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Market potential for pork products with embedded environmental attributes: an experimental approach

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Market potential for pork products with embedded environmental attributes: An experimental approach

by

Sean Patrick Hurley

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ABSTRACT

This dissertation focuses on determining benefits or value of environmental improvements in agricultural production, specifically, with an application to the pork industry. Values or benefits from reduced odor, reduced manure run-off, and reduced manure spills were elicited from consumers from Iowa, Kansas, Vermont, Oregon, and North Carolina. For the study, two pound packages of pork chops with selected combinations of air, ground water, and surface water environmental attributes were used to obtain consumer willingness-to-pay for environmental improvements. These benefits or willingness-to-pay for improved environmental practices have been obtained through research using a multiple trial second-price sealed-bid auction.

A focus of this dissertation is to investigate the relationship between willingness-to-pay for embedded environmental attributes and socioeconomic characteristics. The dependent variables analyzed had a mix of continuous and discrete points within the distribution because of self-selectivity. Given this, a two-stage econometric procedure employing a polychotomous choice function, specifically an ordered probit, was used to investigate this relationship. Predictive ability of the model was limited and sensitive to the variables included.

Two measures of willingness-to-pay for improved environmental attributes were developed and examined. It was found that under both these measures, approximately two-thirds of the participants indicated they would be willing to pay a premium for pork products with embedded environmental attributes. The average premium paid by premium payers under both measures ranged from $1.62 to $2.23 for the package with all three embedded environmental attributes. Statistical methods were used to examine whether there were differences in premiums with differing levels of embedded environmental attributes. Examining the premiums across the different locations in this study shows that there were no significant differences in the premium level by location. Demographic and attitudinal data of the participants in this study are presented. Statistical tests are employed to see whether they are significantly different across premium payers and non-premium payers.

CHAPTER ONE: INTRODUCTION

Environmental issues related to livestock production have received increased attention in recent years. These environmental issues have included odors, and surface and ground water quality. An industry at the forefront of this attention has been the pork production industry. One of the major issues the industry is facing is odor from production. This has been due to recent scientific research which has shown the effects that odor from production can have on nearby residents. Schiffman et al. cite studies that provide evidence of the health risks that can occur in highly odorous environments including swine housing facilities (1998). These health risks can cause localized health concerns especially in large producing states like Iowa and North Carolina.

Manure spills and odor from production have increased the concerns surrounding livestock production and the environment. Large concentrations of hog operations have received a heightened focus on their effect to the environment. The three most vocalized concerns have been odor, contamination of ground water by both slow seepage and run-off of hog waste, and major catastrophic events such as lagoon spills (Honeyman 1995, 1996; Perkins 1996; Beeman 1996a, 1996b; Letson and Gollehon 1996). This recent attention has brought much scrutiny to the pig industry and effort by the industry is focusing on these concerns.

While odor has been a more local issue, the industry has attracted wide spread public scrutiny starting in the mid 1990's. In June of 1995, North Carolina suffered a large spill that resulted in approximately 25 million gallons of hog waste flowing into a nearby river (U.S. News and World Report 1996). About one month later, the Des Moines Register reported a major spill in Iowa amounting to 1.5 million gallons of hog manure flowing into a local river

(1995). Both of these spills had a profound effect on the local environment. Additional manure spills have occurred since that time further expanding the concern.

Due to this heightened focus, much work is currently ongoing with respect to technologies and/or production practices that assist in reducing potential for manure spills or leaks and resulting pollution of surface and ground water and odor reduction. However, there is little research on what the value of improved environmental quality is for consumers.

For the past few years, the pork industry in the United States has been undergoing a major structural change. In the past, this industry has been reliant on the "community" farmer located in the region known as the Corn Belt with an average hog inventory between 500 to 999 head. In 1988, firms marketing less than 1000 hogs a year accounted for thirty-two percent of the market, whereas firms marketing 50,000 or more accounted for only seven percent (Lawrence et al. 1999a). More recently the pork industry has seen a rapid expansion of large production operations with inventories that well exceed 1000 head and adopt state of the art production facilities to mass produce pigs (Meyer 1995). By 1997, the producers who market less than a 1000 head of hogs only marketed five percent of the total United States production. In this same year, those producers that marketed 50,000 or more hogs produced thirty-seven percent of the market hogs (Lawrence et al. 1999a). This expansion has allowed these larger farms to gain production cost efficiencies and caused increasing competitive pressures for the traditional pork producer. There has been a dramatic shift from the small-scale operations to large-scale pork production.

With the increased competitive pressure, the Iowa pork industry, too, has witnessed the movement to large-scale operations. This adoption of large-scale operations has had two

major effects in Iowa. First, small-scale producers have been rapidly exiting the industry. Second, in the adjustment process, Iowa has regained much of its competitive advantage.

States like Iowa and North Carolina have a large vested interest in the pork industry, as it is an important part of the economic base of the state. Swine production represents a major industry providing much economic activity in Iowa. Approximately 94,000 jobs are directly related to pork production (Otto and Lawrence 1993, 1994). In a typical year swine gross receipts are $2.6 to $3 billion and represent 30 percent of all agricultural marketing (Lawrence et al. 1994). The industry supports a multi-billion dollar input supply industry consuming about twenty-two percent of Iowa's corn production. Industry stakeholders represent a key economic component of Iowa's economy. For a typical small rural community in Iowa with a ten square mile trade area, swine production represents approximately $8 million in economic activity.

Along with production efficiencies, the industry's ability to effectively handle environmental issues within a sustainable framework will be key to its competitive position. These effects have caused many debates recently in Iowa's legislature on how much regulation is needed in Iowa's pork industry. Additionally, many people from Iowa are beginning to voice concerns about environmental and health issues that accompany large-scale hog production facilities. These issues cover ground and water quality, as well as air quality relating to odor and transmission of disease organisms. For the legislature to choose optimal legislation (i.e. taxes on polluters, subsidies for environmental sustaining technologies, etc.), it must have knowledge on how its constituents value environmental issues.

Dissertation Content

While environmental issues exist about livestock production, little is known about how society views the value or benefit of reduced livestock odors, reduced levels and/or probability of run-off from livestock production systems or manure spills. This dissertation focuses on determining perceived benefits or value of environmental improvements in livestock production, specifically, with an application to the pork industry. There are two values/benefits that can be solicited from an experimental setting that are used in this dissertation. One value is related to the consumer's willingness-to-pay for environmental attributes when the basis for environmental improvement is known. The other value is related to the consumers willingness-to-pay for environmental attributes where the consumer's environmental expectation related to the product is unknown ex ante.

The first value that is important to calculate is the consumer's willingness-to-pay for embedded environmental attributes given an ex ante expectation of what levels of environmental attributes are incorporated in the product. This expectation is derived when consumers do not have complete information related to the product attributes. This value will be known as the consumer's willingness-to-pay given unknown ex ante expectations as to the level of embedded environmental attributes within the product, or more simply referred to as consumer's willingness-to-pay given unknown ex ante expectations. Throughout this dissertation this value will also be known as definition one for willingness-to-pay. Unlike consumer's willingness-to-pay with a known basis, this value is calculated across different information sets where the ex ante expectation as to the level of embedded environmental attributes is unknown. This value represents the initial benefit the consumer receives due to the release of environmental information.

The second value that is important to measure is the consumer's willingness-to-pay when the basis for environmental improvement is known. This value is derived from taking the difference in the value of a product with embedded environmental attributes with a product that is considered the basis of the environmental improvement. This will be known as the consumer's willingness-to-pay for pork products with embedded environmental attributes with a known basis, or more simply consumer's willingness-to-pay with a known basis. Throughout this dissertation this value will also be known as definition two for willingness-to-pay. This value is calculated within a specific information set where the consumer can compare an environmental package with a non-environmental package. This value will arise when markets have been allowed to adjust and consumers have full knowledge of the products they consume. Knowing this value can assist policy makers in determining the importance of environmental attributes to consumers.

There are four main objectives of this dissertation. The first objective is to theoretically model the behavior of a consumer in a second-price sealed-bid auction when there are embedded environmental attributes in the item being auctioned. A part of this objective is to be able to interpret what bids represent from a second-price auction when there are embedded environmental attributes. From a second-price auction where the products have no embedded environmental attributes, the bids given in the auction can be interpreted as the consumer's true valuation for that product. This is a unique feature of the second-price auction. A related sub-objective is to show how the two willingness-to-pay measures discussed above can be extracted from a multiple round, multiple object, second-price auction when different information sets exist about the attributes of the products.

The second objective of this dissertation is to outline an experimental setting in which the willingness-to-pay measures mentioned above can be collected, while the third objective is to identify how much consumers are willing to pay for pork products with embedded environmental attributes when looking at both of the above definitions separately—consumer's willingness-to-pay with a known basis and consumer's willingness-to-pay given unknown ex ante expectations. An extension of this third objective will be to investigate whether these values are different across different locations of the United States. Another extension is to investigate if these values differ for selected combinations of environmental attributes.

The fourth main objective is to investigate the relationship socioeconomic factors, specifically the core variables used in the willingness-to-pay literature, have on willingness-to-pay for embedded environmental attributes using both definitions for willingness-to-pay. Within this fourth objective, there are three secondary objectives. The first is to predict the directional effect environmental information has on the participants using socioeconomic variables. This directional effect would be positive, negative, or no effect. This information can assist in marketing decisions by helping marketers to more efficiently target consumers that will pay for products with embedded environmental attributes. Once directional impact has been predicted the magnitude of the shift will be evaluated for positive premium payers under both definitions of willingness-to-pay. Finally, a comparison of the two models for both definitions will be given.

Values or benefits from a reduction of odors from production facilities, and/or a decrease in the impact to surface and ground water have been elicited from consumers from the states of Iowa, Kansas, Vermont, Oregon, and North Carolina. Participants included pork

producers, their neighbors, rural community residents and urban residents. Sites selected for the study ranged from those with a large pork production base to sites located a long distance from pork production facilities.

Valuations are elicited from what is referred to as the experimental contingent valuation method (XCVM). This approach uses surveys to collect participant information along with experimental economics to elicit participant values for attributes such as improved environmental production practices (contingent value). For this study, XCVM is used to study both definitions of consumer's willingness-to-pay for environmental sustainability and or improvement of air, surface water, and ground water quality as it is associated with pork production.

Sustainability within agriculture requires that at least two broad conditions be met: one is that of environmental sustainability, and the second is economic sustainability. An overriding issue in both areas is that of social acceptability or overall impacts on society. These societal issues feed into both the environmental and economic areas and will, at least in part, be reflected in the participants' willingness-to-pay for products from systems with differing environmental impact attributes.

The dissertation proceeds as follows. In chapter two, a discussion of related literature is presented. The four main topics are the use of contingent valuation and hedonic pricing studies to obtain willingness-to-pay, the use of experimental economics to elicit willingness-to-pay, ecolabeling, and the problem of free-riding in experimental settings with public goods. Chapter three presents a model of consumer behavior in an experimental setting with products that have embedded environmental attributes. From this chapter, an interpretation is given to bids that are solicited in a second-price auction when the products being sold have

embedded environmental attributes. Also within this chapter is a derivation of the two willingness-to-pay measures that will be examined throughout the rest of the dissertation. Chapter four presents the experimental process and protocol that was used for this study. It explains how the experiment was developed and what instruments were used for collecting data. Chapter five presents results and provides discussion of the data collected from the experimental process. Summary statistics are also provided here along with some standard statistical tests of pertinent hypotheses. Chapter six presents the results of the pre and post surveys completed. It provides similarities and differences in the socioeconomic characteristics of participants who were willing to pay a premium for embedded environmental attributes versus those who were not. Chapter seven investigates the relationship between willingness-to-pay and demographic and attitudinal data using a two-stage econometric model which incorporates a polychotomous choice function. It demonstrates how data can be modeled when the dependent variable has both continuous and discrete points. Chapter eight presents a summary of the findings, provides final conclusions that can be drawn from this research, and discusses future research ideas.

CHAPTER TWO: LITERATURE REVIEW

There are four major areas in the literature pertaining directly to this dissertation. The first deals with survey methods to determine willingness-to-pay for environmental protection and/or sustainability of the environment. These primarily use, but are not limited to, contingent valuation methods (CVM) and hedonic price models to elicit values and/or prices for environmental amenities. The second area pertains to the use of XCVM, i.e., the use of experiments, in place of CVM in eliciting consumers' willingness-to-pay for product attributes. The third major area is that of ecolabeling and nutritional labeling. Due to the public nature of the topic this dissertation investigates, the fourth major area in the literature is related to the problem of free-riding and public goods being valued in an experimental setting.

Valuation Studies for Groundwater and Livestock Odor Valuation

Portney describes CVM studies as the use of surveys to obtain willingness-to-pay for hypothetical projects or programs (1994). These elicited values are contingent upon the constructed or simulated market presented in the survey. He defines three major elements that are incorporated in virtually every CVM study. The first element is a description of the scenario of the policy or program that the respondent will value or vote upon. The second element is a mechanism used to elicit values or choices from the respondent. The third element is a questionnaire that elicits demographic and/or attitudinal data that will be used for econometric and statistical purposes. For a discussion and critical evaluation of CVM, see Portney (1994), Whitehead and Van Houtven (1997), Hanneman (1994), and Diamond and Hausman (1994).

Much work has been completed on willingness-to-pay for ground water protection. A primary approach has been the use of CVM surveys to gain information on willingness-to-pay for ground water protection (Boyle et al. 1994; Powell et al. 1994; Edwards 1998; Sun et al. 1992; Caudill and Hoehn 1996; Poe and Bishop 1992; Jordan and Elnagheeb 1993; Laughland et al. 1993). These studies have found an average household willingness-to-pay for ground water protection ranging between $1 to $155 per month (Whitehead and Van Houtven 1997). This wide range of results is due to the various design methods used to collect the data. For instance, there was not a clear definition across studies of ground water contamination, or a consistent payment method used for collecting this willingness-to-pay, e.g., taxes, bond referendum, etc.

Boyle et al. performed a meta-analysis of current CVM studies that measure the benefits of ground water protection (1994). This meta-analysis approach was conducted by using unique point estimates from a group of studies as observations. In their study they found a wide range for annual willingness-to-pay. They cite three major points of interest that relate directly to this work. First, they suggested that there is a need for improvements in future ground water valuation studies that would more clearly identify systematic differences in ground water values. Secondly, they expressed the need for more studies to expand the knowledge base of depth of information and specific characteristics of ground water. Third, they found that educating households about ground water issues could influence the level of willingness-to-pay.

Boyle et al. found that a major limitation to their meta-analysis was the lack of a consistent definition for groundwater contamination (1994). Even with this limitation, which constrained the variables they could use, they found that the core variables demonstrated

remarkable consistency. These variables were: 1) change in the probability of contamination, 2) nitrates mentioned as a source of contaminant, 3) substitute sources of portable water mentioned, 4) cost of substitute mentioned, 5) average household income, 6) policy was to contain contamination, 7) a dichotomous variable indicating whether the study was primarily focused on use values, and 8) change in supply of water.

Powell et al. studied the impact CVM has on policy (1994). They point out that one of the drawbacks of their study was that the information was collected through a mail survey. Lacking from their method was a way of checking the intensity of respondent evaluation of CVM information provided before filling out the questionnaire. They concluded that local level decision making on ground water policy could be aided by CVM information. However, they point out that while mail surveys are very useful in collecting information, interpretation of results needs to be done with caution. It is difficult, if not impossible, to observe how the respondents filled out the survey. There is no way of knowing the time and care respondents took in filling out the survey.

Recently there has been a rise in interest for organic agriculture. The importance of organic agriculture stems from the perceived attributes embedded within organic products. Klonsky and Tourte identify an existing perception that organic agriculture provides solutions to problems related to environmental quality, food safety, the viability of rural communities, and market concentration (1998). Hence, organic farming has the perception of a market that provides incentives for farmers to follow good environmental production practices, providing a safe food product, having a positive community impact, and having favorable market concentration, i.e., an acceptable mixture of small and large farms.

Due to this rise in interest of organic agriculture, issues such as willingness-to-pay for organic produce (Misra et al. 1991; Weaver et al. 1992) and marketing organic products (Thompson and Kidwell 1998; Thompson 1998; Lohr 1998; Krissoff 1998; Duram 1998) have received increased attention. While premiums are being paid for organic agriculture (Dobbs 1998), it is difficult to know which attributes within organic products are commanding these premiums. There have been many studies that have investigated one of the perceived attributes, the issue of food safety (Misra et al. 1991, Weaver et al. 1992, Roosen et al. 1998; Fox et al., 1994; Fox et al., 1995), but little has been done in the area of embedded environmental attributes.

A study by Misra et al. focuses on willingness-to-pay for pesticide-free fresh produce (1991). Like most of the ground water papers, their CVM study was also conducted through mail survey methods. They found that a majority of Georgia consumers surveyed indicated that produce certified to be pesticide free was a very important to a somewhat important consideration in food purchases. However, consumers in general were not willing to pay more for certified pesticide free fresh produce.

Weaver et al. evaluate the willingness-to-pay for pesticide-free tomatoes (1992). They used a different methodology than Misra et al. (1991). Instead of doing mail surveys, they conducted face to face surveys in three retail grocery locations in Pennsylvania. Weaver et al. found that consumers were not only concerned about how pesticides affected them, but they also showed altruistic concerns about the effects pesticides had on farm workers, ground water, and the environment. They further note that consumer's willingness-to-pay for pesticide free tomatoes was positive and significant.

Rather than using the survey methods of Misra et al. (1991) and Weaver et al. (1992) to obtain willingness-to-pay and/or attitudes for pesticide free produce, Thompson and Kidwell (1998) did an in-store study to obtain information on consumers' choice between organic products and conventional products. They explained the usefulness of their study comes from actually observing consumers' choices. They were able to map attitudes into actual purchasing behavior. Most organic food studies have focused on attributes such as pesticides that may be in the food product. The study by Thompson and Kidwell focused on measuring how cosmetic defects affect the decision of purchasing organic.

There is one area of study where willingness-to-pay work is lacking. This area deals with odors from production systems. This has become an increasing problem in the hog industry with the growth of large production facilities. There are three papers that have investigated the effects of livestock odor on property values (Palmquist et al. 1995; Abeles-Allison and Connor 1990; Taff et al. 1996). Both Palmquist et al. and Abeles-Allison and Connor show that the proximity of hog operations has a statistically significant and negative impact on family housing property values. Taff et al. found a completely opposite result. They found property values rising as housing was located closer to large livestock facilities. They suggest that this counterintuitive result is due to livestock operation workers bidding up housing prices to live closer to where they work. Palmquist et al. explained that they had much difficulty with their study due to the lack of information in this area of odor valuation.

