Error
Intercept	1.8942***	0.4581
Age	-0.0124**	0.0050
CB	-0.2591	0.2664
NP	0.0557	0.2630
NW	0.0046	0.2717
SE	0.0631	0.2798
SP	0.0768	0.2804
Member	0.0449	0.0430
Education	0.0292	0.0346
Years	0.0541	0.0395
ExpYears	0.0040	0.0261
Income	-0.0148	0.0306
OIncome	-0.0039	0.0358
Labor	-0.0374	0.0562
OFeed	-0.0259	0.0513
Cows	0.0273	0.0362
Auctions	-0.1943*	0.1062
RegNAIS	0.2276**	0.1012
Limit 2	0.3355***	0.0617
Limit 3	1.0084***	0.0842
Limit 4	2.0225***	0.0970

• *** 1% significance level, ** 5% significance level, * 10% significance level

Table A.4.6. ME to Improving Marketability

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
Age	0.0015	0.0008	0.0018	0.0002	-0.0043
Auctions	0.0236	0.0130	0.0276	0.0038	-0.0680
RegNAIS	-0.0277	-0.0152	-0.0324	-0.0044	0.0797

"In designing a national, individual animal traceability system how important is improving on-farm management to the U.S. beef industry?"

Table A.4.7. Improving On-Farm Management Estimates

Parameter	Estimate	Standard Error
Intercept	1.5890***	0.4420
Age	-0.0070	0.0049
CB	0.1508	0.2578
NP	0.2178	0.2527
NW	-0.0293	0.2622
SE	0.2583	0.2702
SP	0.2735	0.2700
Member	0.0115	0.0422
Education	-0.0282	0.0345
Years	0.0188	0.0388
ExpYears	-0.0148	0.0258
Income	-0.0326	0.0299
OIncome	-0.0062	0.0353
Labor	-0.0408	0.0553
OFeed	-0.0583	0.0499
Cows	0.0572*	0.0350
Auctions	-0.0289	0.1043
RegNAIS	0.1311	0.0993
Limit 2	0.3919***	0.0534
Limit 3	1.0597***	0.0721
Limit 4	1.8547***	0.0844

- *** 1% significance level, ** 5% significance level, * 10% significance level

Table A.4.8. ME to Improving On-Farm Management

	ME				
Parameter	Entirely Unimportant	Unimportant	Neutral	Important	Very Important
Cows	-0.0109	-0.0052	-0.0061	0.0036	0.0185

"Implementing individual animal traceability systems is more cost effective for larger cow-calf operations."

Table A.4.9. Economies of Scale Estimates

Parameter	Estimate	Standard Error
Intercept	1.0683**	0.4375
Age	0.0065	0.0048
CB	-0.3830	0.2627
NP	-0.2211	0.2581
NW	-0.3110	0.2672
SE	-0.0601	0.2747
SP	-0.2197	0.2734
Member	-0.0005	0.0409
Education	0.0232	0.0334
Years	-0.0052	0.0383
ExpYears	-0.0213	0.0250
Income	0.0259	0.0293
OIncome	0.0609*	0.0345
Labor	-0.0045	0.0548
OFeed	0.0683	0.0491
Cows	-0.0641*	0.0345
Auctions	-0.0042	0.1015
RegNAIS	-0.0279	0.0967
Limit 2	0.5780***	0.0631
Limit 3	1.4383***	0.0798
Limit 4	2.2579***	0.0924

• * 1% significance level, ** 5% significance level, *** 10% significance level

Table A.4.10. ME to Economies of Scale

	ME				
Parameter	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
OIncome	-0.0104	-0.0079	-0.0052	0.0080	0.0155
Cows	0.0110	0.0083	0.0055	-0.0084	-0.0163

"Implementing individual animal traceability results in more liability for cow-calf producers than cattle owners at other stages of production."

Table A.4.11. Shifts in Liability Estimates

Parameter	Estimate	Standard Error
Intercept	0.9697**	0.4443
Age	-0.0045	0.0049
CB	-0.0114	0.2633
NP	0.1679	0.2593
NW	0.0483	0.2683
SE	0.3616	0.2759
SP	0.1634	0.2751
Member	-0.0226	0.0415
Education	0.0264	0.0343
Years	0.0661*	0.0386
ExpYears	-0.0244	0.0254
Income	0.0585*	0.0299
OIncome	-0.0016	0.0352
Labor	-0.0492	0.0561
OFeed	0.0482	0.0504
Cows	0.0732**	0.0350
Auctions	0.1275	0.1027
RegNAIS	-0.2539**	0.0989
Limit 2	0.7544***	0.0892
Limit 3	1.4416***	0.1003
Limit 4	2.3166***	0.1085

• *** 1% significance level, ** 5% significance level, * 10% significance level

Table A.4.12. ME to Shifts in Liability

	ME				
Parameter	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Years	-0.0059	-0.0098	-0.0085	0.0020	0.0222
Income	-0.0052	-0.0087	-0.0076	0.0018	0.0197
Cows	-0.0065	-0.0109	-0.0095	0.0022	0.0246
RegNAIS	0.0225	0.0378	0.0329	-0.0078	-0.0854

"Implementing individual animal traceability systems as a mandated system is exaggerated in need."

Table A.4.13. Mandatory Traceability Exaggeration Estimates

Parameter	Estimate	Standard Error
Intercept	0.7849*	0.4364
Age	-0.0018	0.0049
CB	-0.0774	0.2599
NP	0.0481	0.2550
NW	0.1256	0.2646
SE	0.1857	0.2715
SP	0.1464	0.2716
Member	-0.0413	0.0413
Education	0.0164	0.0340
Years	0.0976**	0.0385
ExpYears	-0.0134	0.0252
Income	-0.0005	0.0296
OIncome	-0.0446	0.0349
Labor	-0.0202	0.0553
OFeed	0.0804	0.0497
Cows	0.0066	0.0346
Auctions	0.1565	0.1025
RegNAIS	-0.2841***	0.0981
Limit 2	0.6262***	0.0672
Limit 3	1.5078***	0.0835
Limit 4	2.1969***	0.0932

- *** 1% significance level, ** 5% significance level, * 10% significance level

Table A.4.14. ME to Mandatory Traceability Exaggeration

	ME				
Parameter	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Years	-0.0150	-0.0134	-0.0091	0.0094	0.0281
RegNAIS	0.0435	0.0389	0.0266	-0.0272	-0.0818