All three of these papers used hedonic price techniques to obtain a value for the effect livestock odor has on property values. Freeman defines this technique as a "method for estimating the implicit prices of the characteristics that differentiate closely related products in a product class (1994, p. 125)." This technique gets at a value of a characteristic indirectly

by estimating implicit prices. Using this method, Palmquist et al. (1995), Abeles-Allison and Connor (1990), and the Taff et al. (1996) studies were not able to investigate whether the food consumer would actually be willing to pay to alleviate the livestock odor problem. They just show the effect livestock odor has on nearby property values. Hence, there is a further need for a study that obtains values on what consumers' indicate they would pay for a reduction in livestock odors.

Experimental Economics and the Measure of Willingness-to-Pay

Much of the literature and studies that have been done on willingness-to-pay for surface and ground water impacts have utilized CVM with mail surveys. While mail surveys represent a cost-effective method of obtaining willingness-to-pay information, they provide limited incentive for respondents to truthfully reveal their valuation of a good. Whitehead and Van Houtven discuss three limitations of the CVM approach (1997). The first limitation of CVM is that it can be tainted by strategic bias. Strategic bias occurs when respondents overstate or understate their true willingness-to-pay because they perceive that their answer will influence policy. The second limitation arises because CVM studies can be very sensitive to the various methods for eliciting values, e.g., using an open-ended question versus a close-ended question. The third limitation of the CVM comes from the hypothetical nature of the questions asked which may cast doubts on the reliability of the values generated.

Experimental economics, on the other hand, provides more incentive for the participants to reveal their true value for a good. Fox et al. state "the non-hypothetical experimental method provides a more accurate and reliable estimate of economic value than traditional survey techniques (1995, p. 1048)." It uses real money, real goods, and real

auctions (Fox et al. 1996). Hence, it provides more incentive for participants in the study to reveal their preferences truthfully compared to typical CVM studies.

There can be a large benefit to using experiments to discover willingness-to-pay. Within an experiment a researcher can control the parameters which go into the experiment and the participant decisions can be observed (Davis and Holt 1993). Experimental economics allows the researcher to provide information and observe how it affects the outcome. The XCVM method is a very controlled environment, whereas CVM using mail surveys leaves many unanswered questions.

When valuing willingness-to-pay it has been argued that the second-price sealed-bid auction is one of the most efficient methods of gaining a consumer's value of a good (Shogren et al. 1994a). The second-price sealed-bid auction is conducted as follows. A group of participants (consumers) are allowed to bid on a good(s). The highest bidder for the good is obligated to buy the good at the second highest bid price. The dominant strategy in this auction setting is for participants to reveal their true willingness-to-pay (Hoffman et al. 1993, Menkhaus et al. 1992). The robustness of this auction method is shown in Shogren et al. (1994a). Their results "suggest that the revealed preferences for low-probability risk reductions are relatively robust to variations in the Vickrey auction. While this does not prove that subjects revealed their true preferences, it does suggest that the bids were not particularly susceptible to refined changes in the set of market prices (1994a, p. 1094)."

There have been multiple studies that have used experimental economics, specifically auctions, to obtain consumers' willingness-to-pay for attributes related to products. This method has been used to elicit values for food safety attributes in selected food products (Fox, 1993; Fox et al., 1995; Fox et al., 1996; Hayes et al. 1996; Roosen et al. 1998), quality

differences in food products (Melton et al. 1996a, 1996b), and packaging of food products (Hoffman et al. 1993; Menkhaus et al. 1992). Fox et al. went one step further and used experimental techniques to calibrate contingent values from a CVM study (1998).

Hoffman et al. (1993) and Menkhaus et al. (1992) have used experimental auctions to investigate whether people have a preference on how their meat products are packaged. Specifically, they test whether there is a difference in willingness-to-pay for packages of steaks placed in a traditional over-wrapped styrofoam tray versus steaks that are vacuum-skin packaged. Packaging can be an important attribute related to a product because it can affect the visual appeal of the good. To obtain these values, they use a fifth-price, sealed bid auction. [1]

There are a few major findings in Hoffman et al. (1993) and Menkhaus et al. (1992) that are of interest. First, they found that with no information, the bids for the steaks in the styrofoam packaging were not significantly different from the bid for the steaks in the vacuum-skin packaging. Once information was released about the benefits of vacuum-skin packaging, the bids for the steaks in the vacuum-skin, as well as the styrofoam packaging, were significantly higher than in the no information case. Releasing information also caused the bids for the steaks in the vacuum skin packaging to be significantly greater than the bids for the steaks in the styrofoam packaging (Hoffman et al. 1993). When regressing the dependent variable (difference in bids for the two different packages of steaks) on the independent variables (demographic characteristics), they found that most of the demographic variables "were not particularly important explanators (Menkhaus 1993, p.

[1] A fifth-price, sealed-bid auction is where the four highest bidders purchase the good they bid on at the fifth highest price. This auction has the same demand revealing properties as the second-price, sealed-bid auction.

51)." Only income, number of people in household, and employment were significant factors (Menkhaus et al. 1992).

Rather than investigating attributes that are not embedded in the product, Melton et al. studied the effects physical attributes have on consumers' willingness-to-pay for a pork product (1996a, 1996b). They used a second-price, ascending bid auction to investigate pork chop characteristics such as color, marbling, and size. This auction method works much like the second-price, sealed-bid auction. The only difference is that there are successive rounds where bids must stay the same or be increased. In their study, they presented these pork chop characteristics three ways—appearance by photograph, appearance by visual inspection, and appearance after a taste test of similar chops.

There are three major results of the Melton et al. paper (1996b). The first result is that the level of physical attributes embodied in pork chops does matter. Secondly, appearance and taste are not equally good sources of information for evaluating pork chop characteristics. Third, consumers are not consistent in their preferences for fresh pork chops. The method used to convey information does matter. Melton et al. conclude that consumers are able to "distinguish and value subtle differences in the attributes of a fresh food product, such as pork chops (1996b, p. 923)." In the Melton et al. paper, standard regression analysis is used to investigate the relationship between bid prices for pork chops and demographic characteristics and physical attributes (1996a). After the taste test for the pork chops, they found that women, households with children, and multi-income households tend to bid less for the pork chops. Furthermore, age, education, and household size reduce prices bid for chops, while household income was positively related to chop bid prices.

Ecolabeling

Researchers in the third area, ecolabeling, examined firms which engage in environmentally friendly practices and then inform the public through advertising and or product labeling. Bagnoli and Watts cite many examples of ecolabeling; including the recent shift to selling dolphin-safe tuna (1996). Another example pertains to the use of recycled materials in packaging or in the product itself, e.g., recycled paper. A third class of examples is the production and sale of cruelty-free products. Each of these examples carries one particular common denominator; these attributes have no physical effect on the product's characteristics. This in turn has led to the production of a public good by the market without involving government intervention, such as regulations or taxation. This public good provided by the market relates to the environment.

There are five primary papers that pertain to ecolabeling. Two of the papers, one by Bagnoli and Watts (1996) and one by Kirchhoff (1996), deal with a more theoretical view of ecolabeling. The third paper by van Ravenswaay develops the current situation with ecolabeling and some possible problems and policy issues related to products with environmental attributes (1996). The fourth paper by Nimon and Beghin (1997) and the fifth paper by Teisl et al. (1999) evaluate consumers' willingness-to-pay premiums for products with embedded environmental attributes.

Bagnoli and Watts provide a basic overview of ecolabeling (1996). They also set up a theoretical model that shows how effective ecolabeling can be in using the market to provide a public good such as environmental protection and sustainability. Their model incorporates a Bertrand and a Cournot economic setting. In the Cournot setting, the firm selects the amount of good it wants to sell and allows the market to dictate the price; while,

in the Bertrand setting, the firm sets the price and lets the market dictate the quantity sold. Furthermore, they test this theoretical model in both the Cournot and Bertrand settings using an experimental economic environment. Bagnoli and Watts found from their experiments that firms would have an incentive to produce some of the public good, i.e., the environmental good, but not necessarily the most efficient level (1996).

The second theoretical paper is by Kirchhoff (1996). She presents a model in which a monopoly over-complies with legal environmental standards under asymmetric information. She cites findings by Salop and Scheffman (1983) which have shown that "a firm might rationally want stricter regulations if complying with them is relatively costlier for its competitors (1996, p. 3)." Kirchhoff further cites a poll by Greenberg/Lake which has found that: "In the United States, 83 percent of consumers in a 1993 poll stated that they were willing to pay more for environmentally sound products (1996, p. 3)." Hence she is making the argument that firms will sell goods with environmental attributes to gain the premium that people would pay for those attributes. Furthermore, she believes that a firm would seek out a third-party labeling system to assist in the validity of the environmental attributes. This third party would provide credibility to the product sold.

Having cited some evidence that this is actually going on in the United States, Kirchhoff lays out a theoretical model to explain why this might be true (1996). She states that "voluntary over-compliance is shown to be more likely when quality premia are relatively high, cost differences are relatively low, and the probability of cheating being discovered is sufficiently high" (1996, p. 19). Hence her major conclusion is that if there were a large enough premium to be gained in producing a good with environmental

attributes, then the firm would have an incentive to produce and market that good with those attributes.

This theoretical view of Bagnoli and Watts (1996) and Kirchhoff (1996) has been substantiated in the real world by van Ravenswaay (1996). She states that "over the last decade, a growing number of consumers have been demanding more environmentally friendly products, and manufacturers have been meeting that demand by voluntarily including a growing number of environmental claims on their product label (1996, p. 1)." She further cites that more than 20 countries have developed ecolabeling programs. These countries have come together to form an international organization to facilitate harmonization of product claims across different participating programs all over the world.

In her paper, van Ravenswaay also looks at two major controversies that arise with ecolabeling and discusses the policy implications that arise from it (1996). The first controversy she discusses pertains to the potential for consumer deception. She discusses potential difficulties in substantiating environmental claims of being "environmentally friendly." Hence she cites the key issue in this controversy is what types of environmental labels are and are not deceptive.

The second controversy van Ravenswaay introduces is whether environmental labels should also serve environmental objectives (1996). Thus, the label should not only be truthful, but it should reduce the environmental impact of consumption. This implies that even though the claims on the label may be true, the claims can not come from increasing some other environmental impact that more than offset the original impact. For example, if a firm claims to reduce the impact of production on water pollution, it cannot at the same time

increase its impact in another environmental area such as odor that more than offsets the original impact. Hence, the claim must have a positive net return to environmental impacts.

More firms are adopting ecolabeling to gain an advantage over their competitors while meeting the changing demands of consumers. This, in turn, will lead more firms to adopt ecolabeling methods with this approach as a method of removing or improving competitiveness. The market can provide a public good, that of environmental sustainability, with little or no government intervention. This has been verified in an area closely related to ecolabeling. This area is nutritional and food safety product labeling. Caswell and Mojduszka study how information labeling of nutritional and food safety attributes can effect the market demand of a product (1996). They cite evidence that information labeling does have a positive influence on demand. Since information labeling can affect consumer demand, the focus of their paper is on the economic rationales for labeling policies and issues related to how the success or failure of these policies should be judged.

Caswell and Mojduszka (1996) cite some of the same problems of information labeling of food safety and nutritional attributes that van Ravenswaay (1996) has espoused with ecolabeling. In many aspects they are the same. A major difference between ecolabeling and information labeling of food safety and nutritional attributes is that the former deals with nonuse values and the latter pertains to use value. Nonuse values are values that are independent of people's present use. Whereas, use values are values that are directly related to present consumption (Freeman 1994).

Nimon and Beghin investigate whether consumers pay a premium for environmental attributes embedded in clothing (1997). The specific attributes they looked at were organic cotton and environmental-friendly dyes. Using a hedonic price function, they found that

consumers paid a premium for organic cotton. On the other hand, they found no evidence that consumers paid a premium for environmentally friendly dyes. Hence their paper suggest that certain environmental attributes may receive a premium while others do not.

Along the same line as Nimon and Beghin (1997), Teisl et al. investigated the effect ecolabeling has on tuna with the attribute that it was caught with nets that are safe to dolphins (1999). Their goal was to measure the effectiveness of dolphin-safe labeling of canned tuna. They used a product expenditure approach to show that dolphin-safe labeling, i.e., ecolabeling, affected consumer behavior. This labeling caused tuna to gain market share over substitute products. While they were able to show that ecolabeling tuna as dolphin-safe had an effect on market share, they were not able to deduce what the value of that ecolabel was. Hence, they were not able to get at willingness-to-pay for dolphin-safe tuna.

The Public Good Nature of Environmental Attributes

Any product that has embedded environmental attributes is going to have a public good nature to it. Public goods tend to have two major properties related to them. The first property relates to the nonrivalry aspect of a public good. A good is said to be nonrival if the good can be consumed by an individual without detracting from another person's consumption of that good. The second property that relates to public goods is the idea of nonexcludability. A nonexcludable good is a good that can not be costlessly withheld from others once it is provided. (Cornes and Sandler 1996) A product that has embedded environmental attributes, such as the one being studied in this dissertation, tends to have a public good nature to it because, once produced, its benefits cannot be excluded from others and is nonrival.

There is a vast literature on the nature of public goods. One major area of this literature that pertains directly to this dissertation is the free-riding literature. This literature stems from an inherent problem that arises due to the two major attributes of public goods—nonrivalry and nonexcludability. Free-riding as it relates to provision of public goods is when people underrepresent their true benefits from the public good to avoid having to pay for the total benefits they receive from that provision. Hence free-riding tends to lead to the underprovision of public goods. In its extreme, free-riding would lead to no provision of the public good.

Much research has been done in the area of free-riding as it relates to the provision of a public good in an experimental setting. One of the first papers to look at this issue was done by Marwell and Ames (1979). They designed an experiment to test whether people truly free-ride when giving to the provision of a public good. In their research they found approximately fifty-seven percent of the available resources went to the provision of the public good. Strong free-riding tendencies of the participants would have predicted that this number would have been closer to zero. Hence, Marwell and Ames were able to show that while there was an underprovision of the public good in their experiment, there were still a substantial amount of resources given by the participants towards a public good (1979).

Marwell and Ames investigated provision of the public good in a one-shot setting (1979). They received criticism of their work because they did not investigate what would happen to provision to the public good over time. Isaac et al. (1985) built upon Marwell and Ames' work (1979) by adding repetition to the experimental process. Isaac et al. had the participants in their study give to the public good many times within one experiment. They found that in the first round their results were much the same as Marwell and Ames. But,

they further found with repetition that there was a tendency of the participants to give less to the public good in later rounds. Hence, they found that with repetition there was a significant underprovision of the public good within the experimental setting.

The two studies above show that with less experienced participants there is a tendency for them to give to the public good. But with repetition, it was also found that provision of the public good declines. Neither of these studies systematically looked at the free-riding principle. The first group of researchers to take a systematic investigation of what causes free riding was Isaac, Walker, and Thomas (1984). In Isaac et al., they systematically investigated how repetition, group size, and pay-off to providing the public good affects participants contribution levels to the public good (1984). They found three major results. First, having a higher pay-off to the provision of the public good leads to higher contribution levels. Obviously, if the return from the provision of the public good is high, participants will tend to give more to the public good. Second, they found that experience does matter. In their study, the more experienced participants tended to give less to the provision of the public good. Third, they found that group size had a positive correlation with contribution to the public good, i.e., as group size increased, the contribution to the public good increased.

While many researchers have investigated within an experimental setting the provision of public goods, there has been no definitive research which shows why people give the amount they do. In public good experiments, some participants give to the public good while others do not. The free-riding problem can be prevalent, i.e., underprovision of the public good, but not to the extent that theory would suggest (Davis and Holt). It should be noted that all of the studies looked at public goods in a very abstract manner, i.e., the public good was a pot of money. No research has been done in an experimental setting

testing how people would give to an actual public good, e.g., a park bench, environment, etc., that is not related to the participants within the respective studies. One part of this dissertation investigates this issue.

CHAPTER THREE: INTERPRETING PRICES FROM A VICKREY AUCTION WHEN THE OBJECT HAS ENVIRONMENTAL ATTRIBUTES

This chapter examines consumer behavior in a second-price sealed-bid auction with products having different environmental quality attributes. A unique feature of this model is that it describes consumer behavior with different information sets. From this model, a demonstration will be given on how to derive consumers willingness-to-pay for embedded environmental attributes through the consumer's behavioral choice using a second-price sealed-bid auction. It will be shown that if free-riding exists, then prices from the second-price auction cannot be interpreted as the consumer's true valuation of the product being sold. Furthermore this chapter will show how prices for products with embedded environmental attributes from a second-price sealed-bid auction can be interpreted.

In this chapter it will also be shown that in an auction setting with different information sets, willingness-to-pay can be derived in at least two ways. One way relates to comparing a typical good to one that has an environmental improvement over the typical good in the same round. This willingness-to-pay measure assures that the expectation of the environmental attributes for the consumer is known, but it does not directly account for any visual nonenvironmental quality differences between the two products being considered. Another way to look at consumer's willingness-to-pay is to observe it for similar products with different information sets. This allows for the visual attributes of the product to remain constant, but there is no ex ante information on the consumer's prior expectation of embedded environmental attributes. It should be noted that, ex post, these expectations could be inferred.

Auctions

McAfee and McMillan define an auction as a "market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from the market participants." (1987, p. 701) Over the centuries, auctions have been used to establish value for many different kinds of commodities. Some of these commodities include plundered booty from the people who were conquered by the Roman Empire, federal land, artwork, timber rights, stamps, and wine. The four most common auctions are the English auction, the Dutch auction, the first-price sealed-bid auction, and the second-price sealed-bid auction. (Milgrom and Weber, 1982) [1]

In a typical English auction, an auctioneer starts the bidding sequence at a low price and steadily increases the price for the item until only one willing bidder remains. In this auction, everyone involved in the auction knows the number of active bidders and the current bid price at any point in time in the auction. While the English auction starts at a low price and increases, the Dutch auction starts at a high price that decreases. The price in this auction decreases until some bidder stops the auction at an acceptable price and claims the item for the price at which the auction stopped. The Dutch auction is used to sell flowers in Holland. In the first-price sealed-bid auction, each bidder submits a bid to the auctioneer which is unknown to the other bidders.[2] In this auction, the highest bidder claims the object being auctioned at the price she bid. In the second-price sealed-bid auction, each bidder also submits a bid to the auctioneer which is unknown to other bidders. The difference between a

[1] For an in-depth discussion on each of these auction mechanism see: Milgrom and Weber; 1982, McAfee and McMillan, 1987; and Milgrom, 1989; Vickrey, 1961.
[2] A sealed-bid auction is an auction where each bidder submits a bid to the auctioneer which is unknown to the other bidders. Only the auctioneer knows who submitted a particular bid.

first-price and a second-price auction is that in a second-price auction the highest bidder claims the object being auctioned at the second highest bid.

In 1961, William Vickrey laid the foundations for the study of auctions (1961). He investigated the four auctions mentioned above under what is now considered the benchmark model for studying auctions. In his paper he investigated these four auctions under six basic assumptions. One basic assumption Vickrey used for studying auctions was that the bidders in the auction are risk neutral. Another assumption Vickrey made was that the bidders were symmetric. Bidders are said to be symmetric when they draw their valuations from the same probability distribution. Symmetry also requires that bidders who draw the same valuation give identical bids. A third assumption made by Vickrey is that there is no collusion among the bidders. The fourth assumption is that payment is a function of the bids alone. This implies that there are no reservation values of the auctioneer or initial payments to the auctioneer to enter the auction.[3] No initial payment implies that anyone can participate in the auction without paying a fee to the auctioneer. An implicit fifth assumption Vickrey made was that bidders have expected utility maximizing behavior.[4] The sixth assumption in Vickrey's investigation is that the independent-private-values assumption applies. Under this assumption, each bidder is assumed to know her exact valuation of the good she is bidding on, while not knowing anyone else's valuation. Also, the bidder perceives the value of any other bidder as a random draw from some probability distribution where the value of other bidder's is statistically independent from her own.

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[3] A reserve price is the minimum price set by the auctioneer at which she will sell the item being auctioned. If the highest bidder's bid is below the reserve price, the item being auctioned will not be sold.

[4] This specific assumption was not given in Vickrey's 1961 paper explicitly. Karni and Safra (1986, 1989) demonstrated that Vickrey needed to assume that the bidders are expected utility maximizing agents to make some of his arguments.

Under these six assumptions, which will be referred to as the benchmark model of assumptions, Vickrey was able to demonstrate some remarkable findings through argumentation. One of these findings is that the Dutch auction and the first-price auction are strategically equivalent. Strategic equivalence implies that the sets of strategies and their mapping to outcomes are identical for both auctions. Another finding of Vickrey was that the English auction and the second-price sealed-bid auction both have a dominant strategy equilibrium of revealing one's true valuation.[5] A dominant strategy is a strategy such that no other strategy is better than it is. A third finding by Vickrey is that the English auction and the second-price sealed-bid auction are Pareto optimal in the sense that the bidder with the highest valuation wins the object. The most remarkable finding in Vickrey's paper relates to expected revenue of the auctions. He conjectured that the four typical auctions described above with the same benchmark assumptions would generate on average the same revenue to the seller.[6] This would imply that from the point of view of the seller, it would not matter which auction mechanism was utilized to sell an object.[7]

Of the four auctions mentioned above, two stand out as better mechanisms for gathering consumer's willingness-to-pay for embedded environmental attributes. These two auctions are the second-price sealed-bid auction and the English auction. The reason these two auctions stand out is because under the benchmark assumptions, they both have as

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[5] Karni and Safra showed that to obtain this result it is necessary to assume that bidders follow expected utility maximizing behavior (1989). To prove that true value revelation is a dominant strategy in a second-price sealed-bid auction it is a necessary and sufficient condition for the bidders to have expected utility maximizing behavior. Karni and Safra (1986) also showed that the existence of a dominant strategy of truth revelation does not imply utility maximizing behavior for the second-price auction.

[6] This is known as the Revenue Equivalence Theorem. For a discussion of why this is true, see McAfee and McMillan (1987).

[7] It should be noted that while the four auctions under the benchmark assumptions have the same expected revenue, this does not imply that they have the same variance.

dominant strategies truthful revelation of the bidders' preferences. Theoretically, in the Dutch auction and the first-price sealed-bid auction, it is in the interest of the bidders to bid a value below their true valuation. The amount each bidder shaves her bid from her true valuation will depend upon the probability distribution of the other bidders' valuations and the number of competing bidders (McAfee and McMillan, 1987).

Truthful Revelation Property of the Second-Price Sealed-Bid Auction

Before consumer behavior can be understood in a second-price sealed-bid auction where the product has embedded environmental attributes, a major characteristic of the auction must be discussed. A major characteristic of the single-unit second-price sealed-bid auction is that it requires the top bidder to purchase the object being bid upon at the second highest bid price. This feature of the auction ensures that each participant will bid his/her true willingness to pay for the product being auctioned, i.e., each participant's true valuation (Vickrey 1961). The reason this holds true is because in a game theoretic setting it is the bidder's weakly dominant strategy to bid his/her true value.[8] This true valuation can be defined as the maximum income that the bidder would be willing to give up to obtain the product. The bidder's utility in this situation is equal to the bidder's utility when she has her full amount of income and no product.

To see why the second-price sealed-bid auction gives the true willingness-to-pay for an object, the following standard argument from the literature is presented (Vickrey 1961; McAfee and McMillan 1987, Karni and Safra 1989). Suppose there are N bidders where bidder i, i = 1, 2, ... , N, gives a bid of b_i for an object and has a true valuation of v_i for that

[8] A weakly dominant strategy is a strategy such that no other strategy is strictly better than it is. In this case, some strategies may be equally good, but not necessarily for all cases.

object. It is also assumed that the benchmark model set of assumption explained above holds true for each bidder—the bidders are risk neutral expected utility maximizers, there is no collusion among the bidders, the independent-private-values assumption holds, the bidders are symmetric, and the bidders payment is a function of their bids alone. Let W be the maximum bid of all other bidders excluding bidder i. Without loss of generality, assume that if bidder i does not purchase the object her utility level is 0. Also assume that if she does purchase the good her utility is equal to her true valuation minus the second highest bid. Hence, if her true valuation is greater than the second highest bid she obtains a positive utility from purchasing the good.

There are two general scenarios that must be investigated. The first scenario is when bidder i bids higher than her true valuation, i.e., $b_i > v_i$. In this first scenario, suppose that $W \geq b_i$. This would imply that bidder i receives 0 utility whether she bids her true valuation or not because she is not the highest bidder. Now suppose that $W \leq v_i < bi$. In this case bidder i obtains utility level $v_i - W$, which she would have obtained by bidding her true valuation v_i. Suppose that the maximum bid from all other participants is greater than the true valuation of bidder i but less than the bid given by bidder i, i.e., $v_i < W < b_i$. This would imply that the utility of bidder i is equal to $v_i - W$, which is obviously a negative number. In this situation, it would have been better for bidder i to bid her true valuation v_i and obtain a utility level of 0. Hence, it has been shown that bidder i would have done no worse by bidding her true valuation and in some cases would have been better off.

The second scenario that needs to be investigated is when bidder i bids less than her true valuation, i.e., $b_i < v_i$. In this situation, when bidder i bids greater than or equal to the maximum of the other bidders, i.e., $b_i \geq W$, she receives a utility level of $v_i - W$, which is a

positive level. Bidder i, in this case, would have received the same utility level if she bid her true valuation. If the true valuation of bidder i is less than or equal to the maximum bid of all the other individuals, i.e., $W \geq v_i$, then she received 0 utility. In this case, she could receive the same utility level by bidding her true valuation because she will never be the highest bidder. Finally, if the bid of bidder i is strictly less than the maximum bid of the other individuals, which is strictly less than the true valuation of bidder i, i.e., $v_i \geq W > b_i$, then bidder i foregoes a positive utility level by under bidding. In this case it would have been in the best interest of bidder i to bid her true valuation. Hence, it has been shown under this second scenario that bidder i would have done no worse by bidding her true valuation and in some cases would have been better off.

Two major implications of the Vickrey auction can be drawn from the above discussion. The first implication is that the second-price sealed-bid auction has the property of optimizing individuals revealing their true preferences in a noncooperative game theoretic setting. The second implication is that this auction mechanism divorces the bidders from strategic interaction, i.e., the bidders do not base their bids on what they believe the other bidders are doing. This can be seen from the fact that probabilities were not utilized in the argument above.[9] These implications will be important when looking at willingness-to-pay for environmental attributes and consumer behavior.

[9] Implicitly, the bidder increases her probability of being the highest bidder by increasing her bid, but this does not increase her gains (utility) compared to bidding her true valuation. The assumption that relates to probability structures in the benchmark model of assumptions is used to prove revenue equivalence among the four auctions. This assumption is not necessary when establishing the dominant strategy of the second-price auction.

Second-Price Auction Research

Since Vickrey's seminal paper, there has been much research done in the area of auctions. Much of this research has focused on the seller's side of the auction and usually consists of optimal auction theorems or comparing different auctions in the areas of revenue generation and equivalence (Matthews, 1987). The literature on optimal auction theorems attempts to characterize auctions which optimize seller's revenue given a particular set of assumptions. In the literature related to revenue generation, auctions are ranked by the amount of money each generates to the seller using a particular set of assumptions. The revenue equivalence literature investigates what assumptions are required for a set of auctions to generate equivalent expected revenue.

In the benchmark model, the most fundamental assumption that is studied in the second-price auction literature is related to the differences among the bidders' valuations of the item. There are two extreme assumptions that can be made about the bidders' valuations (McAfee and McMillan 1987). The first extreme is known as the independent-private-values assumption. Under this assumption, each bidder is assumed to know exactly her true value of the item being auctioned. She does not know any other bidder's value of the item; rather, she perceives any other bidder's value as a random draw from some probability distribution. This value is independent of any other bidder's value. The common-value assumption is the converse of the independent-private-values assumption. Under the common-value assumption, the object being auctioned has a single objective value which is unknown to the bidders. This implies that every bidder has the same valuation of the product being auctioned, but they do not know with certainty what that valuation is. Hence, each bidder draws her valuation from the same distribution as the other bidders given this single objective

value. An example of this type of item being auctioned would be a tract of oil lying beneath the ground.

When valuing embedded environmental attributes, it is more appropriate to use the independent-private-values assumption. This assumption allows the bidders to value environmental attributes differently, i.e., the utility derived from environmental attributes can be different for different bidders. The common-value assumption requires that the bidders have the same value for environmental attributes.

Within the theoretical literature related to second-price sealed-bid auctions using the independent-private-values assumption there are three major areas that are studied which relax the assumptions of Vickrey's seminal paper. The first set of papers examines collusion in a second-price auction. Second-price auctions when more than one item is sold are examined in the second set of papers. The third set of papers examines bidder's risk behavior, conjectures, and behavior without expected utility.

There are three major papers that study collusion in a second-price auction with the independent-private-values assumption. One paper examines why the second-price auction has a tendency of facilitating collusion among bidders compared to other auction methods (von Ungern-Sternberg 1988). The two other papers that study collusion examine mechanisms for maintaining collusion in a second-price auction (Graham and Marshall 1987; Mailath and Zemsky 1991).

von Ungern-Sternberg studies why a second-price auction is a better facilitator of collusive behavior than the other auctions, i.e., first-price, Dutch, and English auctions, by modeling the collusive behavior in a second-price auction as a cartel (1988). This cartel designates who the high bidder will be for any particular auction. The bidders that are not

designated the high bidder must submit a predetermined bid set by the cartel. He argues that since the highest bidder only has to pay the second highest bid in a second-price auction, collusion can be maintained in this type of auction by having the designated high bidder submit a bid exorbitantly higher than the highest valuation of the other members of the collusive group. When bidders exist outside the cartel, von Ungern-Sternberg argues that the designated highest bidder from the cartel will still submit a bid higher than his valuation if he believes it will encourage cartel discipline. He further argues that collusion in the second-price auction is even more pronounced when the bidders repeatedly interact with each other in other second-price auctions.

Graham and Marshall study collusion and the auctioneer's best response to collusion in the second-price auction with ex ante homogeneous bidders (1987). In their model, they have an outside agent which coordinates the collusion of a subset of bidders. This agent operates an incentive compatible mechanism prior to the actual auction, known as a preauction knockout, to implement efficient collusion among any subset of bidders. Collusive behavior in Graham and Marshall's model is maintained by the outside agent offering side payments to the collusive bidders. Except for the designated high bidder from the preauction knockout, the rest of the members of the collusive group submit a bid less than their true valuation in the second-price auction. From their model, Graham and Marshall show that coalitions among a subset of bidders in the actual auction is possible and that gains to the coalition are increasing in the size of the coalition. They also showed that the optimal response of the auctioneer is to develop a reserve price that is a function of the coalition's size.

Mailath and Zemsky (1991) take the work of Graham and Marshall (1987) one step further by studying collusion with ex ante heterogeneous bidders. Mailath and Zemsky were able to show that a mechanism exists to obtain an ex post budget balancing efficient collusion in a second-price auction.[10] In Graham and Marshall's work, their mechanism was ex ante budget balancing, not necessarily ex post budget balancing. To obtain efficient collusion, Mailath and Zemsky show that each bidder's net payoff from participating in the coalition is a constant, which is independent of her valuation.[11] They also show that the collusive surplus can always be allocated in such a way that every subset of bidders will always wish to participate in the coalition.

In the independent-private-values setting, there are two major papers that examine issues related to selling multiple objects in a second-price auction. The first paper examines the auctioneer's choice of whether to sell multiple objects in multiple single unit auctions or to group the items into one single unit auction (Chakraborty 1999).[12] The second paper studies the properties of selling multiple objects in multiple sequential auctions when the bidders have diminishing marginal valuations of the items being sold (Katzman 1999).

In the context of a second-price auction, Chakraborty investigates under what conditions an auctioneer would want to sell multiple objects in multiple auctions versus selling the multiple objects in one bundle in a single auction (1999). In his model, he assumes that the bidders employ the same strategies whether they face a single auction or multiple auctions and that the values of the multiple objects are additive. Without proof, he

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[10] Budget balancing is said to exist when the summation of the side payments are less than or equal to zero.
[11] The net payoff of the bidder is defined as the difference between the expected payoff when colluding and the payoff when not colluding.
[12] Note that in a single unit auction only an item or a group of items are sold as one unit.

states that "it is the dominant strategy for each bidder to bid his true valuation for the objects when the objects are sold simultaneously or sequentially through Vickrey auctions (1999, p. 725)." In essence, he has assumed away any wealth effects that might occur in the multiple auction setting due to a buyer having obtained an item in a previous auction.[13] By assuming away wealth effects, he is implicitly assuming that there is no complementarity or substitutability between the products being auctioned. The major result that Chakraborty found was the existence of a unique critical number of bidders for each set of objects being auctioned such that the seller prefers to bundle the objects when there are fewer bidders than the critical value. When there are more bidders than the critical number of bidders, the seller prefers to sell the objects in separate auctions. Furthermore, he was able to show that this property still holds even when the valuations for the objects are correlated for a given bidder.

In the complicated world of multi-unit demands, Katzman studies behavior in a second-price auction with diminishing marginal valuations (1999). To make the problem tractable he uses the most simplistic model he can. He assumes that there are two bidders and a sequence of two auctions. Within this setting, Katzman studies the behavior of bidders when there is complete and incomplete information sets. Katzman examines four situations that could occur with complete information. He shows that in a few situations bidders reveal their true valuation of the item being auctioned, but in most situations they do not. Price sequences tend to be constant or decreasing in the complete information setting and there is the possibility for inefficient allocations.[14] Bidding behavior is quite different in the incomplete information setting. In the first sequence of bidding, both bidders shave their

[13] Wealth effects are when participants change their bids because they won an earlier trial (Fox et al. 1995). See Davis and Holt (1993) for a discussion of wealth effects in experimental markets.
[14] Inefficiency in this context implies that the bidder with the highest valuation does not obtain the item.

high valuations when bidding. In the final auction, bidders bid their true valuations. Thus, in the incomplete world, there are efficient allocations of the item being auctioned.

There are five main papers that are related to bidders' conjectures and risk attitudes in the second-price auction with the independent-private-values assumption. A paper by Rothkopf et al. studies the question why Vickrey auctions are rarely used in the real world setting (1990). Two papers examine the implications from the buyers and seller's point of view when bidders are risk averse (Matthews 1987; Smith and Levin 1996). Neilson examines second-price auctions when the bidders are not expected utility maximizers (1994), while Lo examines uncertainty averse bidders (1998).

With revenue equivalence of the four auctions and the truthful revelation property of the Vickrey auction using the benchmark model, Rothkopf et al. ask the question of why the Vickrey auction is seldom used in practice (1990). To answer this question, they examine seven possible reasons, five of which have been examined by other authors, why the Vickrey auction is rarely used. From the standpoint of Rothkopf et al. there are five inadequate reasons for the rarity of the second-price auction studied in the literature. These reasons are: 1) many auctions sell multiple objects for sale, 2) bidder risk aversion, 3) bidder asymmetry, 4) non-independent values, i.e., the common-value assumption, and 5) inertia.[15] Two reasons that were not examined in the literature prior to Rothkopf et al. are strictly related to the bidders. These authors argue that one of the major reasons why second-price auctions are rare is because the bidders fear bid takers might cheat them. A second reason, which the authors argue is an even more plausible reason, is that bidders have a resistance to truth-

[15] Inertia is the argument that the second-price auction is not used because bidders have become accustomed to other auction methods.

revealing strategies. In this first case, the authors argue that in a Vickrey auction, it would be lucrative for the auctioneer to place a phony bid higher than the actual second highest bid to capture the surplus that is given to the highest bidder due to the nature of the auction.[16] In an English auction where everyone at every point in time sees the bids in the auction, this phony bid is not as big of a problem. In the second case, the authors argue that bidders are conditioned not to give their true valuations because of later interactions with other bidders. Bidders may fear that revealing their true valuation in a particular auction may harm them in future auctions.

When examining the second-price auction within the context of the independent-private-values assumption, the predominant emphasis of the literature has been placed on the seller's point of view. To counter this bias, Matthews investigates second-price auctions from the point of view of the buyer (1987). Specifically, he studies which auctions the buyers would prefer when each bidder is risk averse. He examines three different auctions—the first price auction, the second-price auction, and the first price auction when the number of bidders is revealed—where bidders exhibit decreasing (DARA), constant (CARA), or increasing (IARA) absolute risk aversion.[17] One of the major findings of Matthews is that with no reserve price, it is the dominant strategy to reveal one's true valuation under all three risk aversion states. Matthews is able to also show that when CARA holds, the bidders are

[16] The surplus that goes to the bidder is the difference between the highest bid and the second highest bid. In a Vickrey auction, this surplus goes fully to the bidder.