APPENDIX 5: SAS, STATA, AND LIMDEP CODE

5.1 SAS

```
*/Factor Analysis SAS Code*/

PROC IMPORT OUT= WORK.rawdata
DATAFILE= "E:Estimation Data Set 05.04.08.xls"
DBMS=EXCEL REPLACE;   SHEET="Non CE Est Data";   GETNAMES=YES;
MIXED=NO;   SCANTEXT=YES; USEDATE=YES;   SCANTIME=YES;
RANGE="A1:CE656";RUN;

title 'proc means data=rawdata;run;';
proc means data=rawdata;run;

/*********************************************************************/

/*FIRST CONSIDER ALL INDICATORS IN Q17, 18, and 19*/
title1 'Conduct a principal component analysis (Q17-19)';
proc factor data=rawdata method=principal score
outstat=factor_a rotate=varimax mineigen=1;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty cricost criconf crirelia
criliabi crifride crigoals asce asliabi ascool asmanex;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_a out=scores_factor_a;run;

/*compare with forcing a 4th factor*/
/*note this results in the 3rd and 4th factors having only 2 indicators each*/
title1 'Conduct a principal component analysis (Q17-19)';
proc factor data=rawdata method=principal score
outstat=factor_a4 rotate=varimax nfactors=4;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty cricost criconf crirelia
criliabi crifride crigoals asce asliabi ascool asmanex;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_a4 out=scores_factor_a4;run;

/*compare with forcing a 5th factor*/
/*note this results in the 3rd, 4th, & 5th factors having only 2 indicators each*/
title1 'Conduct a principal component analysis (Q17-19)';
proc factor data=rawdata method=principal score
outstat=factor_a5 rotate=varimax nfactors=5;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty
cricost criconf crirelia criliabi crifride crigoals asce asliabi ascool asmanex;run;
```

```
title2 'compute principal component scores';
proc score data=rawdata score=factor_a5 out=scores_factor_a5;run;

/*NOW CONSIDER ONLY INDICATORS IN Q17 & Q18*/
title1 'Conduct a principal component analysis (Q17-18)';
proc factor data=rawdata method=principal score
outstat=factor_b rotate=varimax mineigen=1;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty cricost criconf crirelia
criliabi crifride crigoals;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_b out=scores_factor_b;run;

/*compare with forcing a 3rd factor*/
title1 'Conduct a principal component analysis (Q17-18)';
proc factor data=rawdata method=principal score
outstat=factor_b3 rotate=varimax nfactors=3;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty
cricost criconf crirelia criliabi crifride crigoals;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_b3 out=scores_factor_b3;run;

/*compare with forcing 4 factors*/
title1 'Conduct a principal component analysis (Q17-18)';
proc factor data=rawdata method=principal score
outstat=factor_b4 rotate=varimax nfactors=4;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty
cricost criconf crirelia criliabi crifride crigoals;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_b4 out=scores_factor_b4;run;

/*AS A SIDE EVALUATION, A FACTOR ANAYSIS INCORPORATING THE Q21
BENEFIT/COST VALUES WITH Q17-19 WAS PERFORMED:*/

title1 'Conduct a principal component analysis (Q17-19 & 21)';
proc factor data=rawdata method=principal score
outstat=factor_c rotate=varimax mineigen=1;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty
cricost criconf crirelia criliabi crifride crigoals asce asliabi ascool asmanex benret
benproc benfdlp benccp costret costproc costfdlp costccp;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_c out=scores_factor_c;run;
```

```
/*compare with forcing only 5 factors*/
title1 'Conduct a principal component analysis (Q17-19 & 21)';
proc factor data=rawdata method=principal score
outstat=factor_c5 rotate=varimax nfactors=5;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty cricost criconf crirelia
criliabi crifride crigoals asce asliabi ascool asmanex benret benproc benfdlp benccp
costret costproc costfdlp costccp;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_c5 out=scores_factor_c5;run;

/*compare with forcing 7 factors*/
title1 'Conduct a principal component analysis (Q17-19 & 21)';
proc factor data=rawdata method=principal score
outstat=factor_c7 rotate=varimax nfactors=7;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty cricost criconf crirelia
criliabi crifride crigoals asce asliabi ascool asmanex benret benproc benfdlp benccp
costret costproc costfdlp costccp;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_c7 out=scores_factor_c7;run;

/*compare to only including the cow-calf portion of Q21*/
title1 'Conduct a principal component analysis (Q17-19 & 21 cow-calf)';
proc factor data=rawdata method=principal score
outstat=factor_c2 rotate=varimax mineigen=1;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty cricost criconf crirelia
criliabi crifride crigoals asce asliabi ascool asmanex benccpcostccp;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_c2 out=scores_factor_c2;run;

/*NOW CONSIDER ONLY INDICATORS IN Q17*/
title1 'Conduct a principal component analysis (Q17)';
proc factor data=rawdata method=principal score
outstat=factor_b rotate=varimax mineigen=1;
var ioidis ioicons ioimarkt ioimcfm ioiafm ioimngt ioischn ioifsfty;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_b out=scores_factor_b;run;

/*NOW CONSIDER ONLY INDICATORS IN Q18*/
title1 'Conduct a principal component analysis (18)';
proc factor data=rawdata method=principal score
outstat=factor_b rotate=varimax mineigen=1;
var cricost criconf crirelia criliabi crifride crigoals;run;
```

```
title2 'compute principal component scores';
proc score data=rawdata score=factor_b out=scores_factor_b;run;

/*NOW CONSIDER ONLY INDICATORS IN Q19*/
title1 'Conduct a principal component analysis (18)';
proc factor data=rawdata method=principal score
outstat=factor_b rotate=varimax mineigen=1;
var asce asliabi ascool asmanex;run;

title2 'compute principal component scores';
proc score data=rawdata score=factor_b out=scores_factor_b;run;

/*********************************************************************/
/*********************************************************************/

*/Tobit and Probit Estimation SAS Code*/

PROC IMPORT OUT= WORK.rawdata
DATAFILE= "E:Estimation Data Set 05.04.08.xls"
DBMS=EXCEL REPLACE; SHEET="Non CE Est Data"; GETNAMES=YES;
MIXED=NO; SCANTEXT=YES; USEDATE=YES; SCANTIME=YES;
RANGE="A1:CY656"; RUN;

title 'proc means data=rawdata;run;';
proc means data=rawdata;run;

/*********************************************************************/

*Binary Probit for Evaluating Question 22 (regnais)*/
*(22)Are your operation's premise(s) currently registered with USDA in the NAIS
(National Animal Identification System)? (Yes or No)*/

title 'Estimation of regnais';
PROC QLIM DATA=Rawdata outest=outest;
MODEL  regnais = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla dumpetid dumenid dumbrdid dumtatid dumbrid dumrfid
dumnoid mannais /discrete (dist=normal);output out=outMEregnais marginal;
nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEregnais';
proc means data=outMEregnais;run;

/*********************************************************************/
```

```
*Tobit for Evaluating Question 24 (fnais)*/
*(24)If the NAIS system remains a system of voluntary participation, by December 31,
2008 what do you predict will be (please circle your answers):*/
*(a)The percentage of U.S. cow-calf operations with premises registered in NAIS.*/

title 'Joint Estimation of fnais & regnais';
PROC QLIM DATA=Rawdata outest=outestfnaisreg;
MODEL  regnais = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla dumpetid dumenid dumbrdid dumtatid dumbrid dumrfid
dumnoid mannais /discrete (dist=normal);
MODEL  fnais = age countfo yrsr expyrsr bctc dumla dumrfid regnais mannais cretmccp
cprocmccp cfdlpmccp/discrete (dist=normal);endogenous fnais ~ censored(lb=0 ub=100);
nloptions maxiter=500;RUN;

*Since there is no endogeneity with regnais*/
title 'Estimation of fnais';
PROC QLIM DATA=Rawdata outest=outestfnais;
MODEL  fnais = age countfo yrsr expyrsr bctc dumla dumrfid regnais mannais cretmccp
cprocmccp cfdlpmccp/discrete (dist=normal);endogenous fnais ~ censored(lb=0 ub=100);
output out=outMEfnais marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEfnais';
proc means data=outMEfnais;run;

/*********************************************************************/

*(b)The percentage of U.S. cow-calf operations with premises registered in NAIS AND
using NAIS approved RFID animal identification devices on the percentage of cattle
leaving their premises. (fnaisrfid)*/

title 'Joint Estimation of fnaisrfid & regnais';
PROC QLIM DATA=Rawdata outest=outest;