[17] Matthews assumes that in the standard first-price and second-price auctions that the bidders do not know how many bidders there are in the auction. In the second-price auction it does not matter how many bidders there are from the point of view of the optimal strategy to use when bidding (1996). But, it will matter to the bidders in the first-price auction because they shave there bid from their true value based on the number of bidders in the auction.

indifferent between all three auctions. Under DARA, Matthews shows that the bidders prefer the second-price auction to the first price auction, while under IARA, it is the exact opposite.

Smith and Levin (1996) take Matthews (1987) research one step further. Rather than having a fixed number of bidders, Smith and Levin study the first-price and second-price auction when entry is endogenous under the three types of risk aversion. They are able to show that under IARA and CARA, that the results of Matthews remain robust with endogenous entry. However, under DARA, the ranking of the auctions can change with endogenous entry. Smith and Levin show that the reason the ranking can change with endogenous entry is because the first price auction "mechanism discourages entry to an extent that offsets its inherent tendency to stimulate more aggressive bidding (1996, p. 550)." Even with endogenous entry, it is still a dominant strategy for the bidders to reveal their true valuation in the second-price auction.

One of the assumptions made in the benchmark model is that the bidders in the auction must be expected utility maximizing agents. This necessary and sufficient condition was shown by Karni and Safra (1989). They showed that when this assumption is missing, i.e., when the bidder's preferences are represented by a non-expected utility functional, it is the dominant strategy of bidders to bid their certainty equivalence of the item. Building on Karni and Safra's work, Neilson investigates what happens to the results of the second price auction when expected utility fails (1994). Specifically, he examines what happens when the number of bidders change in the auction, what happens to the optimal reserve price set by the auctioneer, and what happens to revenue equivalence between the English and second-price auction. Neilson is able to show that when the number of bidders or the reserve price changes, the bids by the participants will change. He also shows that when expected utility

fails, the English auction and the second-price auction do not give the same expected revenue.

Another author who relaxes the expected utility assumption is Lo (1998). The focus of his paper is to study what happens to the first-price and second-price auction when bidders are uncertainty averse. Uncertainty aversion is a state when each bidder is unsure of the probability measures of the other bidders. While one of the main focuses of Lo's paper is to classify the equilibrium bidding strategies of the first price auction, he does state that the equilibrium bidding strategy for the second-price auction is still the dominant strategy of revealing one's true valuation. Under uncertainty aversion, Lo is able to show under certain conditions that the first-price auction Pareto dominates the second price auction.

When studying the literature related to the second-price sealed-bid auction using the independent-private-values assumption, three general results emerge. In all three papers pertaining to collusion in a second-price auction, it is clear that the bidders who participate in collusion and are not selected to be the winning bidder by the group have no incentive to reveal their true valuations. Hence, the first general result is that the property of truthful revelation of preferences breaks down when collusion exists. The second result is that the second-price auction from the point of view of the seller, when comparing it to other auctions, can be very sensitive to the assumptions made within the model. Excluding collusive behavior, the third result is that the dominant strategy of bidding one's true value is robust to change in the assumptions of bidders' behavior.

Interpreting the Bids from a Second-Price Auction when the Item Has Embedded Environmental Attributes

In the literature above, it was seen that the dominant strategy in a second-price sealed-bid auction is to bid one's true value for the item being auctioned. This result is very robust unless the bidder is not an expected utility maximizer or if collusion exists among the bidders. One of the implicit assumptions that was made to prove the dominant strategy in the second-price auction is that the item being auctioned is a purely private good with no public good attributes. When examining items with embedded environmental attributes, this implicit assumption does not hold. These items have a public good aspect to them. From chapter two, it is known that when public good attributes exist, there is a possibility of free-riding by consumers. This motivates the question as to how to interpret the bids from a second-price auction when some of the goods have embedded environmental attributes. To understand how to interpret bids in an auction when the item has embedded environmental attributes, an understanding of a bidder's valuation is necessary.

It shall be assumed that there are I bidders in a second-price sealed-bid auction bidding on one item which has embedded environmental attributes. Bidder i's, i = 1, 2, ..., I, true valuation of the product being auctioned is v_i. Bidder i's true valuation v_i is assumed to be the sum of three disjoint values, i.e., $v_i = v_{i1} + v_{i2} + v_{i3}$. v_{i1} is defined to be the maximum amount of money bidder i is willing to give up to obtain the physical attributes embodied in the product being auctioned. In the case of a pork chop, this value is derived from such physical attributes as tenderness, color, type of cut, marbling, etc. The second value, v_{i2}, is defined as the true value the bidder receives from being the one that contributes to the public good, i.e., it is the maximum amount of money the bidder is willing to give up

to provide to the public good no matter what other bidders do. This value could be derived from altruism or warm-glow altruism.[18] Altruism is where people give to a public good and receive utility from the consequences of their giving. Warm-glow altruism is where people receive satisfaction from the process of giving to the public good with no regard to the consequences of giving (Kotchen et al. 2000). For this value to exist, the bidder must be the one who obtains the item from the auction. v_{i3} can be viewed as the value one receives from the public good being provided by some other person. It is the maximum amount of money the bidder is willing to give to the public good, which does not overlap with v_{i2}, assuming that no other person is contributing to the public good. If other bidders are contributing to the public good, this value is going to be conditional on the other bidder's contribution. This value exists for each bidder no matter who provided the public good. Hence, this is a value where free-riding can occur. The distinction made between v_{i2} and v_{i3} is that v_{i2} is only realized if the bidder is the highest bidder, whereas, v_{i3} is realized no matter who is the highest bidder.

To interpret the bids from a second-price auction when the item has embedded environmental attributes, the same type of reasoning used to prove the pure private good case can be used, i.e., Vickrey's argument can be adapted to this situation. First of all, it shall be assumed that the assumptions of the benchmark model hold.[19] In the pure private good case, it was assumed without loss of generality that the utility of the bidder was 0 if she did not purchase the object. This is no longer the case with an item that has embedded environmental attributes. Even if bidder i does not purchase the good, she still obtains v_{i3}.

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[18] Altruism and warm-glow altruism have been studied by Andreoni (1988, 1990).
[19] Note that the assumption of bidders' being risk neutral can be weakened to risk averse.

This is because no matter who provides the public good, bidder i receives utility from the public good characteristic of the product being auctioned. Hence, as long as bidder i believes that someone will purchase the good with embedded environmental attributes, it will never be in the interest of the bidder i to incorporate v_{i3} into her bid function.[20] This implies that in a second-price auction it is not a dominant strategy for the bidder to reveal her true valuation of the item. To show this rigorously, a stronger statement will be proven. Under the assumptions of the benchmark model, when the item has embedded environmental attributes and the bidder has some free-riding tendencies, it shall be proven that the dominant strategy for each bidder is for her to bid a value equal to $v_{i12} = v_{i1} + v_{i2}$.

Define W as the maximum bid given by all bidders excluding bidder i. If bidder i is the highest bidder, then W is the second highest bid. Bidder i is assumed to have a true valuation of the product of v_i, where $v_i = v_{i1} + v_{i2} + v_{i3}$. Define V_i as the difference between bidder i's true valuation, v_i, and W. There are two scenarios, one with four cases and the other with three, that need to be examined to show that bidding v_{i12} is the dominant strategy.

The first scenario is when bidder i bids higher than v_{i12}, i.e., $b_i > v_{i12}$. In this first scenario, suppose that $W \geq b_i$. This would imply that bidder i receives a utility level of v_{i3} whether she bids v_{i12} or not because she is not the highest bidder. Suppose that the maximum bid from all other participants is greater than the true valuation of bidder i but less than the bid given by bidder i, i.e., $v_i < W < b_i$. This would imply that the utility of bidder i is equal to $V_i = v_i - W$, which is obviously a negative number. In this situation, it would have been better for bidder i to bid v_{i12} and obtain a utility level of v_{i3}. Under this situation, if the

[20] In auction setting, this belief is not unrealistic. Since the item being auctioned has already been produced, the environmental characteristics have already been provided. This being the case, bidder i can view v_{i3} as an initial endowment of utility which she does not have to pay for.

bidder bid her true valuation v_i, she would have obtained a positive utility of v_{i3}. Now suppose that $v_{i12} < W \leq v_i < bi$. In this case bidder i obtains utility level $V_i = v_i - W$. Since W is less than bidder i's true valuation v_i, then $V_i \geq 0$. While V_i is nonnegative in this case, this does not imply that bidding one's true valuation is a dominant strategy. Since W is greater than $v_{i1} + v_{i2}$, then the bidder would have done better off by bidding v_{i12}. By bidding v_{i12}, bidder i would have received utility level v_{i3}. In this case, $V_i = v_i - W \leq v_{i3}$. The final case in scenario one assumes that $W \leq v_{i12} < v_i < b_i$. While bidding b_i in this case gives the bidder a utility level greater than v_{i3}, the bidder could have done just as well by bidding v_{i12}. Hence, it has already been shown that it is not the bidder's dominant strategy to bid her true valuation. It has also been shown for scenario one that bidder i can do no better than bidding v_{i12}.

The second scenario that needs to be investigated is when bidder i bids less than v_{i12}, i.e., $b_i < v_{i12}$. In this situation, there are only three cases that need to be examined. In case one, assume that $W \geq v_{i12} > b_i$. Under this first case, bidder i could have received the same utility v_{i3} if she bid v_{i12}. Suppose that for case two, $v_{i12} \geq W > b_i$. By bidding below v_{i12}, bidder i obtains utility v_{i3}. Bidder i could have been better off had she bid v_{i12}, because V_i would have been equal to $v_i - W \geq v_i - v_{i12} \geq v_{i3}$. In this case, bidder i foregoes a greater utility level by under bidding. Finally for case three, suppose that $v_{i12} \geq b_i \geq W$. In this case, it would make no difference whether bidder i bid b_i or v_{i12}. Under each bid she would obtain the utility $V_i = v_i - W$. Hence, it has been shown under this second scenario that bidder i would have done no worse by bidding v_{i12} and in some cases would have been better off.

Coupling the results in scenario two with scenario one's results, it has been shown that bidding $v_{i12} = v_{i1} + v_{i2}$ is a dominant strategy for bidder i. The intuition behind this result is the following. Since v_{i3} represents the value of the public good, which the bidder gets even if she is not the highest bidder, it is not in her best interest to incorporate it into her bidding strategy. v_{i12} represents the value to the bidder only if she obtains the item being auctioned. Hence, if the bidder wants to maximize her probability of obtaining the largest surplus from the auction procedure, she should bid v_{i12}. It should be noted that if a person is a perfect free-rider and the product being auctioned has embedded environmental attributes, then the bid received in this auction would be equal to the bid received in a second-price auction when the item has no embedded environmental attributes.

It has been shown that in a second-price sealed-bid auction, only the private value v_{i12}, which is less than v_i when free-riding exists, is submitted as the bid. When environmental attributes exist or any other type of spillover effect, the second-price auction does not get at a bidder's true valuation.

Theoretical Base for Modeling Consumer Behavior with Differing Information Sets

It has just been shown how to interpret bids for a product with embedded environmental attributes from a second-price sealed-bid auction. The next step in understanding value in a multiple-round second-price auction with different information sets, is to understand the theoretical base of consumer behavior when different information sets exist. Teisl et al. provide this theoretical framework for handling consumer behavior when there are different information sets (1999).

In the paper by Teisl et al., they studied what effects dolphin-safe labeling had on the tuna industry (1999). To study this issue, they adopt a model proposed by Foster and Just

(1989) that takes into account when consumers have different information sets about the product. Their model starts with an indirect utility function that incorporates environmental assessments for a given set of products, a vector of other quality characteristics for those products, prices, and income. Specifically, they represent their indirect utility function as:

(3.1) $V^S = V(\mathbf{A}^S, \mathbf{q}, Y, \mathbf{p})$

where $\mathbf{A}^S$ = environmental assessments for m products given information set S,

$\mathbf{q}$ = vector of other quality characteristics,

Y = income,

$\mathbf{p}$ = a vector of prices for the m products.

They assume that this indirect utility function increases with quality characteristics and income, and decreases with prices.

To translate environmental information into an environmental assessment $\mathbf{A}^S$, Teisl et al. assume that the assessment function can be modeled as a household production process. This process takes into account the individual's environmental knowledge, cognitive abilities, time, and the environmental information presented at the time of purchase. They model this process as the following:

(3.2) $A^S_j = f(S_j, G, t_j; \theta)$.

In this process, A^S_j is the individual's subjective environmental assessment of purchasing good j given information set S. Note that A^S_j is an element in $\mathbf{A}^S$. S_j is the environmental information displayed about product j at the time of purchase. The consumer's prior stock of environmental information is represented by G. This would include any news accounts, advertising, word-of-mouth, or any other source of information previously obtained about the product. The time spent analyzing the environmental information about product j is denoted

by t_j. Finally, θ represents the objective levels of environmental impact from consumption of the products.

This model lays the foundations for thinking about how consumer's value is derived in a second-price sealed-bid auction with rounds having different information sets. Specifically, it incorporates different information sets into the standard consumer optimization problem. This model elaborates on what a bidder's true value v_i is dependent upon, i.e., v_i is dependent on income, prices, quality characteristics, information.

Deriving the Exogenous Factors of the Bid Function in a Multiple Round Vickrey Auction with Different Information

The standard utility maximization problem assumes that prices are fixed and consumers choose the quantity they want to consume. While this is the usual setting in which consumers make decisions, it is not necessarily indicative of how consumers make decisions in a multiple round second-price sealed-bid auction. In this auction setting, the consumers have a fixed quantity to consume and are allowed to submit bids. In this case, participants will set bids for the objects they are bidding upon at their true valuation for that product when there are no embedded environmental attributes and v_{i12}, which was explained above, when environmental attributes exist. This is the unique behavioral characteristic associated with the second-price auction and must be taken into consideration of the model. Another characteristic of this model is that different information sets can be used in the different rounds of bidding. This section sketches the exogenous factors that affect the bid function in a multiple round second-price auction with different information sets.

The utility function of a consumer can be modeled as having three different components. The first component relates to the products that will be consumed and how they

show up in the utility function. The second component within the utility function is an assessment function that maps certain attributes of the products into utility. The third component that is related to the utility function is the socioeconomic characteristics that make up the consumer. Hence the consumer's utility function for an information set **I** is represented as:

(3.3) $U = U(\mathbf{y}, x_1, x_2; \mathbf{A^I}, \mathbf{S})$

where $\mathbf{y}$ = a vector of goods not in the auction,

x_1 = a nonenvironmental product in the auction,

x_2 = an environmental product in the auction,

$\mathbf{A^I}$ = environmental assessments for x1 and x2 given information set S,

S = vector of socioeconomic characteristics of the consumer.

It is assumed that the consumer's utility function is increasing at a decreasing rate for $\mathbf{y}$, x_1, x_2, and any element of $\mathbf{A^I}$.

For this model, assume that the consumer's utility is dependent on the characteristics of purchased goods. Further assume that these goods can be broken up into three groups. The first group is the normal basket of goods that the consumer purchases outside of the auction setting. This basket of goods will be denoted by $\mathbf{y}$ and have an associated vector of fixed prices $\mathbf{p_y}$. The second group of goods is the set of products in the auction that have no particular environmental attributes, while the third group of goods is the set of products in the auction that have embedded environmental attributes. The only differences between these last two groups are that they differ in the level of embedded environmental attributes and possibly perceived visual quality attributes. Without loss of generality, it is assumed that the

last two groups of goods only consist of one product each.[21] The non-environmental product, i.e., the typical product, will be denoted by x_1 and the product with embedded environmental attribute(s) will be denoted by x_2. In this setting, the choice variables for the consumer are the normal basket of goods **y**, the bid for the typical product p_1, and the bid for the product with embedded environmental attribute(s) p_2.

Following Teisl et al. (1999), it is assumed that within the consumers utility function there is an assessment function $\mathbf{A}^{\mathbf{I}}$ which evaluates the products based on a set of characteristics given an information set **I**. This assessment function contains the assessment of each product, i.e., $\mathbf{A}^{\mathbf{I}} = [A_1^I, A_2^I, \ldots, A_n^I]$ where A_n^I is the assessment of product n based on information set **I**. This assessment function maps certain attributes such as quality characteristics into utility. Within this information set **I**, there is information pertaining to the attributes embodied within the products and previous market prices. In the case of an auction for products with embedded environmental attributes, one information set may contain no environmental information regarding the products. This could be known as a naïve information set. In another information set, there could be environmental information released.

The set of characteristics in the assessment function can be divided into two subsets. The first subset is related to the physical attributes related to the products and will be denoted by **Q**. These characteristics revolve mainly around visual quality—color, texture, marbling, etc. Within this **Q**, the evaluation of each product can be divided by product, i.e., $\mathbf{Q} = [Q_1,$

[21] For the second group, there is usually only one product in that set which is used as a basis for comparison. For the third group of products, there will be independence between the products that have different environmental attributes. This independence will come from the fact that in this auction at most one product will be sold after all the rounds of bidding are completed. Hence, by adding products to this group there will be no affect on the budget constraint of the consumer.

$Q_2, \ldots, Q_n]$ where Q_n is the quality evaluation of product n based on visual inspection. It is assumed that the utility function is increasing in **Q**, i.e., a consumer has an ordered preference for different visual attributes. Across information sets, these visual attributes are constant for each product. The visual quality of a product does not change across information sets. Due to the constant visual quality, no adjustments will need to be made when comparing products across information sets. Within a particular information set, these visual qualities can be very different across products or at least perceived as such. This would imply that any comparison of products within an information set must account for possible perceived visual quality differences.

The other subset of characteristics is related to environmental attributes and will be denoted by **E(I)**. Within **E(I)**, the evaluation of each product can be segregated by product, i.e., $\mathbf{E(I)} = [E_1(I), E_2(I), \ldots, E_n(I)]$ where $E_n(I)$ is the quality evaluation of product n based on perceived or expected environmental attributes given information set I. It is assumed that the utility function is increasing in both the level of environmental attributes and the number of environmental attributes. A consumer's utility will increase if they perceive that the number of environmental attributes has increased or if the level of a particular environmental attribute is perceived to increase. These characteristics are related to the perceived or expected environmental attributes embodied in each product. Whether these characteristics are perceived versus expected will depend upon which information set the consumer has. In a naïve round with no environmental information, this set of characteristics would be related to the consumer's expectation of the environmental attributes embodied in each product. In a bid round where environmental information exists for each product, then the set of characteristics are perceived.

One component that is not directly represented in the standard utility function or the model of Teisl et al. (1999) is the socioeconomic characteristics of the consumer. These characteristics are usually implied within the utility function by assuming that all consumers are the same. Since all the consumers are considered identical, there is no need to have the socioeconomic characteristics explicitly given. However, these characteristics are seldom equal. There are gender differences, age differences, educational differences, attitudinal differences, etc. Each of these characteristics can have an affect on how the consumer values products. Hence, they can cause the utility function of one person to be different to the utility function of another person. In this model, **S** will denote the socioeconomic characteristics.

For each purchase decision, the consumer will maximize her utility function given a fixed amount of income **M** under the given rules of the second-price sealed-bid auction. Adapting the model of Teisl et al. (1999) to this situation, the consumer's indirect utility function can be represented as:

(3.4) $V^i = V(\mathbf{A}^I, M, \mathbf{p}_y, S)$

where $\mathbf{A}^I = f(\mathbf{Q}, \mathbf{E(I)})$.

From this indirect utility function, a person's true valuation v_i can be derived through examining what happens to a person's utility when a new allocation of attributes or a new information set is provided. A person's true valuation can be defined as the maximum amount of income she would be willing to pay to obtain a change. In this case, it would be the amount of money the consumer would be willing to give up to obtain the environmental

attributes or the information pertaining to the environmental attributes. This is also known as compensating variation.[22]

Since a person's true valuation of a particular change is dependent on the indirect utility function, this would imply that a person's true valuation is dependent on the same exogenous factors. In this case, a person's true valuation depends on the assessment function, the information set, income, socioeconomic factors, and the prices of other goods. Taking this a step further, since it has been shown that a person's bid in an auction setting is dependent on a person's true valuation, this would imply that the exogenous factors of a person's true valuation would also be influencing factors in a person's bid function. With this information, willingness-to-pay in a multiple round second-price auction with different information sets can now be defined.

Defining Willingness-to-Pay

As mentioned above, this dissertation looks at two willingness-to-pay measures. To see where these different measures come from, an examination of the bids given in each round of the second-price auction is necessary. Within this auction, the participants will buy no more than one of the goods being auctioned, i.e., a final characteristic of this model is that only one product will be sold after the auction is over. The product sold is randomly selected from a round that is also randomly selected. This allows an auction that investigates the value of many goods to maintain the properties of the Vickrey auction explained above.

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[22] Another way of defining a person's true valuation is by using equivalent variation. Equivalent variation is the amount of money would be willing to accept to forgo a change. There are two basic reasons compensating variation can be a better choice for examining a person's true valuation. First of all, a typical second-price auction for a good is a natural way for gathering compensating variation. Secondly, compensating variation is bounded by a person's income, whereas equivalent variation is unbounded.

Without loss of generality, it is assumed that there are two products being bid upon. The first product is a product that has no embedded environmental attributes, while the second product is a product that has the same physical attributes as the first product but has embedded environmental attributes. In the naïve bidding round where there is no specific environmental information about the two products, the bidders only have expectations about the embedded environmental attributes. In a bidding round with environmental information, the bidders know the embedded environmental attributes. The bids for the first and second product are defined respectively as $b_1(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^I)$ and $b_2(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^I)$. These bids are a function of the person's true valuation for each product. Since it is assumed that each bid is derived from the second-price auction, it has been shown earlier that that $b_i(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^I)$ will be equal to v_{i12} if the bidders are strategically optimizing their payoff.[23] When the bidder expects or knows that the product has no environmental attributes, her bid for that product will equal her true valuation. In a second-price auction setting, it can be expected that $b_1(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^I)$ and $b_2(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^I)$ will be different across different information rounds if participants value environmental attributes. Each of these bids is independent of each other since the bidder will only purchase, at most, one of the products.

To make this analysis more clear, assume that there are two information rounds in the second price auction. In the first round, it is assumed that there is no specific information $\mathbf{I}'$ related to the environmental attributes. This is usually known as a naïve bidding round where consumers usually bid on visual attributes. For the next round, information $\mathbf{I}''$ is released on the embedded environmental attributes of the product. This would imply that

[23] It should be noted that for the case of a product with no environmental attributes, $v_{i12} = v_{i1}$. This is because v_{i2} and v_{i3} are equal to zero when the product has no environmental attributes.

under the first information set $\mathbf{I'}$, the set of bids are $b_1(\mathbf{p_y}, M, \mathbf{S}, \mathbf{A^{I'}})$ and $b_2(\mathbf{p_y}, M, \mathbf{S}, \mathbf{A^{I'}})$.[24] Under the second information set $\mathbf{I''}$, the set of bids are $b_1(\mathbf{p_y}, M, \mathbf{S}, \mathbf{A^{I''}})$ and $b_2(\mathbf{p_y}, M, \mathbf{S}, \mathbf{A^{I''}})$. It should be obvious that the prices for the goods outside of the experiment $\mathbf{p_y}$, consumer income M, and the socioeconomic characteristics **S** of the consumer have not changed. Hence, the only thing that has changed is the information in the assessment function. This would imply that further investigation of the assessment function is necessary.

As mentioned above, the assessment function can be written as $\mathbf{A^I} = f(\mathbf{Q}, \mathbf{E(I)})$. Since there are only two products being examined, this function can be written as $\mathbf{A^I} = f(Q_1, Q_2, E_1(\mathbf{I}), E_2(\mathbf{I}))$. In this case, Q_1 and Q_2 denote the visual quality assessment of the typical package and the environmental package respectively. No matter which information set the consumer is in, these quality attributes do not differ across information sets for each product. Within a particular information set, these quality evaluations can be quite different. $E_1(\mathbf{I})$ and $E_2(\mathbf{I})$ denote the perceived or expected environmental attributes in the typical package and the environmental package in information set **I**. In the naïve information set $\mathbf{I'}$ where no information related to environmental attributes has been released, these environmental quality assessments are based on expectations. Within this information set, there is no way for the researcher to know the basis for the expectation. In the environmental information set $\mathbf{I''}$, the consumer knows the level and number of environmental attributes embedded in each product. They also know that the product with environmental attributes is using the typical product as the basis, i.e., a comparison is made between the two products within this information set where the typical product is used as the basis of comparison.

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[24] It should be noted that in this naïve round, the participant has no environmental information. Hence, the subscripts on prices are only being used to keep track of each product through the different rounds.

Up to this point, the bids given in the auction represent all of the attributes incorporated in the products being auctioned, i.e., the bids represent both the visual quality attributes and the environmental attributes. The objective of this dissertation is to value the environmental attributes only. To do this, the visual quality attributes must be factored out. This implies that there are two major definitions for willingness-to-pay that can be developed from this auction setting with different information sets to obtain the value for environmental attributes. The first definition for willingness-to-pay that arises from this setting is related to comparing bids across information sets. In chapter one, this measure was called the consumer's willingness-to-pay with unknown ex ante expectations. This measure of willingness-to-pay examines the bid differential for the product due to the release of information. In this case, willingness-to-pay for any embedded environmental attributes in product i due to the information provided (WTP_i) can be defined as:

$$
\begin{aligned}
(3.5)\quad WTP_i &= b_i(\mathbf{p_y}, M, \mathbf{S}, \mathbf{A^{I''}}) - b_i(\mathbf{p_y}, M, \mathbf{S}, \mathbf{A^{I'}}) \\
&= b_i(\mathbf{p_y}, M, \mathbf{S}, f(Q_1, Q_2, E_1(\mathbf{I''}), E_2(\mathbf{I''}))) - b_i(\mathbf{p_y}, M, \mathbf{S}, f(Q_1, Q_2, E_1(\mathbf{I'}), E_2(\mathbf{I'}))) \\
&= b_i(\mathbf{p_y}, M, \mathbf{S}, f(Q_i, E_i(\mathbf{I''}), E_j(\mathbf{I''}))) - b_i(\mathbf{p_y}, M, \mathbf{S}, f(Q_i, E_i(\mathbf{I'}), E_j(\mathbf{I'})))^{25} \\
&= WTP_i(\mathbf{p_y}, M, \mathbf{S}, Q_i, E_i(\mathbf{I''}), E_j(\mathbf{I''}), E_i(\mathbf{I'}), E_j(\mathbf{I'})),
\end{aligned}
$$

for i,j = 1 or 2. This measure represents the consumer's willingness-to-pay environmental attributes for product i.[26] Since Q_i is the same across both information sets, an advantage of this measure is that no adjustment is needed for visual quality differences in the product. A major problem with this measure is that the attributes of $E_i(\mathbf{I'})$ are unknown to the researcher

[25] The visual quality Q_j for product $j \neq i$ can be dropped because it is assumed to have no effect on the price of product i.

[26] This is not the value of the new information set as a whole. This represents the value of the information related to product i. To obtain the value of the information set as a whole, WTP_i would be summed over all i. In this case $WTP_1 + WTP_2$ equals the consumer's willingness-to-pay for the new information set.

because it is based on the expectation of the consumer. There is no way of knowing ex ante what the consumer's expectations are for each product.

The real benefit of this measure is that it gives an ex post view of the consumer's expectation. If this measure is positive, this would imply that the consumer's expectations on a particular product were lower than the actual environmental attributes embedded in the product. A measure of zero implies that the consumer's expectations from the naïve round are met in the round with environmental information. Finally, if this measure is negative, then the consumer had a higher expectation of what attributes were embedded in the product than what actually was. Another way of viewing this measure is to think of it as the short-term effect when environmental information is released into the market. It is the initial gain or loss before the market has time to react and the consumer can change her spending habits. This measure also gives a producer a more accurate picture of the initial gains to be made by selling a product that has environmental attributes.

The second definition of willingness-to-pay looks at the premium a consumer will pay for a product with embedded environmental attributes as compared to a basis product within the same information set. In this case, this product is the typical product. In chapter one, this measure was known as the consumer's willingness-to-pay for environmental attributes with a known basis. Hence, this definition of willingness-to-pay can be represented as:

$$(3.6)\quad WTP = b_2(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^{I''}) - b_1(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^{I''})$$

$$= b_2(\mathbf{p}_y, M, \mathbf{S}, f(Q_2, E_1(\mathbf{I}''), E_2(\mathbf{I}''))) - b_1(\mathbf{p}_y, M, \mathbf{S}, f(Q_1, E_1(\mathbf{I}''), E_2(\mathbf{I}')))$$

$$= WTP(\mathbf{p}_y, M, \mathbf{S}, Q_1, Q_2, E_1(\mathbf{I}''), E_2(\mathbf{I}'')).$$

Assuming Q_1 equals Q_2, i.e., each product has the same visual qualities, this measure represents the consumer's willingness-to-pay for a product with embedded environmental attributes over a typical product. As was mentioned earlier, this is a long-term measure where the consumer has information related to environmental attributes and is allowed to adjust her market decisions.

The real advantage to this definition is that the environmental attributes embedded within each product is known to the consumer where one of the products is being used as the basis of comparison. $E_1(\mathbf{I}'')$ and $E_2(\mathbf{I}'')$ are known to the researcher as well as the consumer. The major disadvantage of this definition is that it must assume that the visual quality attribute across products is the same. This is usually not the case. If possible, this measure will need to be adjusted for the perceived visual quality differences. One way to adjust for the visual quality difference is to take the difference of the two products in the naïve round and use it to adjust the willingness-to-pay appropriately. This of course assumes that the expectation of embedded environmental attributes for each product in the naïve round are equal. Hence, the second willingness-to-pay measure adjusted for visual quality differences can be represented as:

(3.7) $\quad WTP = WTP(\mathbf{p}_y, M, \mathbf{S}, Q_1, Q_2, E_1(\mathbf{I}''), E_2(\mathbf{I}'')) - (b_2(\mathbf{I}') - b_1(\mathbf{I}'))$

where $b_i(\mathbf{I}') = b_i(\mathbf{p}_y, M, \mathbf{S}, \mathbf{A}^{\mathbf{I}'})$ for $i = 1, 2$.

If $b_1(\mathbf{I}')$ is greater than $b_2(\mathbf{I}')$, this would imply that the participant viewed the first product having a better visual appeal than the second product. In this case, there would be a positive adjustment to willingness-to-pay compared to equation 3.6. When visual attributes are perceived by the participant of the auction to be the same for both products equation 3.7 is equal to equation 3.6.

In this chapter two main results have been shown. The first result shows how to interpret bids from a second-price auction when the item being sold has embedded environmental attributes. Specifically, it is the dominant strategy of each bidder to bid the part of her true valuation that cannot be provided by another bidder. The second result in this chapter is that in a multiple round second-price auction with different information sets, there are two approaches to define willingness-to-pay. The first approach relates willingness-to-pay for embedded environmental attributes across the different information sets for the same product. The second approach to derive willingness-to-pay for embedded environmental attributes is by comparing a certain product with a base product within the same information set. Depending on which method is used, there are advantages and disadvantages to each.

Equation 3.5, 3.6, and 3.7 all can be used to represent v_{i12} explained above. Each equation measures a person's private valuation, v_{i12}, from a different point of view. For each of these willingness-to-pay measures, the policy maker must keep in mind that v_{i12} represents only a portion of the consumers true valuation when embedded environmental attributes exist in the product, i.e., it is a lower bound of a person's true valuation for the embedded environmental attributes. There is no way of knowing from this experiment what the person's true valuation is when embedded environmental attributes exist because the level of free-riding is unknown to the researcher. Equation 3.5 looks at v_{i12} for embedded environmental attributes before the consumer can adjust to all the information released about the multiple products. It does not allow the participants to adjust the base product of comparison for the new information provided. This is why it is a short-run view of v_{i12}. By examining equation 3.5 for each product, the researcher can infer the environmental

expectations each participant had when no information of environmental information is present.

Equations 3.6 and 3.7 are essentially measuring the same thing. The only difference between them is that equation 3.7 relaxes the assumption that the visual qualities between the products being auctioned are the same. Thus, equation 3.7 attempts to adjust for visual quality differences. Both equations 3.6 and 3.7 represent a long-run view of v_{112}. These equations allow the consumer to adjust the bid for the product being used as a basis, as well as, allowing her to adjust the bid for the product that has environmental attributes. Equation 3.5 does not account for the released information affecting any other products. Since equations 3.6 and 3.7 represent a long-run view of a person's private valuation v_{112}, it is a more pertinent measure for policy makers to examine. It is also a more accurate measure of the utility a person receives from the existence of the environmental attributes.

CHAPTER FOUR: STUDY DESIGN AND DATA COLLECTED

Introduction

Development of the study design for data collection can be divided into two major components. The first component focused on initial information gathering that helped shape the questions asked in the surveys and assisted in experimental design. The second part was conducting the experiments and surveys for data collection.

During the first stage of study design, information on different pork production methods and what effects they have on the environment was analyzed. This was an interdisciplinary focus including personnel from the Departments of Animal Science and Agricultural Engineering at Iowa State University. The National Pork Producers Council and The Iowa Pork Producers Association were also contacted to provide information on pork production and manure management systems.

Environmental attributes, such as level and potential for air and water degradation from different systems were determined. From this information it was concluded that two environmental impact levels would be used in the study: a low reduction and a high reduction. These represent a reduction over the typical levels. Potential odor reduction levels were chosen to be either at a thirty to forty-percent or an eighty to ninety-percent reduction over the typical level. Ground and surface water impact were chosen to be at either fifteen to twenty-five percent or forty to fifty-percent reduction levels over the typical.

Experimental Locations

The second part, conducting the experiments, was completed in six different locations of the United States: Ames, Iowa; Iowa Falls, Iowa; Manhattan, Kansas; Raleigh, North Carolina; Burlington, Vermont; and Corvallis, Oregon. These experiments were conducted

during the months of June and July over a two-year period in 1997 and 1998. Site selection was not from a random draw. Each site was selected for a particular purpose.

The first area in which the experiment was conducted was Iowa. Two sites for the Iowa experiments represented a rural site (Iowa Falls) where there is a high concentration of hog production and a site with a lower livestock concentration (Ames). At each site in Iowa, three sets of surveys/experiments were conducted. Another three experiments were conducted in Kansas for comparisons to the Iowa results. This allowed for a test to evaluate whether results differ for an agricultural area which has a livestock population density less than that faced in Iowa. North Carolina was selected to provide a comparison of two major hog producing states, one dominated by large pork production operations (North Carolina) and one with a broader mix of types of pork production operations (Iowa). Two sets of experiments were conducted in Raleigh, North Carolina because following the first experiment it was determined that a random procedure had not been followed in selecting experiment participants. Thus, a second set of experiments was conducted at this location. The personnel who recruited participants for the first Raleigh experiment had difficulty obtaining a sufficient number of participants for the study. Hence they partially filled the experiment with graduate students who were near at hand. Thus, the selection was not a comparable random procedure. Using students is a well-known practice when doing experiments and there does not seem to be any definitive evidence that use of students bias the results. There have been some studies that have shown that behavior is not different between students and adults.

The last six experiments, three at each location, were conducted in Burlington, Vermont and Corvallis, Oregon. These locations allowed for comparison of pork consumers

at locations which are not reliant on pork production as an economic base with states that have a much larger vested interest in economic activity from hog production. Another aspect to these locations is that some contend that there is a higher environmental awareness in these locations.

While these sites were selected to meet specific conditions the researchers had ties with individuals in the area. These ties allowed for better quality control when it came to sample selection and running the experiment. It also helped in facilitating the data collection process. Since sites were not selected randomly, care must be taken in interpreting the results. All of the sites selected, except Iowa Falls, had a major university located within the city. It should be noted that while Raleigh, North Carolina is not typically considered a university town, it has many of the same properties because it is located in an area known as the research triangle where much research is undertaken. Thus, these will tend to have a population that, on average, has a higher income as well as being better educated. Sites associated with universities tend to be more culturally diverse than that found in a typical community. These factors can have a biasing effect on the data and results compared to a pure random sample draw of the population or a comparison to a large metropolitan area. Hence, if environmental attributes are a normal good, it is expected that participants in the study area will tend to pay a higher price than a typical consumer for a good with embedded environmental attributes. This fact must be taken into consideration when interpreting the results. Given this, the directional change is an important result.