MODEL  regnais = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla dumpetid dumenid dumbrdid dumtatid dumbrid dumrfid
dumnoid mannais /discrete (dist=normal);
MODEL  fnaisrfid = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla dumpetid dumenid dumbrdid dumtatid dumbrid dumrfid
dumnoid regnais mannais/discrete (dist=normal);
endogenous fnaisrfid ~ censored(lb=0 ub=100);  nloptions maxiter=500;RUN;
```

```
*Since there is no endogeneity with regnais*/
title 'Estimation of fnaisrfid';
PROC QLIM DATA=Rawdata outest=outest;
MODEL  fnaisrfid = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla dumpetid dumenid dumbrdid dumtatid dumbrid dumrfid
dumnoid regnais mannais/discrete (dist=normal);
endogenous fnaisrfid ~ censored(lb=0 ub=100);output out=outMEfnaisrfid marginal;
nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEfnaisrfid';
proc means data=outMEfnaisrfid;run;

/*********************************************************************/

*Ordered Probit for Evaluating Questions 17-19*/
*(17)In designing a national, individual animal traceability system how important are the
following issues in the U.S. beef industry (please circle your answers where 1 = Entirely
Unimportant, 2 = Unimportant, 3 = Neutral, 4 = Important, 5 = Very Important):*/

title 'Estimation of ioidis';
PROC QLIM DATA=Rawdata outest=outestdis covb;
MODEL  ioidis = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEdis marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEdis';
proc means data=outMEdis;run;

/*********************************************************************/

title 'Estimation of ioicons';
PROC QLIM DATA=Rawdata outest=outestcons covb;
MODEL  ioicons = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEcons marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEcons';
proc means data=outMEcons;run;

/*********************************************************************/
```

```
title 'Estimation of ioimarkt';
PROC QLIM DATA=Rawdata outest=outestmarkt covb;
MODEL  ioimarkt = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr
income oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEmarkt marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEmarkt';
proc means data=outMEmarkt;run;

/******************************************************************/

title 'Estimation of ioimcfm';
PROC QLIM DATA=Rawdata outest=outestmcfm covb;
MODEL  ioimcfm = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr
income oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEmcfm marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEmcfm';
proc means data=outMEmcfm;run;

/******************************************************************/

title 'Estimation of ioiafm';
PROC QLIM DATA=Rawdata outest=outestafm covb;
MODEL  ioiafm = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEafm marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEafm';
proc means data=outMEafm;run;

/******************************************************************/

title 'Estimation of ioimngt';
PROC QLIM DATA=Rawdata outest=outestmngt covb;
MODEL  ioimngt = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEmngt marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEmngt';
proc means data=outMEmngt;run;
/******************************************************************/
```

```
title 'Estimation of ioischn';
PROC QLIM DATA=Rawdata outest=outestschn covb;
MODEL  ioischn = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEschn marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEschn';
proc means data=outMEschn;run;

/*****************************************************************/

title 'Estimation of ioifsfty';
PROC QLIM DATA=Rawdata outest=outestfsfty covb;
MODEL  ioifsfty = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEfsfty marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEfsfty';
proc means data=outMEfsfty;run;

/*****************************************************************/

*(18)In designing a national, individual animal traceability system how concerned are
you regarding the following issues in the U.S. beef industry (where 1 = Entirely
Unconcerned, 2 = Unconcerned, 3 = Neutral, 4 = Concerned, 5 = Very Concerned):*/

title 'Estimation of cricost';
PROC QLIM DATA=Rawdata outest=outestcost covb;
MODEL  cricost = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEcost marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEcost';
proc means data=outMEcost;run;

/*****************************************************************/

title 'Estimation of criconf';
PROC QLIM DATA=Rawdata outest=outestconf covb;
MODEL  criconf = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEconf marginal;nloptions maxiter=500;RUN;
```

```
/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEconf';
proc means data=outMEconf;run;

/**********************************************************************/

title 'Estimation of crirelia';
PROC QLIM DATA=Rawdata outest=outestrelia covb;
MODEL  crirelia = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMErelia marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMErelia';
proc means data=outMErelia;run;

**********************************************************************/

title 'Estimation of criliabi';
PROC QLIM DATA=Rawdata outest=outestliabi covb;
MODEL  criliabi = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEliabi marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEliabi';
proc means data=outMEliabi;run;

**********************************************************************/

title 'Estimation of crifride';
PROC QLIM DATA=Rawdata outest=outestfride covb;
MODEL  crifride = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEfride marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEfride';
proc means data=outMEfride;run;

**********************************************************************/
```

```
title 'Estimation of crigoals';
PROC QLIM DATA=Rawdata outest=outestgoals covb;
MODEL  crigoals = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEgoals marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEgoals';
proc means data=outMEgoals;run;

/*****************************************************************/

*(19)Please circle your level of agreement with each of the following
statements (Where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree,
5=Strongly Agree):  Implementing individual animal traceability sytems*/

title 'is more cost effective for larger cow-calf operations';
PROC QLIM DATA=Rawdata outest=outestscale covb;
MODEL  asce = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEscale marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEscale';
proc means data=outMEscale;run;

/*****************************************************************/

title 'results in more liability for cow-calf producers';
PROC QLIM DATA=Rawdata outest=outestrliability covb;
MODEL  asliabi = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMErliabi marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMErliabi';
proc means data=outMErliabi;run;

/*****************************************************************/

title 'is unnecessary if COOL';
PROC QLIM DATA=Rawdata outest=outestcool covb;
MODEL  ascool = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr income
oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEcool marginal;nloptions maxiter=500;RUN;
/*now show summary of marginals (across individuals)*/
```

```
title1 'marginals from outMEcool';
proc means data=outMEcool;run;

/************************************************************************/

title 'as a mandated system is exaggerated in need';
PROC QLIM DATA=Rawdata outest=outestasmanex covb;
MODEL  asmanex = age erscb ersnp ersnwa erssea erssp countfo edu yrsr expyrsr
income oincome labor ofeed bctc dumla regnais /discrete (dist=normal);
output out=outMEmanex marginal;nloptions maxiter=500;RUN;

/*now show summary of marginals (across individuals)*/
title1 'marginals from outMEmanex';
proc means data=outMEmanex;run;

/************************************************************************/
/************************************************************************/

/*Panel Data Development and Effects Coding SAS Code*/

PROC IMPORT OUT= WORK.rawdata
DATAFILE= "E:Estimation Data Set 05.04.08.xls"
DBMS=EXCEL REPLACE; SHEET="SASImport"; GETNAMES=YES;
MIXED=NO; SCANTEXT=YES; USEDATE=YES; SCANTIME=YES;
RANGE="A1:ER656"; RUN;

/* create a panel data set of 655*4*3 total observations since CE has 4 scenarios and 3
options per scenario*/

premium/discount denoted by PD
managing entity denoted by ME
additional information denoted by AI

data Rawdata_Panel;
set Rawdata;