Participant Selection

A random sample of individuals from the area being studied was used to obtain participants for the study. This sample was obtained by a random computer generated sample

drawn from telephone numbers found in the respective local telephone directory. For each location, a set of 700 names was drawn.[1] Following the procedures established by Fox (1994), an initial letter was sent out informing each person in the set that they would be receiving a call in the next two to three weeks asking them to participate in a consumer experiment. This letter was sent out four to five weeks before the experiment was to be conducted. A copy of the letter is provided in Appendix A.

The letter sent to the households was used to familiarize the potential participants with the general aspects of the study. It stated that the nature of the study was to collect information about knowledge and concerns related to pork production. Beyond this, there were three additional pieces of information that was provided to the household about the nature of the study. First, they were told that the study would take less than two hours and would be on an upcoming Saturday. Second, the potential participants were assured that there was no risk to them and they would be paid forty dollars for their participation. Third, the location of the study was revealed to them. Accompanying the letter was a map that assisted the participants in finding the location of the experiment. There were two pieces of information left out of the letter, the actual date and time. The reasoning behind leaving this information out was to minimize the chance that someone would not show up without having signed-up. On average, approximately twenty percent of these letters came back as return to sender for various reasons. The majority of these were sent back because the potential participant had moved.

[1] For the first Iowa experiment, only 350 names were drawn for the sample. Using this small sample, it was very difficult to sign-up the desired number of participants. Hence, for the remaining experiments, the random sample was increased to 700 to assure that there was no problems obtaining the desired number of participants.

Phone calls to the potential participants drawn from the sample started approximately three weeks before the experiment was conducted. Phone calls to sign up participants for the study were usually made between the hours of 5 p.m. to 9 p.m. When called, each potential participant was screened to make sure he/she was the primary food shopper in his/her household. The potential participant was then asked whether he/she received the letter sent to his/her household about the experiment. If they did not, the caller would explain the contents of the letter and then asked him/her if they wanted to participate. If he/she had received the letter, the caller would ask if he/she wanted to participate. The caller provided no further information to the potential participant about the study to minimize study bias.[2]

At the time initial calls were made, approximately seventy-five percent of the potential participants were not at home. In this case, messages were not left and the caller went to the next person on the list. This was done for two reasons. First, it allows for better control of the number of participant's signed up for each experiment. Secondly, it assures that a bias does not result based on the potential participants who self-selected themselves to have an answering machine. Of the people reached, approximately sixty percent turned down the offer to participate. A majority of the people who turned down participating did so because of a prior engagement.

Data Collection

Each experiment lasted about two hours at each site. The first experiment was conducted at 9:00 a.m., the second at 11:30 a.m., and the third at 2:00 p.m. When the participants arrived for their experiment session, they were instructed to wait outside the

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[2] Most of the callers who solicited participants for the study had no information about the experiment. This was to ensure that they would not release any information that would cause a self-selectivity bias.

experimental room until all participants arrived. Once all participants had arrived, they were escorted to a room where the experiment was to be conducted. Participants were instructed to sit where there was paper and pencil and were discouraged from talking to each other during the experiment. The papers were spread out across the room so participants were sitting away from each other. Within the general instructions, the participants were notified that talking could result in a penalty of three dollars. These measures were used to discourage collusive behavior being formed within the auction.

When the participants sat down, they found three items in front of them. The first item was a consent form notifying the participants of their rights during the experiment. Their primary right was that at any time during the experiment they could leave with no prejudice to them. It also mentioned that the results from the experiment are strictly confidential. The second item was general instructions for the experiment. See appendix B for these materials. Each one of these was read aloud. The third item was a piece of paper with a randomly generated number. This randomly generated number was used as the participants' identity throughout the experiment and ensured their anonymity from the other participants.

Once all instructions were read and the consent forms signed, the monitor went around to each participant and collected their consent forms. Next, as done in one of the experiments by Fox (1994), each participant was paid forty dollars for participating in the experiment. This forty dollars was to compensate participants for their time spent in the experiment plus any other expenses that were incurred for participating in the experiment, e.g., travel costs, etc. It also gave a broad range of participants an incentive to come to the experiment.

Data collection consisted of two main parts: surveys and auction experiments. There were two surveys conducted during each experimental session. The first survey was conducted before the auction and collected personal information and information on participants' perception about industry issues. See appendix B for the pre auction survey. Information collected included items such as participant's age, gender, household income, and education. Other questions were related to issues of concern and importance.

A second survey was conducted immediately following the auction. See appendix B for the post auction survey. This survey dealt with participant knowledge about pork production and contained questions pertaining to perceptions and attitudes about potential methods of improving environmental attributes in products. These questions were related to issues such as livestock production facilities and methods of manure storage and land application. These issues were addressed in the post survey to assure that the pre survey did not influence participants' expectations or create biases prior or during the experiment.

The Auction (Experiment)

There have been many studies that have demonstrated the usefulness of experimental auctions for this type of marketing research, i.e., obtaining willingness-to-pay for some sort of attribute related to the product being studied (Hoffman et al. 1993; Menkhaus et al. 1992; Hayes et al. 1996; Melton et al. 1996a, 1996b). Hoffman et al. (1993) and Menkhaus et al. (1992) investigated willingness-to-pay for beef that is sold in different packaging under different information sets. Hayes et al. did various experiments to obtain consumer's willingness-to-pay for food safety attributes (1996). Melton et al. studied consumer's willingness-to-pay for pork chops with different visual characteristics (1996a, 1996b).

The most commonly used auction method for eliciting willingness-to-pay for an attribute is a second-price sealed-bid auction. The second-price sealed-bid auctioned is conducted in the following manner. Participants are shown an item (or items) which will be put up for auction. Participants submit bids anonymously to the monitor for the item(s). Once the monitor has collected all the bids, he/she determines which participant is the highest bidder and what the second highest bid is. After this is completed, the highest bidder's identification number along with the second highest bid price is posted. If there is a tie for the highest bidder, then the winning bidder is randomly selected among the bidders whom tied. This bidder is required to pay his/her own bid price because the second highest bid is also the highest bid.

Theoretically, a second-price sealed-bid auction for a purely private good with one round is demand revealing, i.e., people reveal their true valuation of a good when this method is used. This demand-revealing property of the second-price auction is because the dominant strategy of the participant is to truthfully reveal his/her preferences. Hayes et al. explain that "bidding less than one's true value only decreases the probability of winning at what otherwise may have been a fair price. Bidding more than one's true value increases the probability of winning, but at a price that is higher than one's true value." (1996, p. 367) Vickrey was the first to discover this demand revealing property (1961). Hence the second-price sealed-bid auction is also referred to as the Vickrey auction.

While the second price auction is theoretically demand revealing in a single round, behaviorally people do not necessarily reveal their true valuations in a single round (Hoffman et al. 1993; Menkhaus et al. 1992). Even though this has been shown to be the case, it has also been found that in multiple round experimental second price auctions, participants have

a tendency to learn that their dominant strategy is to bid their true valuation for a good (Coppinger et al. 1980; Cox et al. 1985. Shogren et al. 1994a). Hence, the auction method used for this study was a second-priced sealed-bid auction segmented into five bidding rounds.

To familiarize the participants with the second price auction, a preliminary auction to sell a brand name candy bar was used. See appendix B for the instructions and the sheet used for bidding for this auction. This was a single round second-price sealed-bid auction and allowed the participants to become familiar with the second price auction. To assure that the participants understood the motivation of the second price auction, we used the following paragraph to explain the intuition of the auction:

> In this auction it is in your best interest to bid the amount you are truly willing to pay for the candy bar. If you bid more than your true willingness-to-pay, then you increase your chances of purchasing the candy bar but you may have to pay a price that is greater than your valuation of that candy bar. On the other hand, if you bid less than the amount that you are truly willing to pay, you may lose the chance to purchase the candy bar at a price that you would be willing to pay.

To further assure that participants understood the auction method, they were given a two-question quiz concerning the auction. After answering the quiz, the monitor discussed the correct answers and asked participants for any further questions about the auction method.

After this first auction was completed, a multiple trial second-price sealed-bid auction was conducted with the pork products. This involved five bidding rounds. See appendix B for the instructions and bid sheets used for this experiment. Similar to the candy bar experiment, the same type of motivating paragraph for the second price auction was used.

Before the experiment began, the participants were invited up to the front of the room to visually inspect the packages of pork chops. They were also advised that anytime during the experiment, they could look at the packages again.

In the first three rounds of this auction, participants bid only on the physical attributes, such as color and marbling, of the product having no other information except for the previous round's bids. This allowed participants to obtain feedback on price information. It also allowed the researchers to determine if some packages of chops were perceived as visually more appealing than other chops. For the fourth round, the participants were informed of the specific environmental attributes associated with the respective products. This information shock allowed for determination of the effect of releasing environmental information had on participants' bids. In the fifth round, the implications of the environmental attributes were further explained and the participants were allowed to bid a final time. See appendix B for the information provided in the fifth round.

The products used to elicit bids were two-pound packages of uniformly cut, boneless, 1¼ inch pork loin chops. These pork loin chops were cut and packaged to look as uniform as possible. The first three rounds of bidding allowed us to identify whether the packages provided were perceived as similar. In round four, participants were bidding on the environmental attribute information provided. Changes in bid responses would reflect the value of the respective environmental attribute.

The Products

The participants were allowed simultaneously to bid on ten different packages of pork chops each having different environmental attributes. The packages of pork chops were arranged in a row, and placed on ice in one of three white coolers. Each of the ten packages

was labeled as Package i, where i = 1,..., 10. Following the third round of each experiment each participant was told that one package was a "typical package" with no specific environmental attributes. In this same round, the other nine packages were assigned varying levels of environmental attributes dealing with ground water, surface water, and odor. See appendix B for the description provided for each package of pork chops in round four for each experiment.

Odor reduction was at two levels: a thirty to forty-percent reduction, and an eighty to ninety-percent reduction over the "typical" product. Ground water and surface water impacts were also available at two levels: a fifteen to twenty-five percent reduction and a forty to fifty-percent reduction over the "typical" product. Packages were provided with single attributes (only air, ground water, or surface water), double attributes, or all three attributes embedded. The double and triple attribute pork packages were all at the high reduction levels. The following description was given for the respective packages:

> ***Package 1*** *has no particular environmental attributes. It is the typical pork loin chops which can be bought at any local store.*
>
> ***Package 2*** *has the environmental attribute of a pig production system using technology that* ***reduces odor by 30 to 40%*** *below the typical (package 1).*
>
> ***Package 3*** *has the environmental attribute of a pig production system using technology that* ***reduces odor by 80 to 90%*** *below the typical (package 1).*
>
> ***Package 4*** *has the environmental attribute of a pig production system using technology that* ***reduces seepage*** *of nutrients, etc., from swine manure* ***into the groundwater by 15 to 25%*** *below the typical (package 1).*
>
> ***Package 5*** *has the environmental attribute of a pig production system using technology that* ***reduces seepage*** *of nutrients, etc., from swine manure* ***into the groundwater by 40 to 50%*** *below the typical (package 1).*

Package 6 *has the environmental attribute of a pig production system using technology that* ***reduces run-off*** *of phosphorus, etc., from manure* ***into surface water by 15 to 25%*** *below the typical (package 1).*

Package 7 *has the environmental attribute of a pig production system using technology that* ***reduces run-off*** *of phosphorus, etc., from manure* ***into surface water by 40 to 50%*** *below the typical (package 1).*

Package 8 *has a combination of two environmental attributes in a pig production system; one using technology that* ***reduces odor by 80 to 90%,*** *and the other using technology that* ***reduces seepage into the groundwater by 40 to 50%*** *below the typical (package 1).*

Package 9 *has a combination of two environmental attributes in a pig production system; one using technology that* ***reduces odor by 80 to 90%,*** *and the other using technology that* ***reduces run-off into surface water by 40 to 50%*** *below the typical (package 1).*

Package 10 *has a combination of three environmental attributes in a pig production system; one using technology that* ***reduces odor by 80 to 90%,*** *the second using technology that* ***reduces seepage into the groundwater by 40 to 50%,*** *and the third using technology that* ***reduces run-off into surface water by 40 to 50%*** *below the typical (package 1).*

Table 4.1 summarizes each of these attributes. For brevity, the descriptions used in this table will be the description used in the discussions throughout the dissertation.

To control for bias bidding due to package labeling and location, package numbering was switched for some of the packages across each of the different time slots at the respective locations. This control for sequencing effects has been done before by Menkhaus et al. (1992). What this does is it averages out the effect that participant's may anchor on a particular package because it has a certain number on the package or location in the display area. Hence, the package with no specific environmental attribute was labeled Package 1 at the 9:00 session, Package 5 at the 11:30 session and Package 10 at the 2:00 session. See

Table 4.1: Environmental Attributes for the Ten Packages of Pork Loin Chops Used in the Experiment

Pork Chop Environmental Attributes (Level of Improvement over the Typical)	Package Labeling for Morning Experiment
No Specific Attributes (Typical Product)	Package 1
Odor 30-40%	Package 2
Odor 80-90%	Package 3
Ground water 15-25%	Package 4
Ground water 40-50%	Package 5
Surface Water 15-25%	Package 6
Surface Water 40-50%	Package 7
Odor 80-90%/Ground Water 40-50%	Package 8
Odor 80-90%/Surface Water 40-50%	Package 9
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	Package 10

Table 4.2 for the corresponding package numbers and respective environmental attributes during each time period. As done in Fox et al. (1995, 1996) and Roosen (1998), an attempt was made to control for wealth effects.[3] Wealth effects are when participants change their bids because they won an earlier trial (Fox et al., 1995). The method used in each experiment to control for wealth effects was a random drawing of one bidding round and one product from that selected round to be the product sold at the end of the experiment. By selecting only one product to be sold, this auction had the properties of a single unit auction rather than a multiple unit auction. Hence, the theoretical demand revealing property still holds for the Vickrey second-price sealed-bid auction.

[3] See Davis and Holt for a discussion of wealth effects in experimental markets (1993).

Table 4.2: A Mapping of Pork Attributes to Package Labeling for Each Session Time

	Session Time		
Pork Chop Environmental Attributes (Level of Improvement)	**9:00**	**11:30**	**2:00**
No Specific Attributes (Typical)	Package 1	Package 5	Package 10
Odor 30-40%	Package 2	Package 1	Package 1
Odor 80-90%	Package 3	Package 2	Package 2
Ground water 15-25%	Package 4	Package 3	Package 3
Ground water 40-50%	Package 5	Package 4	Package 4
Surface Water 15-25%	Package 6	Package 6	Package 5
Surface Water 40-50%	Package 7	Package 7	Package 6
Odor 80-90%/Ground Water 40-50%	Package 8	Package 8	Package 7
Odor 80-90%/Surface Water 40-50%	Package 9	Package 9	Package 8
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	Package 10	Package 10	Package 9

Pretest of the Experimental Procedure

A focus group was utilized to test the experimental procedure and information provided to participants. This provided information and feedback on the experiment, the surveys used, and the environmental impacts. This allowed pre-testing and refinements of the survey questions and procedures and information developed for the experiments, as well as provided feedback on perception and thoughts of the focus group participants. After this, the surveys and experimental approach were finalized.

The focus group consisted of sixteen participants from many different backgrounds. Each participant was selected to gain a differing prospective on the experimental process. One of the participants was selected due to his knowledge of experimental economics. Some

were selected because they were from other countries. This allowed for feedback on the clarity of the English to people with foreign backgrounds. Another group had industry experience in pork production or the related marketing industry. Participant selection was based on bringing in a diverse group of people to give feedback on the experiment from their point of view.

During this session, comments on study design were mainly solicited after the experiment was completed. This allowed the researchers to gauge the time length needed for the experiment. It was found from the focus group that the experimental process and the experiment needed no substantial changes.

While the experimental process and basic information did not change, some aspects of the surveys did change. There were three main changes instituted in the surveys. The biggest change was the addition of an 'I don't know' response for many of the questions that pertained to pork production—including distance participant lives from a pork production facility as well as all the questions in the second survey that related to production methods. The second adjustment was related to age. In the focus group session, participants were provided different categories of ages from which to choose. In the regular experiments, this type of response was changed to asking the person how old they were as of the last birthday. The final change made in the survey was adding a question that related to whether the participant wanted environmental training for pork producers. This question came from the participants who were from the pork industry.

CHAPTER FIVE: RESULTS AND DISCUSSION OF DATA

In chapter three, a model was presented to explain how consumers make decisions in a multiple round second-price sealed-bid auction. It was shown that when embedded environmental attributes do not exist in the product, it is the best interest of the consumer in a second-price sealed-bid auction to reveal her true valuation for the product being auctioned. When embedded environmental attributes exist, it was shown that if the consumer has free-riding tendencies she only reveals the part of her true valuation she cannot receive from another bidder providing the environmental attributes. In chapter three, it was also explained how to derive consumer's willingness-to-pay for embedded environmental attributes, i.e., the premium a consumer would pay for a product with environmental attributes over a typical good.

Two ways of defining willingness-to-pay were discussed in chapter three. The first way dealt with looking at the amount the consumer would change his/her bid on the same product given two different information sets. This was equation 3.5 in chapter three. In one of the information sets, the consumer did not know the level of environmental attributes within the products. The other information set contained the actual improvement in level of embedded environmental attributes within each product. Using this definition of a premium assumes that the products in the naïve information set are viewed as typical products. This may not be the case. The other way of looking at the premium is to compare products within the same information set where the consumer knows the basis good, i.e., the good with no particular environmental attributes. Assuming there is no difference in visual quality, the difference between the price paid for the typical good and the price paid for the good with improved environmental attributes can be considered the consumer's willingness-to-pay for a

product with embedded environmental attributes. Since it is unlikely that the visual qualities will be exactly the same, the visual quality adjustments shown in equation 3.7 from chapter three is the better estimator of v_{112}, i.e., the willingness-to-pay measure for embedded environmental attributes.

Chapter four discussed the design of the experiment for collecting data on consumer's willingness-to-pay for embedded environmental attributes. The experiment used to collect the data was a multiple-round second-price sealed-bid auction that had different information sets in some of the rounds. These information sets pertained to the embedded level of environmental attributes. It was also noted in this chapter that the data was collected in six different locations—Ames, Iowa; Iowa Falls, Iowa; Burlington, Vermont; Corvallis, Oregon; Manhattan, Kansas; and Raleigh, North Carolina.

This chapter discusses and analyzes the results of the data collection process. Specifically, this chapter examines three different aspects of the data. The first aspect of the data examined is the average level of bids across each bid round. The next aspect of the data analysis is an investigation of the consumer's willingness-to-pay for embedded environmental attributes with unknown ex ante expectations, i.e., the premium a consumer would pay under two different information sets. The final aspect of the data analysis consists of examining consumer's willingness-to-pay with a known basis, i.e., the premium paid over the typical product within the same information set.

There are two major statistical tests used in this chapter for data analysis.[1] The first test examines the null hypothesis of $\mu_0 = 0$, i.e., the mean value in question is statistically

[1] Unless otherwise specified, these two tests will be the only tests used in this chapter.

equal to zero. The alternative hypothesis in this case is that it is not equal to zero. To test this hypothesis, a sample t-statistic is generated. This test statistic is the following:

$$t = \frac{\bar{x} - \mu_0}{s / \sqrt{n}},$$

where $\bar{x}$ equals the sample mean, s is the sample deviation, and n is the number of sample data points (Freund 1992). If this sample t-statistic is greater than 2 and n is larger than 30, then the null hypothesis would be rejected at the five-percent level of significance. At the 0.001 level of significance this same t-statistic would have to be greater than 2.756 with n larger than 30 to reject the null hypothesis.

The second test that is commonly used in this chapter is a statistical test to see if the means of two samples are equal. The null hypothesis in this case is $\mu_0 = \mu_1$, i.e., the two means are equal. The alternative hypothesis to this is that the means are not equal. To test this hypothesis, a sample t-statistic is generated from the two sample means. In this case an assumption is being made that the variances are unknown but equal. This test statistic is the following:

$$t = \frac{\bar{x}_1 - \bar{x}_2 - \delta}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}},$$

where

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

For this statistic, $\bar{x}_i$, for i =1 and 2, represents the sample mean from each mean in question. The number of sample data points is represented by n_i, for i = 1 and 2. The sample standard deviation for each sample is represented by s_i, for i =1 and 2. As with the previous test, a test

statistic greater than 2 and $n = (n_1 + n_2 - 2)$ is greater than 30 represents a failure to accept the null hypothesis at the five-percent significance level. At the 0.001 level of significance a t-statistic of 2.756 with $n = (n_1 + n_2 - 2)$ greater than 30 would allow the null hypothesis to be rejected.

General Bid Data

Of the 333 participants in the study, results from 329 were usable.[2] Information provided in Table 5.1 shows the distribution of participants by study region. The experiments were conducted during the summer 1997 through summer 1998 time periods. The number of participants ranged from sixty for the Corvallis, Oregon and Manhattan, Kansas locations to twenty-seven for Burlington, Vermont. In Iowa, the Ames location had forty-nine participants while the Iowa Falls location had fifty-eight participants. Two experiments were conducted in the Raleigh, North Carolina area because it was determined following the first experiment that a random procedure was not followed for participant selection.

Table 5.1: Number of Participants by Area

Experiment Area	Number of Participants
All areas	329
Ames, IA	49
Manhattan, KS	60
Raleigh, NC (6/28/97)	31
Burlington, VT	27
Iowa Falls, IA	58
Corvallis, OR	60
Raleigh, NC (6/27/98)	44

[2] Four participants were omitted because they did not finish the experiment and surveys. One person had to leave during the study because she was ill. The other three did not complete the survey for unknown reasons.

Table 5.2 provides a summary of the average bids for each product during each round. It also provides the t-statistic related to the hypothesis test that the average bid from the current round is equal to the average bid in the previous round for the same product. For round one, the highest average bid for the group of pork chops was $3.47 for the package of pork chop which was later identified with the low-level odor reduction attribute (thirty to forty percent odor reduction). The lowest average bid in round one was $3.21 for the package aligned with low level ground water improvement (fifteen to twenty-five percent reduction in the impact to ground water). When testing the hypothesis that these two means are equal, a sample t-statistic of 1.60 is calculated. This implies that the null hypothesis cannot be rejected at the five-percent level of significance. Thus statistically, they are not significantly different.

Examining the average bids in round two compared to round one, it appears that all the average bids by product increased. Testing the hypothesis that the average bids in round two are equal to the average bids for the same product in round one, it is discovered that at the five-percent significance level that the bids in round two are not equal to the bids in round one. With a second-price sealed-bid auction, the expectation is that these average bids from round one to round two would be equal if participants were truly revealing their preferences. Two explanations can be offered for these bids not being equal. One is that the participants were still in the process of discovering their preferences and responding to the market information. Another is that participants did not fully understand the intuition behind the second price auction. This type of bid increase has been seen in previous studies (Fox et al. 1994; Fox et al. 1995.

Table 5.2: Average Bid for Each Product by Bid Round (All Participants)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bids($)				
	No Environmental Information			Environmental Information	
	Round 1	Round 2	Round 3	Round 4	Round 5
No Particular Environmental Attributes (Typical)	3.35	3.91 (3.32)	4.13 (1.28)	3.61 (-2.96)	3.57 (-0.22)
Odor 30-40%	3.47	4.01 (3.37)	4.26 (1.57)	3.87 (-2.41)	3.90 (0.16)
Odor 80-90%	3.22	3.81 (3.49)	4.05 (1.45)	3.92 (-0.77)	3.91 (-0.04)
Ground water 15-25%	3.21	3.72 (3.00)	3.91 (1.13)	3.85 (-0.33)	3.86 (0.03)
Ground water 40-50%	3.25	3.84 (3.61)	4.03 (1.18)	3.94 (-0.50)	4.00 (0.36)
Surface Water 15-25%	3.43	4.00 (3.27)	4.15 (0.87)	3.99 (-0.93)	4.05 (0.34)
Surface Water 40-50%	3.26	3.82 (3.38)	4.06 (1.43)	4.10 (0.23)	4.12 (0.14)
Odor 80-90%/Ground Water 40-50%	3.43	4.10 (3.94)	4.25 (0.88)	4.56 (1.77)	4.68 (0.65)
Odor 80-90%/Surface Water 40-50%	3.45	4.08 (3.53)	4.17 (0.52)	4.58 (2.22)	4.66 (0.37)
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	3.46	4.06 (3.28)	4.19 (0.67)	5.13 (5.00)	5.17 (0.23)

Note: The number in parenthesis is the t-statistic for the test of whether the average bid in the current round is equal to the average bid in the previous round.

In round three, there were further increases in the aggregate bids of all the bids, but not by as much as from round one to round two. The question arises whether the bids from round three are statistically equal to the bids for round two. Another way of posing this is to ask whether the bids seem to converge. One way to define convergence is to test whether the average bid in a current round is not statistically different from the average bid in a previous round. If this type of convergence occurs, this could be evidence that the intuition of the second-price sealed-bid auction holds, i.e., participants truthfully reveal their preferences. If participants were truthfully revealing their preferences, little change in bids should be seen when no substantial new information has been released. Hence, from round two to round three, little change should be noticed between the two means. Table 5.2 shows that all the average bids for the products in round three are statistically equal at the five-percent significance level to the average respective bids in round two. Hence, at the aggregate level, it appears that bids are converging by the definition provided.

While convergence in the bids seems to be evident after the third round is completed when aggregating all the participants together, it is more appropriate to evaluate each respective study location for convergence. Drawing inferences about bid convergence at the national level may be misleading because the set of pork chops are not exactly the same for all the locations. A set of fresh pork chops was bought for each location on the day of the study to assure quality. Hence, a particular package of chops could have different visual characteristics and perceived desirability across each location. These differences could cause variations between regions that could lead a particular package of chops to converge at the aggregate level even though it does not converges within each specific location.

Table 5.3 shows the percent of products by region that converged by round three. It also provides the number of the corresponding products that converged. When looking at each study site separately, convergence in the third round on the local level seems to support the aggregate data. At the five-percent level of significance, testing for difference in means from round two to round three for each package of pork chops shows that all test sites had a product convergence of eighty percent or greater. There were only two locations that did not have complete convergence—Manhattan, Kansas and Corvallis, Oregon. This result coupled with the aggregate data provide further support for the initial findings of Coppinger et al. (1980) and Cox et al. (1985) that participants eventually discover their preferences and the Vickrey auction with multiple trials does obtain true willingness-to-pay.

Prior to the participants bidding in the fourth round, they were provided information on the environmental attributes embodied within the respective packages of pork. See chapter four and/or appendix B for a detailed description of these attributes. Following release of the information, each participant was allowed to bid on each package with the new information. With this release of information, there was a substantial change in some of the bids. The average bid levels are provided in Table 5.2 in the round four column.

Table 5.3: Number of Products That Had Bids Converge by Round Three by Area

Experiment Area	Percent of Products Converging	Products That Converged by Product Number
All areas	100	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Ames, IA	100	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Manhattan, KS	80	2, 3, 4, 5, 7, 8, 9, 10
Raleigh, NC (6/28/97)	100	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Burlington, VT	100	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Iowa Falls, IA	100	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Corvallis, OR	90	2, 3, 4, 5, 6, 7, 8, 9, 10
Raleigh, NC (6/27/98)	100	1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Figure 5.1 shows the average bids in each round for the low–level environmental attribute products with the typical product as the basis. This figure shows that all the packages with a low-level of environmental attributes increased between rounds one through three. In round four, all of these products decreased in value substantially. In comparison to the previous rounds, the bid changes from round four to round five were small.

Figure 5.2 shows the average bids in each round for the single high–level environmental attribute products again with the typical product with no particular environmental attributes as the basis. Similar to Figure 5.1, all the packages in this group increased substantially between rounds one and three. In round four, the packages with embedded environmental attributes related to odor and ground water decreased in value, while the package with the surface water increased. Again, in round five, there were few adjustments in the bids compared to round four.

Figure 5.3 shows the average bids for the products with the highest levels of embedded environmental attributes—those packages with the double and triple high-level environmental attributes. As in the previous two figures, there was a steady increase in bids between rounds one and three. It is clear from this figure that all the multi-attribute products experienced a substantial increase in bid levels from round three to round four. Again, in round five, there was very little change compared to the previous round.

To summarize Figure 5.1 through Figure 5.3, there was an increase in bids for the first three rounds. By the fourth round, releasing environmental information caused a positive and substantial increase in the bids for the high-level multi-attributes products, had mixed results on the bids of single high-level attribute packages, and negative effects to bids of single low-level attribute packages.

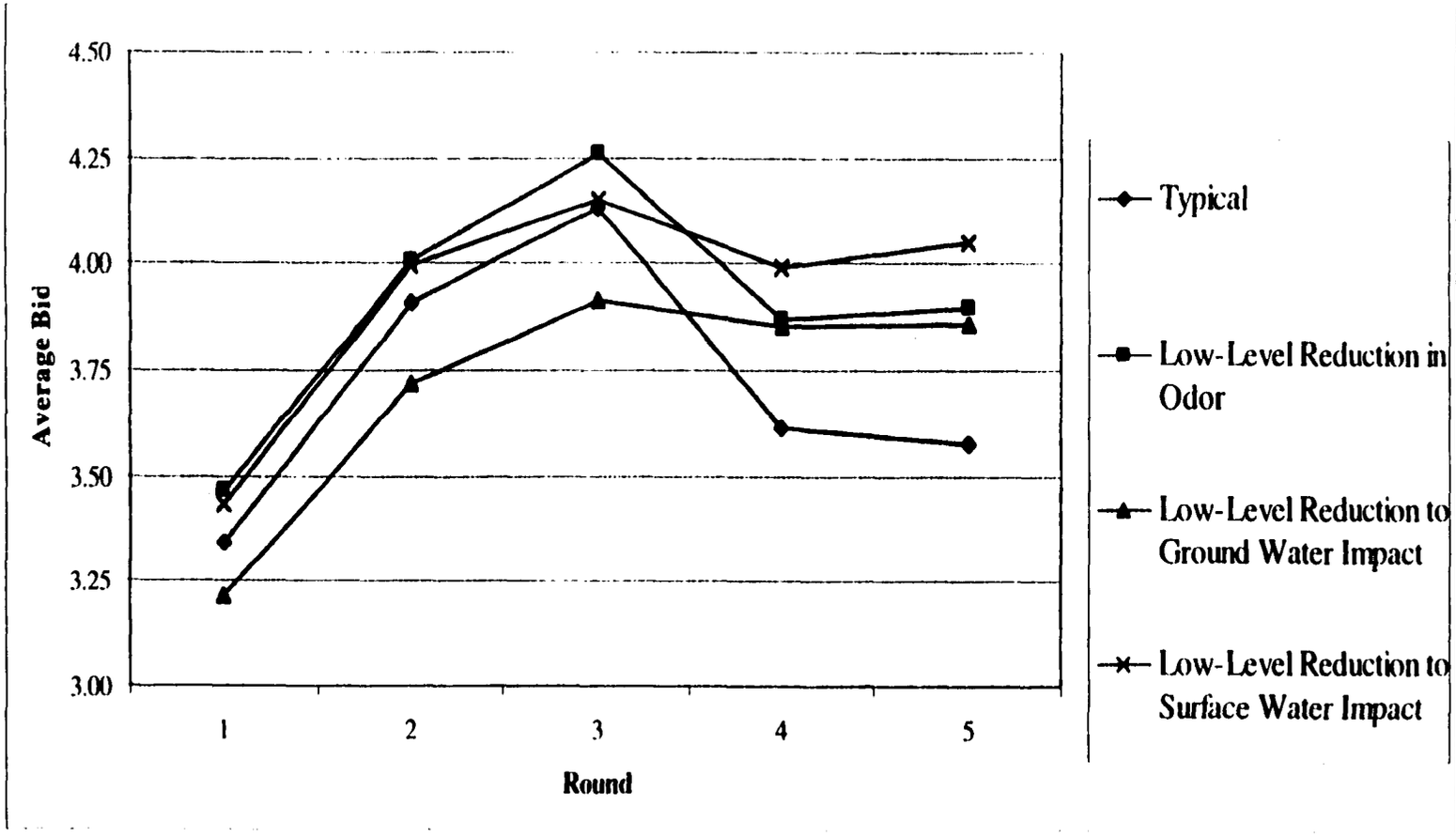

Figure 5.1: Average Bids by Round for the Packages with Single Low-Level Embedded Environmental Attributes in Comparison to the Typical Package with No Particular Environmental Attributes

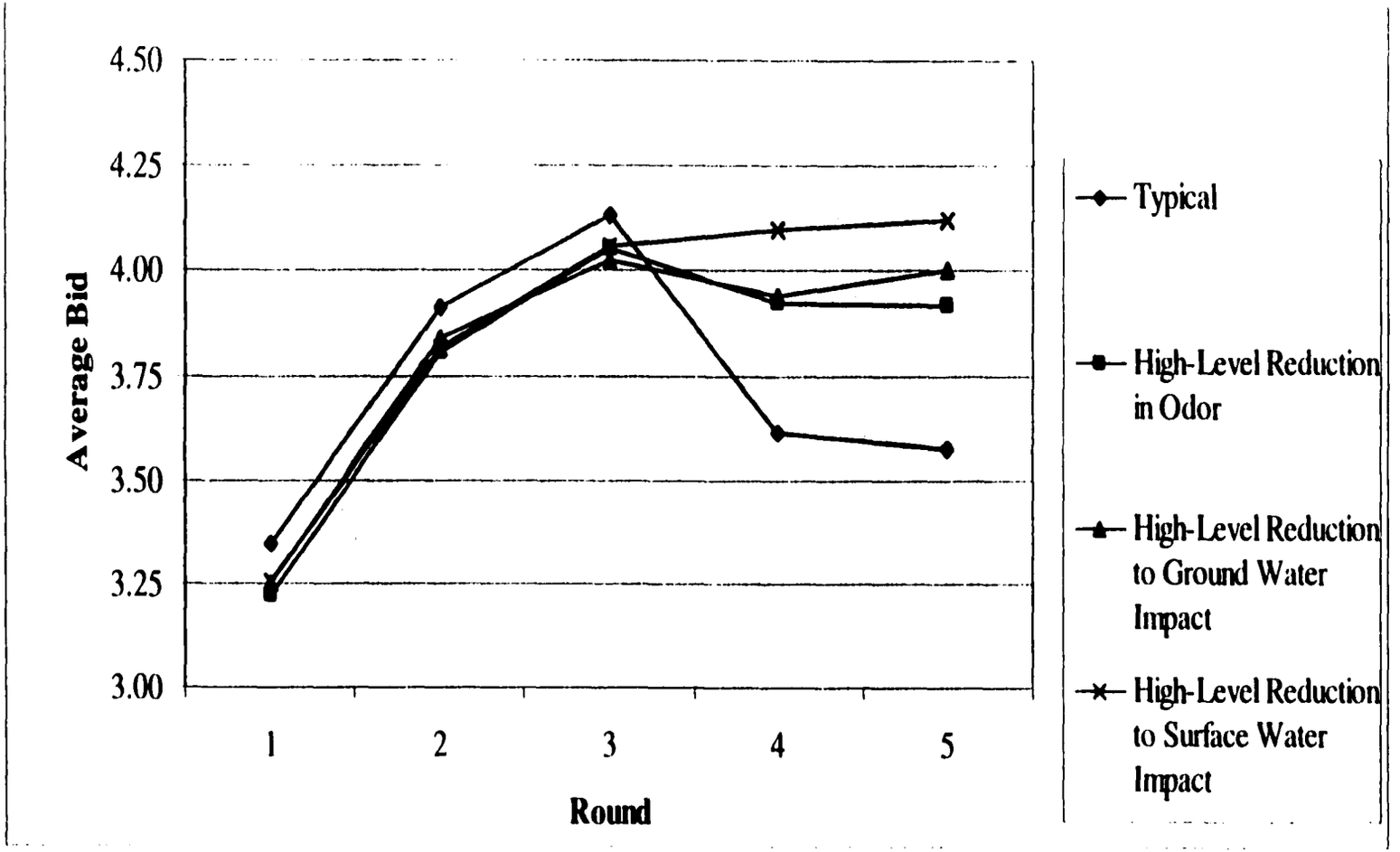

Figure 5.2: Average Bids by Round for the Packages with Single High-Level Embedded Environmental Attributes in Comparison to the Typical Package with No Particular Environmental Attributes