retain SurveyNumb 0;
SurveyNumb+1;

/*T1 - denotes 1st observation in 4 observation panel*/
T=1;T1=1;T2=0;T3=0;T4=0;

decision = S1;PD = S1PDa; ME=S1MEa;AI=S1AIa;Adum = 1; Bdum = 0;Cdum = 0;
output;
```

```
decision = S1;PD = S1PDb; ME=S1MEb;AI=S1AIb;Adum = 0; Bdum = 1;Cdum = 0;
output;

decision = S1;PD = S1PDc; ME=S1MEc;AI=S1AIc;Adum = 0; Bdum = 0;Cdum = 1;
output;

/*T2 - denotes 2nd observation in 4 observation panel*/
T=2;T1=0;T2=1;T3=0;T4=0;

decision = S2;PD = S2PDa; ME=S2MEa;AI=S2AIa;Adum = 1; Bdum = 0;Cdum = 0;
output;

decision = S2;PD = S2PDb; ME=S2MEb;AI=S2AIb;Adum = 0; Bdum = 1;Cdum = 0;
output;

decision = S2;PD = S2PDc; ME=S2MEc;AI=S2AIc;Adum = 0; Bdum = 0;Cdum = 1;
output;

/*T3 - denotes 3rd observation in 4 observation panel*/
T=3;T1=0;T2=0;T3=1;T4=0;

decision = S3;PD = S3PDa; ME=S3MEa;AI=S3AIa;Adum = 1; Bdum = 0;Cdum = 0;
output;

decision = S3;PD = S3PDb; ME=S3MEb;AI=S3AIb;Adum = 0; Bdum = 1;Cdum = 0;
output;

decision = S3;PD = S3PDc;ME=S3MEc;AI=S3AIc;Adum = 0; Bdum = 0;Cdum = 1;
output;

/*T4 - denotes 4th observation in 4 observation panel*/
T=4;T1=0;T2=0;T3=0;T4=1;

decision = S4;PD = S4PDa; ME=S4MEa;AI=S4AIa;Adum = 1; Bdum = 0;Cdum = 0;
output;

decision = S4;PD = S4PDb; ME=S4MEb;AI=S4AIb;Adum = 0; Bdum = 1;Cdum = 0;
output;

decision = S4;PD = S4PDc; ME=S4MEc;AI=S4AIc;Adum = 0; Bdum = 0;Cdum = 1;
output;

run;

data Rawdata_Panel2;set Rawdata_Panel;
```

```
/*note that 7860=655*3*4*/
modelObsID=1; do modelObsID=1 to 7860 by 3; end;

/* create a variable identifying each unique combination of individuals and CEs*/
a=Round(_n_/3);b=lag2(a);if _n_<4 then indCEobs=1;else indCEobs=b+1;

/*change format of decision variable to Two 0s and One 1 for each scenario included*/
if decision=1 & Adum=1 then decUse=1;
if decision=1 & Bdum=1 then decUse=0;
if decision=1 & Cdum=1 then decUse=0;

if decision=2 & Adum=1 then decUse=0;
if decision=2 & Bdum=1 then decUse=1;
if decision=2 & Cdum=1 then decUse=0;

if decision=3 & Adum=1 then decUse=0;
if decision=3 & Bdum=1 then decUse=0;
if decision=3 & Cdum=1 then decUse=1;

/*create a "mode" variable to track 1,2,3 options in each scenario*/
if Adum=1 then mode=1;
if Bdum=1 then mode=2;
if Cdum=1 then mode=3;

/*create 3 dummy vars for managing entity*/
if ME=1 then ME_GV=1; else ME_GV=0;
if ME=2 then ME_PN=1; else ME_PN=0;
if ME=3 then ME_PI=1; else ME_PI=0;

/*create effects coded variables rather than dummy coded variables: base of Government
Managed takes a value of -1 when applicable, note that I added the Cdum=1 condition to
give these variables a value of 0 in the 3rd (No Trace) alternative (price is only observed
variable)*/

if ME=2 then ME_PI_EC=1;else if ME=3 then ME_PI_EC=0;
else if ME=1 then ME_PI_EC=-1;
else if Cdum=1 then ME_PI_EC=0;

if ME=3 then ME_PN_EC=1;else if ME=2 then ME_PN_EC=0;
else if ME=1 then ME_PN_EC=-1;
else if Cdum=1 then ME_PN_EC=0;

/*need to create interactions with effects coded variables*/
ME_PI_EC_AD=ME_PI_EC*Adum;ME_PI_EC_BD=ME_PI_EC*Bdum;
ME_PN_EC_AD=ME_PN_EC*Adum;ME_PN_EC_BD=ME_PN_EC*Bdum;
```

```
/*create 15 dummy vars for additional information*/
if AI=1 then AI_AV=1; else AI_AV=0;if AI=2 then AI_PP=1; else AI_PP=0;
if AI=3 then AI_PG=1; else AI_PG=0;if AI=4 then AI_HV=1; else AI_HV=0;
if AI=5 then AI_AVPP=1; else AI_AVPP=0;
if AI=6 then AI_AVPG=1; else AI_AVPG=0;
if AI=7 then AI_AVHV=1; else AI_AVHV=0;
if AI=8 then AI_PPPG=1; else AI_PPPG=0;
if AI=9 then AI_PPHV=1; else AI_PPHV=0;
if AI=10 then AI_PGHV=1; else AI_PGHV=0;
if AI=11 then AI_AVPPPG=1; else AI_AVPPPG=0;
if AI=12 then AI_AVPPHV=1; else AI_AVPPHV=0;
if AI=13 then AI_PPPGHV=1; else AI_PPPGHV=0;
if AI=14 then AI_AVPPPGHV=1; else AI_AVPPPGHV=0;

/* create effects coded dummies for additional information information: base of AI_AV;
takes a value of -1 when applicable, note that Adum=1 and Cdum=1 condition give these
variables a value of 0 in the 1st (NAIS) alternative (price and managing entity are only
observed variableand 3rd (No Trace) alternative (price is only observed variable)*/

if AI=2 then AI_PP_EC=1;else if AI=1 then AI_PP_EC=-1;
else if AI=3 then AI_PP_EC=0;else if AI=4 then AI_PP_EC=0;
else if AI=5 then AI_PP_EC=0;else if AI=6 then AI_PP_EC=0;
else if AI=7 then AI_PP_EC=0;else if AI=8 then AI_PP_EC=0;
else if AI=9 then AI_PP_EC=0;else if AI=10 then AI_PP_EC=0;
else if AI=11 then AI_PP_EC=0;else if AI=12 then AI_PP_EC=0;
else if AI=13 then AI_PP_EC=0;else if AI=14 then AI_PP_EC=0;
else if Adum=1 then AI_PP_EC=0;else if Cdum=1 then AI_PP_EC=0;

if AI=3 then AI_PG_EC=1;else if AI=1 then AI_PG_EC=-1;
else if AI=2 then AI_PG_EC=0;else if AI=4 then AI_PG_EC=0;
else if AI=5 then AI_PG_EC=0;else if AI=6 then AI_PG_EC=0;
else if AI=7 then AI_PG_EC=0;else if AI=8 then AI_PG_EC=0;
else if AI=9 then AI_PG_EC=0;else if AI=10 then AI_PG_EC=0;
else if AI=11 then AI_PG_EC=0;else if AI=12 then AI_PG_EC=0;
else if AI=13 then AI_PG_EC=0;else if AI=14 then AI_PG_EC=0;
else if Adum=1 then AI_PG_EC=0;else if Cdum=1 then AI_PG_EC=0;

if AI=4 then AI_HV_EC=1;else if AI=1 then AI_HV_EC=-1;
else if AI=2 then AI_HV_EC=0;else if AI=3 then AI_HV_EC=0;
else if AI=5 then AI_HV_EC=0;else if AI=6 then AI_HV_EC=0;
else if AI=7 then AI_HV_EC=0;else if AI=8 then AI_HV_EC=0;
else if AI=9 then AI_HV_EC=0;else if AI=10 then AI_HV_EC=0;
else if AI=11 then AI_HV_EC=0;else if AI=12 then AI_HV_EC=0;
else if AI=13 then AI_HV_EC=0;else if AI=14 then AI_HV_EC=0;
else if Adum=1 then AI_HV_EC=0;else if Cdum=1 then AI_HV_EC=0;
```

```
if AI=5 then AI_AVPP_EC=1;else if AI=1 then AI_AVPP_EC=-1;
else if AI=2 then AI_AVPP_EC=0;else if AI=3 then AI_AVPP_EC=0;
else if AI=4 then AI_AVPP_EC=0;else if AI=6 then AI_AVPP_EC=0;
else if AI=7 then AI_AVPP_EC=0;else if AI=8 then AI_AVPP_EC=0;
else if AI=9 then AI_AVPP_EC=0;else if AI=10 then AI_AVPP_EC=0;
else if AI=11 then AI_AVPP_EC=0;else if AI=12 then AI_AVPP_EC=0;
else if AI=13 then AI_AVPP_EC=0;else if AI=14 then AI_AVPP_EC=0;
else if Adum=1 then AI_AVPP_EC=0;else if Cdum=1 then AI_AVPP_EC=0;

if AI=6 then AI_AVPG_EC=1;else if AI=1 then AI_AVPG_EC=-1;
else if AI=2 then AI_AVPG_EC=0;else if AI=3 then AI_AVPG_EC=0;
else if AI=4 then AI_AVPG_EC=0;else if AI=5 then AI_AVPG_EC=0;
else if AI=7 then AI_AVPG_EC=0;else if AI=8 then AI_AVPG_EC=0;
else if AI=9 then AI_AVPG_EC=0;else if AI=10 then AI_AVPG_EC=0;
else if AI=11 then AI_AVPG_EC=0;else if AI=12 then AI_AVPG_EC=0;
else if AI=13 then AI_AVPG_EC=0;else if AI=14 then AI_AVPG_EC=0;
else if Adum=1 then AI_AVPG_EC=0;else if Cdum=1 then AI_AVPG_EC=0;

if AI=7 then AI_AVHV_EC=1;else if AI=1 then AI_AVHV_EC=-1;
else if AI=2 then AI_AVHV_EC=0;else if AI=3 then AI_AVHV_EC=0;
else if AI=4 then AI_AVHV_EC=0;else if AI=5 then AI_AVHV_EC=0;
else if AI=6 then AI_AVHV_EC=0;else if AI=8 then AI_AVHV_EC=0;
else if AI=9 then AI_AVHV_EC=0;else if AI=10 then AI_AVHV_EC=0;
else if AI=11 then AI_AVHV_EC=0;else if AI=12 then AI_AVHV_EC=0;
else if AI=13 then AI_AVHV_EC=0;else if AI=14 then AI_AVHV_EC=0;
else if Adum=1 then AI_AVHV_EC=0;else if Cdum=1 then AI_AVHV_EC=0;

if AI=8 then AI_PPPG_EC=1;else if AI=1 then AI_PPPG_EC=-1;
else if AI=2 then AI_PPPG_EC=0;else if AI=3 then AI_PPPG_EC=0;
else if AI=4 then AI_PPPG_EC=0;else if AI=5 then AI_PPPG_EC=0;
else if AI=6 then AI_PPPG_EC=0;else if AI=7 then AI_PPPG_EC=0;
else if AI=9 then AI_PPPG_EC=0;else if AI=10 then AI_PPPG_EC=0;
else if AI=11 then AI_PPPG_EC=0;else if AI=12 then AI_PPPG_EC=0;
else if AI=13 then AI_PPPG_EC=0;else if AI=14 then AI_PPPG_EC=0;
else if Adum=1 then AI_PPPG_EC=0;else if Cdum=1 then AI_PPPG_EC=0;

if AI=9 then AI_PPHV_EC=1;else if AI=1 then AI_PPHV_EC=-1;
else if AI=2 then AI_PPHV_EC=0;else if AI=3 then AI_PPHV_EC=0;
else if AI=4 then AI_PPHV_EC=0;else if AI=5 then AI_PPHV_EC=0;
else if AI=6 then AI_PPHV_EC=0;else if AI=7 then AI_PPHV_EC=0;
else if AI=8 then AI_PPHV_EC=0;else if AI=10 then AI_PPHV_EC=0;
else if AI=11 then AI_PPHV_EC=0;else if AI=12 then AI_PPHV_EC=0;
else if AI=13 then AI_PPHV_EC=0;else if AI=14 then AI_PPHV_EC=0;
else if Adum=1 then AI_PPHV_EC=0;else if Cdum=1 then AI_PPHV_EC=0;
```

```
if AI=10 then AI_PGHV_EC=1;else if AI=1 then AI_PGHV_EC=-1;
else if AI=2 then AI_PGHV_EC=0;else if AI=3 then AI_PGHV_EC=0;
else if AI=4 then AI_PGHV_EC=0;else if AI=5 then AI_PGHV_EC=0;
else if AI=6 then AI_PGHV_EC=0;else if AI=7 then AI_PGHV_EC=0;
else if AI=8 then AI_PGHV_EC=0;else if AI=9 then AI_PGHV_EC=0;
else if AI=11 then AI_PGHV_EC=0;else if AI=12 then AI_PGHV_EC=0;
else if AI=13 then AI_PGHV_EC=0;else if AI=14 then AI_PGHV_EC=0;
else if Adum=1 then AI_PGHV_EC=0;else if Cdum=1 then AI_PGHV_EC=0;

if AI=11 then AI_AVPPPG_EC=1;else if AI=1 then AI_AVPPPG_EC=-1;
else if AI=2 then AI_AVPPPG_EC=0;else if AI=3 then AI_AVPPPG_EC=0;
else if AI=4 then AI_AVPPPG_EC=0;else if AI=5 then AI_AVPPPG_EC=0;
else if AI=6 then AI_AVPPPG_EC=0;else if AI=7 then AI_AVPPPG_EC=0;
else if AI=8 then AI_AVPPPG_EC=0;else if AI=9 then AI_AVPPPG_EC=0;
else if AI=10 then AI_AVPPPG_EC=0;else if AI=12 then AI_AVPPPG_EC=0;
else if AI=13 then AI_AVPPPG_EC=0;else if AI=14 then AI_AVPPPG_EC=0;
else if Adum=1 then AI_AVPPPG_EC=0;else if Cdum=1 then AI_AVPPPG_EC=0;

if AI=12 then AI_AVPPHV_EC=1;else if AI=1 then AI_AVPPHV_EC=-1;
else if AI=2 then AI_AVPPHV_EC=0;else if AI=3 then AI_AVPPHV_EC=0;
else if AI=4 then AI_AVPPHV_EC=0;else if AI=5 then AI_AVPPHV_EC=0;
else if AI=6 then AI_AVPPHV_EC=0;else if AI=7 then AI_AVPPHV_EC=0;
else if AI=8 then AI_AVPPHV_EC=0;else if AI=9 then AI_AVPPHV_EC=0;
else if AI=10 then AI_AVPPHV_EC=0;else if AI=11 then AI_AVPPHV_EC=0;
else if AI=13 then AI_AVPPHV_EC=0;else if AI=14 then AI_AVPPHV_EC=0;
else if Adum=1 then AI_AVPPHV_EC=0;else if Cdum=1 then AI_AVPPHV_EC=0;

if AI=13 then AI_PPPGHV_EC=1;else if AI=1 then AI_PPPGHV_EC=-1;
else if AI=2 then AI_PPPGHV_EC=0;else if AI=3 then AI_PPPGHV_EC=0;
else if AI=4 then AI_PPPGHV_EC=0;else if AI=5 then AI_PPPGHV_EC=0;
else if AI=6 then AI_PPPGHV_EC=0;else if AI=7 then AI_PPPGHV_EC=0;
else if AI=8 then AI_PPPGHV_EC=0;else if AI=9 then AI_PPPGHV_EC=0;
else if AI=10 then AI_PPPGHV_EC=0;else if AI=11 then AI_PPPGHV_EC=0;
else if AI=12 then AI_PPPGHV_EC=0;else if AI=14 then AI_PPPGHV_EC=0;
else if Adum=1 then AI_PPPGHV_EC=0;else if Cdum=1 then AI_PPPGHV_EC=0;

if AI=14 then AI_AVPPPGHV_EC=1;else if AI=1 then AI_AVPPPGHV_EC=-1;
else if AI=2 then AI_AVPPPGHV_EC=0;else if AI=3 then AI_AVPPPGHV_EC=0;
else if AI=4 then AI_AVPPPGHV_EC=0;else if AI=5 then AI_AVPPPGHV_EC=0;
else if AI=6 then AI_AVPPPGHV_EC=0;else if AI=7 then AI_AVPPPGHV_EC=0;
else if AI=8 then AI_AVPPPGHV_EC=0;else if AI=9 then AI_AVPPPGHV_EC=0;
else if AI=10 then AI_AVPPPGHV_EC=0;else if AI=11 then AI_AVPPPGHV_EC=0;
else if AI=12 then AI_AVPPPGHV_EC=0;else if AI=13 then AI_AVPPPGHV_EC=0;
else if Adum=1 then AI_AVPPPGHV_EC=0;else if Cdum=1 then
AI_AVPPPGHV_EC=0;
```

```
/* create effects coded dummies for 1st 4 additional information info*/
/*base of AV takes a value of -1 when applicable*/

if AI=2 then AI4PP_EC=1;else if AI=1 then AI4PP_EC=-1;
else if AI=3 then AI4PP_EC=0;else if AI=4 then AI4PP_EC=0;
else if AI=5 then AI4PP_EC=0;else if AI=6 then AI4PP_EC=0;
else if AI=7 then AI4PP_EC=0;else if AI=8 then AI4PP_EC=0;
else if AI=9 then AI4PP_EC=0;else if AI=10 then AI4PP_EC=0;
else if AI=11 then AI4PP_EC=0;else if AI=12 then AI4PP_EC=0;
else if AI=13 then AI4PP_EC=0;else if AI=14 then AI4PP_EC=0;
else if Adum=1 then AI4PP_EC=0;else if Cdum=1 then AI4PP_EC=0;

if AI=3 then AI4PG_EC=1;else if AI=1 then AI4PG_EC=-1;
else if AI=2 then AI4PG_EC=0;else if AI=4 then AI4PG_EC=0;
else if AI=5 then AI4PG_EC=0;else if AI=6 then AI4PG_EC=0;
else if AI=7 then AI4PG_EC=0;else if AI=8 then AI4PG_EC=0;
else if AI=9 then AI4PG_EC=0;else if AI=10 then AI4PG_EC=0;
else if AI=11 then AI4PG_EC=0;else if AI=12 then AI4PG_EC=0;
else if AI=13 then AI4PG_EC=0;else if AI=14 then AI4PG_EC=0;
else if Adum=1 then AI4PG_EC=0;else if Cdum=1 then AI4PG_EC=0;

if AI=4 then AI4HV_EC=1;else if AI=1 then AI4HV_EC=-1;
else if AI=2 then AI4HV_EC=0;else if AI=3 then AI4HV_EC=0;
else if AI=5 then AI4HV_EC=0;else if AI=6 then AI4HV_EC=0;
else if AI=7 then AI4HV_EC=0;else if AI=8 then AI4HV_EC=0;
else if AI=9 then AI4HV_EC=0;else if AI=10 then AI4HV_EC=0;
else if AI=11 then AI4HV_EC=0;else if AI=12 then AI4HV_EC=0;
else if AI=13 then AI4HV_EC=0;else if AI=14 then AI4HV_EC=0;
else if Adum=1 then AI4HV_EC=0;else if Cdum=1 then AI4HV_EC=0;

/* create effects coded dummies for 1st 10 additional information information*/
/*base of AV takes a value of -1 when applicable*/

if AI=2 then AI9PP_EC=1;else if AI=1 then AI9PP_EC=-1;
else if AI=3 then AI9PP_EC=0;else if AI=4 then AI9PP_EC=0;
else if AI=5 then AI9PP_EC=0;else if AI=6 then AI9PP_EC=0;
else if AI=7 then AI9PP_EC=0;else if AI=8 then AI9PP_EC=0;
else if AI=9 then AI9PP_EC=0;else if AI=10 then AI9PP_EC=0;
else if AI=11 then AI9PP_EC=0;else if AI=12 then AI9PP_EC=0;
else if AI=13 then AI9PP_EC=0;else if AI=14 then AI9PP_EC=0;
else if Adum=1 then AI9PP_EC=0;else if Cdum=1 then AI9PP_EC=0;
```

```
if AI=3 then AI9PG_EC=1;else if AI=1 then AI9PG_EC=-1;
else if AI=2 then AI9PG_EC=0;else if AI=4 then AI9PG_EC=0;
else if AI=5 then AI9PG_EC=0;else if AI=6 then AI9PG_EC=0;
else if AI=7 then AI9PG_EC=0;else if AI=8 then AI9PG_EC=0;
else if AI=9 then AI9PG_EC=0;else if AI=10 then AI9PG_EC=0;
else if AI=11 then AI9PG_EC=0;else if AI=12 then AI9PG_EC=0;
else if AI=13 then AI9PG_EC=0;else if AI=14 then AI9PG_EC=0;
else if Adum=1 then AI9PG_EC=0;else if Cdum=1 then AI9PG_EC=0;

if AI=4 then AI9HV_EC=1;else if AI=1 then AI9HV_EC=-1;
else if AI=2 then AI9HV_EC=0;else if AI=3 then AI9HV_EC=0;
else if AI=5 then AI9HV_EC=0;else if AI=6 then AI9HV_EC=0;
else if AI=7 then AI9HV_EC=0;else if AI=8 then AI9HV_EC=0;
else if AI=9 then AI9HV_EC=0;else if AI=10 then AI9HV_EC=0;
else if AI=11 then AI9HV_EC=0;else if AI=12 then AI9HV_EC=0;
else if AI=13 then AI9HV_EC=0;else if AI=14 then AI9HV_EC=0;
else if Adum=1 then AI9HV_EC=0;else if Cdum=1 then AI9HV_EC=0;

if AI=5 then AI9AVPP_EC=1;else if AI=1 then AI9AVPP_EC=-1;
else if AI=2 then AI9AVPP_EC=0;else if AI=3 then AI9AVPP_EC=0;
else if AI=4 then AI9AVPP_EC=0;else if AI=6 then AI9AVPP_EC=0;
else if AI=7 then AI9AVPP_EC=0;else if AI=8 then AI9AVPP_EC=0;
else if AI=9 then AI9AVPP_EC=0;else if AI=10 then AI9AVPP_EC=0;
else if AI=11 then AI9AVPP_EC=0;else if AI=12 then AI9AVPP_EC=0;
else if AI=13 then AI9AVPP_EC=0;else if AI=14 then AI9AVPP_EC=0;
else if Adum=1 then AI9AVPP_EC=0;else if Cdum=1 then AI9AVPP_EC=0;

if AI=6 then AI9AVPG_EC=1;else if AI=1 then AI9AVPG_EC=-1;
else if AI=2 then AI9AVPG_EC=0;else if AI=3 then AI9AVPG_EC=0;
else if AI=4 then AI9AVPG_EC=0;else if AI=5 then AI9AVPG_EC=0;
else if AI=7 then AI9AVPG_EC=0;else if AI=8 then AI9AVPG_EC=0;
else if AI=9 then AI9AVPG_EC=0;else if AI=10 then AI9AVPG_EC=0;
else if AI=11 then AI9AVPG_EC=0;else if AI=12 then AI9AVPG_EC=0;
else if AI=13 then AI9AVPG_EC=0;else if AI=14 then AI9AVPG_EC=0;
else if Adum=1 then AI9AVPG_EC=0;else if Cdum=1 then AI9AVPG_EC=0;

if AI=7 then AI9AVHV_EC=1;else if AI=1 then AI9AVHV_EC=-1;
else if AI=2 then AI9AVHV_EC=0;else if AI=3 then AI9AVHV_EC=0;
else if AI=4 then AI9AVHV_EC=0;else if AI=5 then AI9AVHV_EC=0;
else if AI=6 then AI9AVHV_EC=0;else if AI=8 then AI9AVHV_EC=0;
else if AI=9 then AI9AVHV_EC=0;else if AI=10 then AI9AVHV_EC=0;
else if AI=11 then AI9AVHV_EC=0;else if AI=12 then AI9AVHV_EC=0;
else if AI=13 then AI9AVHV_EC=0;else if AI=14 then AI9AVHV_EC=0;
else if Adum=1 then AI9AVHV_EC=0;else if Cdum=1 then AI9AVHV_EC=0;
```

```
if AI=8 then AI9PPPG_EC=1;else if AI=1 then AI9PPPG_EC=-1;
else if AI=2 then AI9PPPG_EC=0;else if AI=3 then AI9PPPG_EC=0;
else if AI=4 then AI9PPPG_EC=0;else if AI=5 then AI9PPPG_EC=0;
else if AI=6 then AI9PPPG_EC=0;else if AI=7 then AI9PPPG_EC=0;
else if AI=9 then AI9PPPG_EC=0;else if AI=10 then AI9PPPG_EC=0;
else if AI=11 then AI9PPPG_EC=0;else if AI=12 then AI9PPPG_EC=0;
else if AI=13 then AI9PPPG_EC=0;else if AI=14 then AI9PPPG_EC=0;
else if Adum=1 then AI9PPPG_EC=0;else if Cdum=1 then AI9PPPG_EC=0;

if AI=9 then AI9PPHV_EC=1;else if AI=1 then AI9PPHV_EC=-1;
else if AI=2 then AI9PPHV_EC=0;else if AI=3 then AI9PPHV_EC=0;
else if AI=4 then AI9PPHV_EC=0;else if AI=5 then AI9PPHV_EC=0;
else if AI=6 then AI9PPHV_EC=0;else if AI=7 then AI9PPHV_EC=0;
else if AI=8 then AI9PPHV_EC=0;else if AI=10 then AI9PPHV_EC=0;
else if AI=11 then AI9PPHV_EC=0;else if AI=12 then AI9PPHV_EC=0;
else if AI=13 then AI9PPHV_EC=0;else if AI=14 then AI9PPHV_EC=0;
else if Adum=1 then AI9PPHV_EC=0;else if Cdum=1 then AI9PPHV_EC=0;

if AI=10 then AI9PGHV_EC=1;else if AI=1 then AI9PGHV_EC=-1;
else if AI=2 then AI9PGHV_EC=0;else if AI=3 then AI9PGHV_EC=0;
else if AI=4 then AI9PGHV_EC=0;else if AI=5 then AI9PGHV_EC=0;
else if AI=6 then AI9PGHV_EC=0;else if AI=7 then AI9PGHV_EC=0;
else if AI=8 then AI9PGHV_EC=0;else if AI=9 then AI9PGHV_EC=0;
else if AI=11 then AI9PGHV_EC=0;else if AI=12 then AI9PGHV_EC=0;
else if AI=13 then AI9PGHV_EC=0;else if AI=14 then AI9PGHV_EC=0;
else if Adum=1 then AI9PGHV_EC=0;else if Cdum=1 then AI9PGHV_EC=0;

/*create dummy variable indicating discount:*/
if PD<0 then Discount=1;else Discount=0;
if PD>0 then Premium=1;else Premium=0;

PD_Disc=PD*Discount;
PD_Prem=PD*Premium;

run;
/*Create separate data set for only fully complete and balanced panal data set*/
data dataCEcomplete;set Rawdata_panel2;
if CEbalanced=0 then delete;
run;

/**********************************************************************/
/**********************************************************************/
```

5.2 STATA

```
*Now Looking at Endogeneity Bias with regnais*/
dprobit regnais age erscb ersnp ersnwa erssea erssp countfo yrsr expyrsr edu income
oincome labor ofeed bctc dumla dumpetid dumenid dumbrdid dumtatid dumbrid dumrfid
dumnoid mannais

*Predicting Inverse Mills Ratio*/
predict yhat, xb
generate phi = (1/sqrt(2*_pi))*exp(-(yhat^2/2))
generate capphi = norm(yhat)
generate invmills = phi/capphi

*Trinomial Probit or Nested Probit for Evaluating Question 23 (mannais)*/
*(23)Do you believe that NAIS (as previously outlined) should be a mandatory system
requiring all U.S. cattle producers to participate? (Yes, No, or Undecided)*/

*Final Regression After Testing*/
mprobit mannais age erscb ersnp ersnwa erssea erssp countfo yrsr expyrsr income bctc
dumla bretmccp bprocmccp bfdlpmccp cretmccp cprocmccp cfdlpmccp invmills

mfx compute, predict(outcome(2)) dydx at(mean)
mfx compute, predict(outcome(1)) dydx at(mean)
mfx compute, predict(outcome(0)) dydx at(mean)

/**********************************************************************/
/**********************************************************************/
```

5.3 LIMDEP

$LIMDEP Code for CE Estimation$

RESET

READ;FILE="E:\LIMDEP_Import.xls"

$Summary Statistics$
DSTAT;Rhs=DECUSE,PD,PD_prem,PD_disc,Cdum,Bdum,ME_PI_EC,ME_PN_EC,
AI4PP_EC,AI4PG_EC,AI4HV_EC,bctc,countfo,yrsr,dumla,indv_id,group_id,no_ot_id,
erscb,ersnp,ersnwa,erssea,erssp,AI9PP_EC,AI9PG_EC,AI9HV_EC,AI9AVPP_,
AI9AVPG_,AI9AVHV_,AI9PPPG_,AI9PPHV_,AI9PGHV_,AI_PP_EC,AI_PG_EC,
AI_HV_EC,AI_AVPP_,AI_AVPG_,AI_AVHV_,AI_PPPG_,AI_PPHV_,AI_PGHV_,
AI_AVPPP,AI_AVPPH,AI_PPPGH,AI_FL_EC,BD_erscb,CD_erscb,BD_ersnp,
CD_ersnp,BD_ersnw,CD_ersnw,BD_ersse,CD_ersse,BD_erssp,CD_erssp$

$Important DECUSE in this code has a mean of 0.33333, so CE models work$

$Creating BDUM and CDUM interactions with Demos

```
CREA;Fill;BD_age=Bdum*age$
CREA;Fill;CD_age=Cdum*age$
CREA;Fill;BD_bctc=Bdum*bctc$
CREA;Fill;CD_bctc=Cdum*bctc$
CREA;Fill;BD_dumla=Bdum*dumla$
CREA;Fill;CD_dumla=Cdum*dumla$
CREA;Fill;BD_countfo=Bdum*countfo$
CREA;Fill;CD_countfo=Cdum*countfo$
CREA;Fill;BD_erscb=Bdum*erscb$
CREA;Fill;CD_erscb=Cdum*erscb$
CREA;Fill;BD_ersnc=Bdum*ersnc$
CREA;Fill;CD_ersnc=Cdum*ersnc$
CREA;Fill;BD_ersnp=Bdum*ersnp$
CREA;Fill;CD_ersnp=Cdum*ersnp$
CREA;Fill;BD_ersnwa=Bdum*ersnwa$
CREA;Fill;CD_ersnwa=Cdum*ersnwa$
CREA;Fill;BD_erssea=Bdum*erssea$
CREA;Fill;CD_erssea=Cdum*erssea$
CREA;Fill;BD_erssp=Bdum*erssp$
CREA;Fill;CD_erssp=Cdum*erssp$
CREA;Fill;BD_yrsr=Bdum*yrsr$
CREA;Fill;CD_yrsr=Cdum*yrsr$
CREA;Fill;BD_indid=Bdum*indv_id$
CREA;Fill;CD_indid=Cdum*indv_id$
CREA;Fill;BD_grpid=Bdum*group_id$
```

```
CREA;Fill;CD_grpid=Cdum*group_id$
CREA;Fill;BD_notid=Bdum*no_ot_id$
CREA;Fill;CD_notid=Cdum*no_ot_id$

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$Preferred Models
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

$MNL

$MNL (PD & Demos & ERS Regions & 13/14 AI)
NLOGIT;Lhs=DECUSE;Choices=1,2,3;
Rhs=PD,Cdum,Bdum,ME_PI_EC,ME_PN_EC,
AI_PP_EC,AI_PG_EC,AI_HV_EC,AI_AVPP_,AI_AVPG_,AI_AVHV_,AI_PPPG_,
AI_PPHV_,AI_PGHV_,AI_AVPPP,AI_AVPPH,AI_PPPGH,AI_FL_EC,BD_bctc,
CD_bctc,BD_dumla,CD_dumla,BD_count,CD_count,BD_yrsr,CD_yrsr,BD_indid,
CD_indid,BD_grpid,CD_grpid,BD_notid,CD_notid,BD_erscb,CD_erscb,BD_ersnp,
CD_ersnp,BD_ersnw,CD_ersnw,BD_ersse,CD_ersse,BD_erssp,CD_erssp;
Pds=4;PrintVC;Effects:;Means:;Matrix;Crosstab;Prob=prMN5$

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

$RPL Not Correlated

$RPL MODEL (PD & Demos & 13/14 AI):RANDOM PARMS ARE NOT
CORRELATED
NLOGIT;Lhs=DECUSE;Choices=1,2,3;
Rhs=PD_prem,PD_disc,Cdum,Bdum,ME_PI_EC,ME_PN_EC,AI_PP_EC,AI_PG_EC,
AI_HV_EC,AI_AVPP_,AI_AVPG_,AI_AVHV_,AI_PPPG_,AI_PPHV_,AI_PGHV_,
AI_AVPPP,AI_AVPPH,AI_PPPGH,AI_FL_EC,BD_bctc,CD_bctc,BD_dumla,
CD_dumla,BD_count,CD_count,BD_yrsr,CD_yrsr,BD_indid,CD_indid,BD_grpid,
CD_grpid,BD_notid,CD_notid;
RPL;Pts=250;Parameters;
Fcn=Cdum(N),Bdum(N);
PrintVC;Effects:;halton;Means;Maxit=100;Pds=4;Matrix;Crosstab;Prob=prRP5nc$

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```

$RPL Correlated

$RPL MODEL (PD & Demos & ERS Regions & 13/14 AI):RANDOM PARMS ARE CORRELATED W/ DEMOS
NLOGIT;Lhs=DECUSE;Choices=1,2,3;
Rhs=PD,Cdum,Bdum,ME_PI_EC,ME_PN_EC,AI_PP_EC,AI_PG_EC,AI_HV_EC,
AI_AVPP_,AI_AVPG_,AI_AVHV_,AI_PPPG_,AI_PPHV_,AI_PGHV_,AI_AVPPP,
AI_AVPPH,AI_PPPGH,AI_FL_EC,BD_bctc,CD_bctc,BD_dumla,CD_dumla,BD_count,
CD_count,BD_yrsr,CD_yrsr,BD_indid,CD_indid,BD_grpid,CD_grpid,BD_notid,
CD_notid,BD_erscb,CD_erscb,BD_ersnp,CD_ersnp,BD_ersnw,CD_ersnw,BD_ersse,
CD_ersse,BD_erssp,CD_erssp;
RPL;Pts=250;Cor;Parameters;
Fcn=Cdum(N),Bdum(N);
PrintVC;Effects:;halton;Means;Maxit=100;Pds=4;Matrix;Crosstab;Prob=prRP5c$

$$$

$LCM

$LCM MODEL (PD & Demos & 9/10 AI): 3 SEGMENTS:
$NO SEGEMENT EXPLAINING VARIABLES INCLUDED
NLOGIT;Lhs=DECUSE;Choices=1,2,3;
Rhs=PD,Cdum,Bdum,ME_PI_EC,ME_PN_EC,AI9PP_EC,AI9PG_EC,AI9HV_EC,
AI9AVPP_,AI9AVPG_,AI9AVHV_,AI9PPPG_,AI9PPHV_,AI9PGHV_;
LCM=one,bctc,dumla,countfo,yrsr,indv_id,group_id,no_ot_id;
Pts=3;Parameters;Pds=4;Matrix;Crosstab;Prob=prLC2a$

$$$
$Summary Statistics (mean) Used for LCM Willingness-to-Accept Estimates
$$$

DSTAT;Rhs=bctc,dumla,countfo,yrsr,indv_id,group_id,no_ot_id,erscb,ersnp,ersnwa,
erssea,erssp$

$$$
$$$

REFERENCES

REFERENCES

Adamowicz, W., R. Boxall, M. Williams and J. Louviere. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation." *American Journal of Agricultural Economics* 80(1998):64-75.

Adamowicz, W., J. Louviere, J. Swait. "Introduction to Attribute-Based Stated Choice Methods." Submitted to Resource Valuation Branch Damage Assessment Center, National Oceanic and Atmosphere Administration, and U.S. Department of Commerce. Edmonton, Alberta, Canada. January 1998.

Alfnes, F. "Stated Preferences for Imported and Hormone-Treated Beef: Application of a Mixed Logit Model." *European Review of Agricultural Economics* 31(2004):19-37.

Ammendrup, S. and L.O. Barcos. The implementation of traceability systems. *Review of Science Technology* Off. int. Epiz., 25.2(2006):763-773.

Bailey, D. and J. Slade. "Factors Influencing Support for a National Animal Identification System for Cattle in the United States." Selected paper presented at the American Agricultural Economics Association Annual Meetings. Denver, CO. August 1-4, 2004.

Baines, R. N., and W. P. Davies. "Quality Assurance in the International Food Supply." Paper presented at the Third International Conference on Chain Management in Agribusiness and the Food Industry, Wageningen University, Wageningen, The Netherlands, 1998.

Bech, M. and D. Gyrd-Hansen. "Effects Coding in Discrete Choice Experiments." *Health Economics* 14(2005):1079-1083.

Becker, G.S. 2007. Animal Identification and Meat Traceability. CRS report prepared for members and committees of congress. Retrieved from http://www.nationalaglawcenter.org/assets/crs/RL32012.pdf on February 5, 2008.

Becker, T. "Consumer Perception of Fresh Meat Quality: A Framework for Analysis." *British Food Journal* 102.3(2000):158-176.

Blumenschein, K., M. Johannesson, G.C. Blomquist, B. Liljas, R.M. O'Connor. "Experimental Results on Expressed Certainty and Hypothetical Bias in Contingent Valuation." *Southern Economic Journal* 65.1(1998):169-177.

Bockstael, N. E., and I. E. Strand, Jr. "The Effects of Common Sources of Regression Error on Benefit Estimates." *Land Economics* 63(Feb 1987):11-20.

Boxall, P.C., W.L. Adamowicz. "Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach." *Environmental and Resource Economics* 23(2002):421-446.

Brester, Gary W. "Meeting Consumer Demands with Genetics and Market Coordination: The Case of the Leachman Cattle Company." *Review of Agricultural Economics* 24.1 (2002):251-265.

Buhr, B. "Traceability and Information Technology in the Meat Supply Chain: Implications for Firm Organization and Market Structure." *Journal of Food Distribution Research* 34.3(2003):13-26.

Bulut, H., and J. D. Lawrence. 2007. "Meat Slaughter and Processing Plants'Traceability Levels Evidence From Iowa." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. Retrieved from http://www.farmdoc.uiuc.edu/nccc134 on February 5, 2008.

Bunch, D. S. and R. Kitamura. "Probit Model Estimation Revisited: Trinomial Models of Household Car Ownership." Working Paper. University of California Transportation Center. University of California Berkeley, CA. 1991.

Buzby, J. C., P. D. Frenzen, and B. Rasco. 2001. "Product Liability and Microbial Foodbourne Illness." Economic Research Service, AER 799. Retrieved from www.ers.usda.gov/publications/aer799/ on February 5, 2008.

Caswell, J.A. "Labeling Policy for GMOs: To Each His Own?" *AgBioForum* 9(2000):53-57.

Cattle Network. 2008. "Five Minutes With Dr. John Wiemers, USDA, APHIS, NAIS." Retrieved from http://www.cattlenetwork.com/content.asp?ContentId=194952 on February 5, 2008.

Champ, P., R.C. Bishop. "Donation Payment Mechanisms and Contingent Valuation: An Empirical Study of Hypothetical Bias." *Environmental and Resource Economics.* 19(2001): 383-402.

Dickinson, D and D. Bailey. "Meat Traceability: Are U.S. Consumers Willing to Pay for It?" *Journal of Agriculture and Resource Economics* 27.2(2002):348-364.

Dickinson, D. L., J. E. Hobbs, and D. Bailey. 2003. "A Comparison of U.S. and Canadian Consumers' Willingness To Pay for Red-Meat Traceability." Paper prepared for presentation at the American Agricultural Economics Association Annual Meetings. Montreal, Canada. July 27-30, 2003.

Early, R. "Farm Assurance-Benefit or Burden?" *Journal of the Royal Agricultural Society* 159(1998):32-43.

Fishbein, Martin, and Icek Ajzen. Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Addison-Wesley, 1975.

Golan, E., B. Krissoff, F. Kuchler, L. Calvin, K. Nelson, and G. Price. 2004. "Traceability in the U.S. Food Supply: Economic Theory and Industry Studies." Agricultural Economic Report Number 830, Economic Research Service, United States Department of Agriculture. Retrieved from http://www.ers.usda.gov/Publications/AER830/ on February 5, 2008.

Golan, E., B. Krissoff, F. Kuchler, K. Nelson, G. Price and L. Calvin. "Traceability for Food Safety and Quality Assurance: Mandatory Systems Miss the Mark. *Current Agriculture, Food and Resource Issues* 4(2003):27-35.

Gong, W., k. Parton, R. J. Cox, and Z. Zhou. "Transaction Costs and Cattle Farmers' Choice of Marketing Channels in China, A Tobit Analysis." *Management Research News* 30.1(2007):47-56.

Greene, W.H. Econometric Analysis. 4th ed. New Jersey: Prentice-Hall Inc, 2000.

Gregory, A. 2008. "Optimal Economic Design of Mail Surveys: Influences of Response Rates and the Impact of Responses to a Second Mailing." A Disseration. Kansas State University, Department of Agricultural Economics.

Gujarati, Damodar N. Basis Econometrics. 4th ed. New York: McGraw-Hill/Irwin, 2003.

Hall, J., Viney, R., Haas, M., & Louviere, J. 2004, "Using stated preference discrete choice modeling to evaluate health care programs", *Journal of Business Research* 57.9(2004):1026-1032.

Han, J. and R. W. Harrison. 2006. "Consumer Valuation of the Second Generation of Genetically Modified (GM) Foods with Benefits Disclosure." Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meetings. Orlando, Florida. February 4-8, 2006.

Hardy, M. A., A. Bryman. Handbook of Data Analysis. Sage Publications Inc, 2004.

Hensher, D. A., J. M. Rose, and W. H. Greene. Applied Choice Analysis A Primer. Cambridge, UK: Cambridge University Press, 2005

Hobbs, J.E. "Traceability in Meat Supply Chains, Current Agriculture, Food and Resource Issues" 4(2003a):36-49.

Hobbs, Jill E. 2003b. "Consumer Demand for Traceability." Working Paper #03-1, International Trade Research Consortium (IATRC). Retrieved from http://www.iatrcweb.org on February 5, 2008.

Hobbs, J. E. 2003c. “Traceability and Country of Origin Labeling.” Farm Policy Development and Tensions with NAFTA. University of Saskatchewan. Saskatchewan, Canada.

Hobbs, J.E. “Information Asymmetry and the Role of Traceability Systems.” *Agribusiness* 20.4(2004):397-415.

Hobbs, J.E. “Liability and Traceability in Agri-Food Supply Chains.” In Ondersteijn, CJM, Wijnand, JHM, Huirne, RBM and van Kooten, O, editors. *Quantifying the Agri-Food Supply Chain*. Netherlands: Springer, (2006):85-100.

Hobbs, J.E, D. Bailey, D.L. Dickinson, and M. Haghiri. “Traceability in the Canadian Red Meat Sector: Do Consumers Care?” *Canadian Journal of Agricultural Economics*; 53.1(2005):47-65.

Huffman, WE., M. Rousu, J.F. Shogren, and A. Tegene. "Consumer Willingness to Pay for Genetically Modified Food Labels in a Market with Diverse Information: Evidence from Experimental Auctions." *Journal of Agricultural and Resource Economics* 28.3(2003a):481-502.

Huffman, WE., M. Rousu, J.F. Shogren, and A. Tegene. "The Public Good Value of Information from Agribusinesses on Genetically Modified Foods." *American Journal of Agricultural Economics* 85.5(2003b):1309-1315.

International Organization for Standardation. 2000. “Quality management systems-Requirements.” ISO 9001. Retrieved from http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=21823 on July 18, 2008.

Jensen, H. H. and D. J. Hayes. 2006. “Private Sector Approaches to Secure Traceability, Transparency and Quality Assurance in Food Chains.” Paper prepared for the IATRC Summer symposium "Food Regulation and Trade: Institutional Framework, Concepts of Analysis and Empirical Evidence". Bonn, Germany, May 28-30, 2006.

Kansas State University. 2006. “BEEF and K-State Cow-Calf Producer NAIS Survey.” By Prism Media. Department of Animal Science. Manhattan, Kansas.

Kennedy, P. <u>A Guide to Econometrics</u>. 5th ed. Cambridge, MA: The MIT Press, 2003.

Krinsky, I., and A. L. Robb. "On Approximating the Statistical Properties of Elasticities." *Review of Economics and Statistics* 68 (Nov 1986):715-19.

Kuhfeld, W.F., R.D. Tobias, and M. Garratt. “Efficient Experimental Design with Marketing Research Applications.” *Journal of Marketing Research* 31(1994):545-557.

Lancaster, K. 1966. "New Approach to Consumer Theory." *Journal of Political Economy* 74(1966):132-57.

Layton, D.F. 1996. "Rank-Ordered, Random Coefficients Multinomial Probit Models for Stated Preference Surveys." Paper Presented at the Association of Environmental and Resource Economists Workshop. Tahoe City, California. June 2-4, 1996.

Liddell, S. and D. Bailey. 2001. "Market opportunities and threats to the U.S. pork industry posed by traceability systems." *International Food and Agribusiness,* 4(2001): 287-302.

Loureiro, M., and W. Umberger. "Estimating Consumer Willingness to Pay for Country-of-Origin Labeling." *Journal of Agriculture and Resource Economics* 28(2003):287-301.

Lupin, H. 2006. "Traceability." Presented for Discussion at the Committee On Fisheries, and Sub-Committee On Fish Trade (COFI:FT). Tenth Session. Santiago de Compostela, Spain, May 30-June 02, 2006.

Lusk, J.L. "Willingness-to-Pay for Golden Rice." *American Journal of Agricultural Economics* 85.4(2003):840-856.

Lusk, J.L., F.B. Norwood, J.R. Pruitt. "Consumer Demand for a Ban on Antibiotic Drug Use in Pork Production." *American Journal of Agricultural Economics.* 88.4(2006):1015-1033.

Lusk, J., J. Roosen, and J. Fox. "Demand for Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn: A comparison of Consumers in France, Germany, the United Kingdom, and the United States." *American Journal of Agricultural Economics* 85(2003):16-29.

McFadden D. "Econometric models of probabilistic choice." In C.F. Manski and D. McFadden, editors. *Structural Analysis of Discrete Data with Econometric Applications.* pp. 198-272. Cambridge, MA: The MIT Press, 1981.

Mennecke B., A. Townsend, D.J. Hayes, and S. Lonergan. 2006. "A Study of the Factors that Influence Consumer Attitudes Toward Beef Products Using the Conjoint Market Analysis Tool." Iowa State University, CARD Research Paper 06-WP 425. August, 2006.

Meuwissen, M. P. M., A. G. J. Velthuis, H. Hogeveen, and R. B. M. Huirne. 2003. "Traceability and Certification in Meat Supply Chains." *Journal of Agribusiness* 21.2(2003):167-181.

Millimet, D. 2001. "Endogeneity versus sample selection bias. STATA, Data Analysis and Statistical Software." Retrieved from http://www.stata.com/support/faqs/stat/bias.html on February 5, 2008.

Morey, E.R. "TWO RUMS un CLOAKED: Nested-Logit Models on Site Choice and Nested-Logit Models of Participation and Site Choice." In Herriges, J.A. and C.L. Kling editors. *Valuing Recreation and the Environment*. Northampton, MA: Edward Elgar, 1999.

Mus, M. "Traceability System Approaches and Cost Analysis for the Beef Industry." A Thesis. Washington State University, School of Economics Sciences. 2006

Nahuelhual, L., M.L. Loureiro, and J. Loomis "Using Random Parameters to Account for Heterogeneous Preferences in Contingent Valuation of Public Open Space." *Journal of Agricultural and Resource Economics*. 29(2004):537-552.

Nakosteen, R., and M. Zimmer. "Migration and Income: The question of Self-Selection." *Southern Economic Journal* 46(1980):840-851.

National Agriculture Statistics Service (NASS). 2008. United States Department of Agriculture, Quick Stats. Retrieved from http://www.nass.usda.gov/QuickStats/Create_Federal_All.jsp. on January 23, 2008

New Zealand Trade and Enterprise. 2006. "Traceability a Platform for Product Knowledge and Value." A Report for New Zealand Trade and Enterprise. June, 2006.

Ouma, E., A. Abdulai, and A. Drucker. "Measuring Heterogeneous Preferences for Cattle Traits among Cattle-Keeping Households in East Africa." *American Journal of Agricultural Economics* 89.4(2007):1005-1019.

Park, T., J. Loomis, and M. Creel. "Confidence Intervals for Evaluating Benefits From Dichotomous Choice Contingent Valuation Studies." *Land Economics* 67.1(1991):64-73.

Pindyck, R.S. and D.L. Rubinfeld. Econometric Models and Economic Forecasts. 4th ed. Boston, Massachusetts: The McGraw-Hill Companies Inc, 1998.

Revelt, D., and K. Train. "Mixed Logit with Repeated Choices: Households' Choices of Appliance Efficiency Level." *Review of Economics and Statistics* 80(1998):647-657.

Rigby, D. and M. Burton. "Preference Heterogeneity and GM Food in the UK. *European Review of Agricultural Economics*. 32(2005):269-288.

Roberts, T., Busby, J.C., and M. Ollinger. "Using Benefit and Cost Information to Evaluate a Food Safety Regulation: HACCP for Meat and Poultry", *American Journal of Agricultural Economics* 78(1996):1297-1301.

Sanderson, Kim and J. E. Hobbs. 2006. "Traceability and Process Verification in the Canadian Beef Industry." Report prepared for Canfax Research Services. October, 2006.

SAS Institute Inc., SAS 9.1.3 Help and Doc. Cary, NC: SAS Institute Inc., 2008.

Scarpa, R. and T. Delgiudice. Market Segmentation via Mixed Logit: Extra Virgin Olive Oil in Urban Italy. *Journal of Agricultural and Food Industrial Organization.* Vol.2, Article 7(2004).

Schroeder, T., G. Tonsor, J. Mintert, J.M.E. Pennings. "Consumer Risk Perceptions and Attitudes about Beef Food Safety: Implications for Improving Supply Chain Management." Kansas State University Agricultural Experiment Station and Cooperative Extension Service. 2006.

Schroeder et al. 2007. "Benefit Cost Analysis of the National Animal Identification System." U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2007

Small, K.A., and H.S. Rosen. "Applied Welfare Economics with Discrete Choice Models." *Econometricia* 49(1978):43-6.

Smith, G.C., Belk, K.E., Scanga, J.A., Sofos, J.N., Tatum, J.D. 2000. "Traceback, traceability and source verification in the US beef industry." Presented at the XXI World Buiatrics Congress, Punta del Este, Uruguay. December 5, 2000. Retrieved From http://ansci.colostate.edu/dp/msfs/gcs001.pdf on January 23, 2008.

Smith, G.C., J.D. Tatum, K.E. Belk, J.A. Scanga, T. Grandin, and J.N. Sofos. "Traceability from a US Perspective." *Meat Science* 71(2005):174-193

Smyth, S., and P.W.B. Phillips. "Product Differentiation Alternatives: Identity Preservation, Segregation, and Traceability." *AgBioForum* 5.2(2002):30-42

Souza-Monteiro, D.M. and J.A. Caswell. 2004. The economics of implementing traceability in beef supply chains: Trends in major producing and trading countries. Presented at the Annual meeting of the Northeastern Agricultural and Resource Economics Association. Halifax, Nova Scotia. June 20-23, 2004.

Starbird, S. A. and V. Amanor-Boadu. "Contract Sensitivity, Food Safety, and Traceability." *Journal of Agriculture & Food Industrial Organization* 5.2(2007).

The Food Business Forum. "Implementing Traceability in the Food Supply Chain." pp. 5. Paris, France. 2005.

Tobin, James. "Estimation of Relationship for Limited Dependent Variables." *Econometrica*, 26(1958):24-36.

Tonsor, G.T. and T.C. Schroeder. "Livestock Identification: Lessons for the U.S. Beef Industry from the Australian System." *Journal of International Food & Agribusiness Marketing*, 18.3/4(2006):103-118.

Tonsor, G. T., T. C. Schroeder, J. A. Fox, and A. Biere. "European Preferences for Beef Steak Attributes." *Journal of Agricultural and Resource Economics* 30.2(2005):367-380.

Tonsor, G.T., T.C. Schroeder, J.M.E. Pennings, and J. Mintert. 2008. "Consumer Valuations and Choice Processes of Food Safety Enhancement Attributes: An International Study of Beef Consumers." Working paper.

Train, K.E. "Mixed Logit Models for Recreation Demand." in C. Kling and J. Herriges, editors, *Valuing the Environment Using Recreation Demand Models*. Lyme, New Hampshire: Edward Elgave, 1997.

Train, K.E. "Recreation Demand Models with Taste Differences over People." *Land Economics* 74(1998):230-239.

Train, K. E., Discrete Choice Methods with Simulation. Cambridge, MA: Cambridge University Press, 2003.

United States Department of Agriculture, Animal and Plant Health Inspection Service. 2008. "National Animal Identification System." Retrieved from http://animalid.aphis.usda.gov/nais/index.shtml on July 8, 2008.

United States Government Accountability Office. "National Animal Identification, USDA Needs to Resolve Several Key Implementation Issues to Achieve Rapid and Effective Disease Traceback." Report GAO-07-592 to the Chairman, Committee on Agriculture, Nutrition, and Forestry, U.S. Senate. 2007.

Weiss, M. D. 1995. "Information Issues for Principals and Agents in the Market for Food Safety and Nutrition." pp 69-79 in J. A. Caswell, editors, *Valuing Food Safety andNutrition*. Boulder, CO: Westview Press, 1995.

Wooldridge, Jeffrey M. Introductory Econometrics, A Modern Approach. 2nd ed. Mason, Ohio: South-Western College Publishing, 2003.

Wooldridge, Jeffrey M. Introductory Econometrics, A Modern Approach. 3rd E. Mason, Ohio: South-Western College Publishing, 2006.