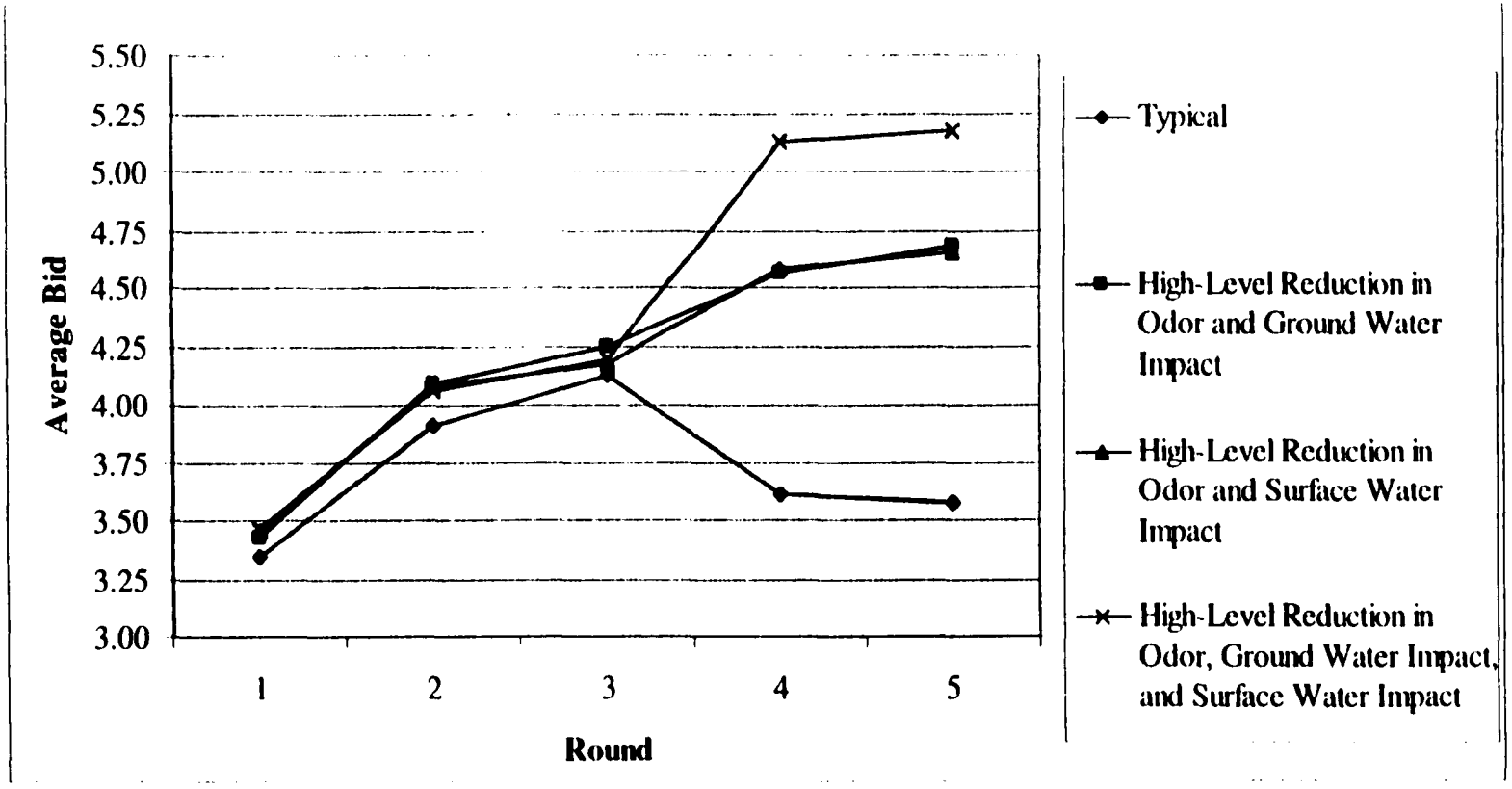

Figure 5.3: Average Bids by Round for the Packages with Double and Triple High-Level Embedded Environmental Attributes in Comparison to the Typical Package with No Particular Environmental Attributes

In round five, another set of information was provided to the participants. This information can be found in Appendix B and was related to more detailed environmental and societal health impacts of the embedded environmental attributes. Comparing round four to round five bids showed that there were only minor movements in the bids for each product. Examining the t-statistics in Table 5.2 shows that none of the average bids in round five are significantly different to their corresponding average bids in round four. This would imply that this new information did not have a large effect on participant bids.

Willingness-to-pay with Unknown Ex Ante Expectations

In chapter three, two types of premium measures were developed from the theoretical model. One of the premiums was known as the consumer's willingness-to-pay for embedded environmental attributes with a known basis. This definition derived consumer's willingness-to-pay by taking the difference of a base product with a product that has some level of embedded environmental improvements over the base product in the environmental information round, round four. This willingness-to-pay measure is equation 3.7 in chapter three. The other definition of a premium derived consumer's willingness-to-pay for embedded environmental attributes by comparing the effect the new information set had on the same product from round three to round four. This is equation 3.5 in chapter three. It was explained in this case that the advantage of this definition is that it assures that the visual characteristics of the product are identical. The draw back to this definition is that the consumer's ex ante expectations on the level of embedded environmental attributes is unknown to the researcher. This section will investigate this definition, i.e., the definition based upon equation 3.5.

Table 5.4 presents an examination of the changes in average bids from round three, the no information round, to round four, the environmental information round. The difference between the average high and low bid in the no information third round is only $0.35. This would reflect the participant perception of the visual quality of the packages and did not represent a significant difference. For the entire group, the average bid increase for the most environmental two-pound package of pork loin chops was $0.94, while the bid for what was the typical package decreased by $0.52. The bids in the no information round are much tighter than the bids in the round in which the environmental information was released. For the three most environmental packages, the double (t-statistic of 4.81 for the product related to odor and ground water and a t-statistic of 5.91 related to the product with odor and surface water attributes) and triple attribute (t-statistic of 11.17) packages, the bid increases were significantly different from zero at the 0.001 significance level.[3] For the typical (t-statistic of -6.90) and low-level odor reduction (t-statistic of -5.67) packages, there was a significant price decrease at the 0.001 significance level. All other bid changes were not significantly different at the 0.001 level. When relaxing the significance level to five-percent, the bid decreases for the packages with the high-level reduction in odor (t-statistic of -2.15) and the low-level reduction in impact to surface water (t-statistic of -2.53) were also significantly different from zero.

Table 5.4 also shows when a pairwise comparison was done, which bid changes are not significantly different from each other. When comparing the typical package with the low-level odor reduction impact package, the decreases in average bids for both are not significantly different at the five-percent level. This also holds true for the pairwise

[3] This result also holds true regionally for the most environmental package.

Table 5.4: Participant Bid Levels by Environmental Attribute Information (All Participants)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bid Level per Package ($)		Premium Bid	
	No Information	Environmental Attribute Added	Absolute Change*	Percent Change
No Particular Environmental Attributes (Typical)	4.13	3.61	**-0.52**[a]	-12.53
Odor 30-40%	4.26	3.87	**-0.39**[a]	-9.19
Odor 80-90%	4.05	3.92	*-0.13*[b]	-3.23
Ground water 15-25%	3.91	3.85	-0.06[b,c]	-1.45
Ground water 40-50%	4.03	3.94	-0.09[b,c,d]	-2.12
Surface Water 15-25%	4.15	3.99	*-0.16*[b,c,d]	-3.94
Surface Water 40-50%	4.06	4.10	0.04[b,c,d]	0.97
Odor 80-90%/Ground Water 40-50%	4.25	4.56	**0.31**[e]	7.41
Odor 80-90%/Surface Water 40-50%	4.17	4.58	**0.41**[e]	9.88
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	4.19	5.13	**0.94**	22.42

*Corresponding letters indicate that at the five percent level of significance the null hypothesis of the two bid changes were equal could not be rejected. Also, note that the bold and italic changes represent a significant difference from zero at the 0.001 and 0.05 level respectively.

comparison between the change in bids of the two double high-level attribute packages. Pairwise comparisons of the change in bids of the low-level and high-level single attribute products also shows that the change in value of many of these products is not significantly different from each other.

Based on a simple assumption, an unexpected result can be seen in Table 5.4. Assuming that environmental attributes are not perceived as negative attributes, and since all the pork packages are physically the same good from round three to round four, the expectation for bidding was that the packages would either increase in value or stay the same. This was not the case. Six of the ten products decreased in value, some by significant amounts as demonstrated above. It was not expected that the typical package, as well as some of the single-level attribute packages, would significantly decrease in value.

This effect to the typical package might be explained by a framing bias that is commonly seen in CVM studies. A framing bias occurs when values are affected by the method from which market values are elicited (Cummings et al. 1986). In this case, since the typical good was used as the basis for environmental improvements in the other nine packages, participants in the study may be viewing this product as having lower overall quality—a lower level of environmental attributes. While this can explain why the typical package decreased in value, it is not as clear why the single low and single high-level environmental packages also decreased in value. Some of the bids for these packages decreased significantly—the low and high level reduction in odor packages, as well as, the low-level surface water impact package.

As was modeled in chapter three, a more formal explanation for this effect could be that the participants' expectations of the product attributes were not being met. These participants

could be modeled as having incomplete information and having environmental quality showing up in their bid functions. Prior to the forth round, the bids were impacted by appearance and market price, i.e., the bids of the second highest bidders. The participants had no specific information on environmental quality, but they may have had a prior or ex ante expectation. Once the environmental information was released in round four, the participants updated their prior information and changed their bids accordingly. For the products that changed significantly in value, the participants' prior expectations of environmental quality were not being met. Hence they changed their bids accordingly. This could explain why the products with lower level environmental impacts experienced a decrease in the value of the package of pork chops. For those products that did not change significantly, the ex ante expectation of embedded environmental attributes is being met.

Figure 5.4 represents averages of the five tiers of environmental information released in round four—typical, single low-level environmental, single high-level environmental, double high-level environmental, and triple high-level environmental. This figure illustrates the profound impact environmental information had on the bidding process. In rounds one through three, the average bids for each package remained relatively close to each other. In round three, the last naïve round, the average bids for each tier of packages were not significantly different from each other. Once the information pertaining to the embedded environmental attributes was released in round four, the bids took on a predictable pattern. In the no information round, the bids were randomly scattered among the packages. Once the information was released about the environmental attributes, the bids followed the pattern of the more environmental pork packages receiving the higher bids and the less

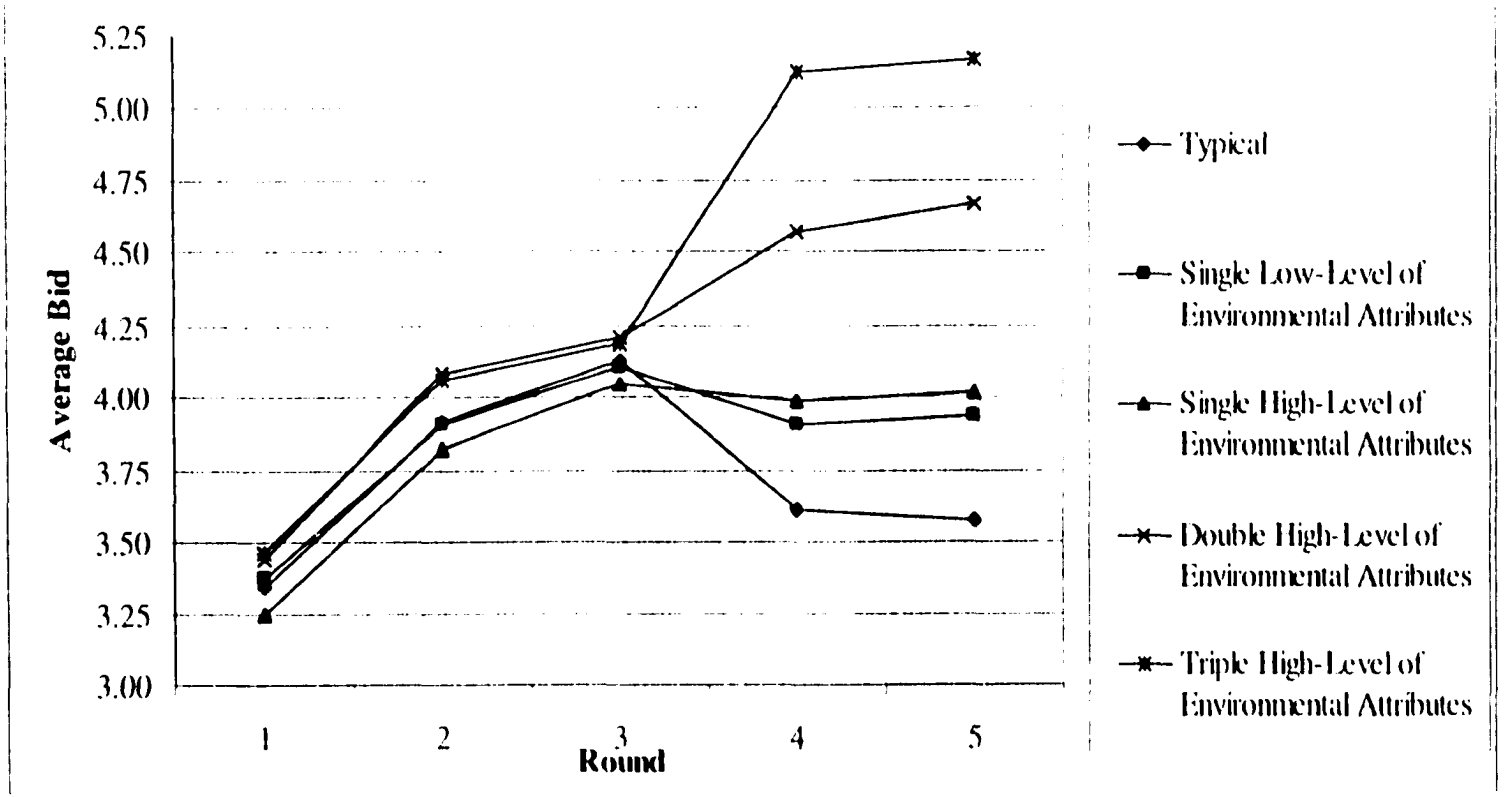

Figure 5.4: Average Bids for Each Tier of Environmental Improvements in Comparison to the Typical Package with No Particular Environmental Attributes

environmental packages receiving lower bids. Thus, values for the single attribute packages were higher than the typical package. Participants paid more for the dual attribute packages than the single attribute packages, while the triple attribute package commanded the highest premium. Hence, releasing environmental information had an impact on the bids.

When testing the hypothesis of whether the changes in each product differ significantly as environmental attribute levels are increased or combined, it was found that at the five-percent level each tier of attributes was significantly different from the other tiers. Hence, the package with three high-level attributes was significantly different from the packages with two high-level attributes. It did not appear to matter what level of attribute was embedded in the package; rather it was the number of attributes that were embedded.

Table 5.5 shows the average absolute change in bids from round three to round four by package for each study area. In each area, the triple attribute package commanded the highest change in premium due to the information shock. The highest change of $1.11 occurred in the second North Carolina experiment, while the lowest change of $0.79 was from the Iowa Falls experiment. For the typical product, every area exhibited a decrease in value. The greatest decrease of $0.77 was in the second North Carolina experiment, while the smallest decrease of $0.19 was in Oregon.

When testing to see whether there was a significant difference in mean bid change across each area for each package, only four comparisons are significantly different at the five-percent significance level. The change in the typical attribute package is significantly different between Corvallis and the second experiment done in North Carolina (t-statistic of 2.26). For the package with single high-level environmental attributes related to surface water, the increase of $0.36 in Ames is significantly different from the decrease of $0.08 in

Table 5.5: Absolute Change in Bids ($) From Round Three to Round Four by Product and Location

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Location						
	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
No Particular Environmental Attributes (Typical)	-0.59	-0.43	-0.47	-0.68	-0.66	-0.19[a]	-0.77[a]
Odor 30-40%	-0.41	-0.34	-0.35	-0.47	-0.45	-0.47	-0.25
Odor 80-90%	-0.02	-0.12	-0.10	-0.33	-0.28	-0.10	-0.02
Ground water 15-25%	0.02	0.04	0.09	-0.02	-0.30	-0.11	-0.01
Ground water 40-50%	0.10	-0.03	-0.23	0.09	-0.31	0.06	-0.27
Surface Water 15-25%	-0.05	-0.33	-0.16	-0.18	-0.24	0.05	-0.25
Surface Water 40-50%	0.36[b]	0.11	-0.03	0.02	-0.11	-0.08[b]	0.00
Odor 80-90%/Ground Water 40-50%	0.59[c]	0.35	0.29	0.25	0.44[d]	0.05[c,d]	0.21
Odor 80-90%/Surface Water 40-50%	0.45	0.50	0.27	0.47	0.37	0.29	0.53
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	1.03	0.89	0.80	0.95	0.79	1.00	1.11

[a] Corresponding letters indicate that at the five percent level of significance the null hypothesis of the two changes being equal across location for each product could not be rejected.

Corvallis (t-statistic of 2.25). As for the package with double attributes related to odor and ground water, Oregon is significantly different from Ames (t-statistic of 2.01) and Iowa Falls (t-statistic of 2.14). It should be emphasized that three out of the four significant differences are related to Oregon for an unknown reason.

Two important conclusions can be drawn from these significance tests. First, there are no systematically significant differences across areas or regions by package when looking at the change in bids from round three to round four. The second conclusion that can be drawn is that the absence of a random sample from the first North Carolina experiment had no significant affect on the change in bids from round three to round four for North Carolina. There were no significant differences in the changes in the bids between these two.

Table 5.6 depicts the distribution of the changes in bids from round three to round four looking at the different tiers of environmental levels. See appendix C for a breakdown of this distribution by location for both the tiers and the ten packages. For the typical package, 45.9% of the participants decreased their bid. This is in contrast to the triple attribute product that had approximately eight percent of the participants decreasing their bid. This decrease may be explained, in part, by a failure of prior expectations being met. The percentage of bids that did not change ranged from 30.4 percent for the high-level attribute package to forty-one percent for the low-level single attribute package.

The information from Table 5.6 shows that the bid distribution shifts to higher bid levels as the number of embedded environmental attributes increases. For example, when considering only premium payers in Table 5.6, the largest percent of participants paying a premium for the low-level single attribute product is ten percent at the $.01 to $.49 bid level. Note that the distribution shifts slightly for the high level single attribute as compared to the

Table 5.6: Distribution of Bid Changes by Environmental Tier Level

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
No Particular Environmental Attributes (Typical)	45.90%	36.17%	6.69%	3.34%	5.47%	0.61%	0.30%	1.52%
Low Level Single Attribute	31.31%	41.03%	10.03%	8.51%	5.88%	0.91%	1.11%	1.22%
High Level Single Attribute	28.57%	38.20%	10.03%	9.93%	7.40%	2.94%	1.01%	1.93%
High Level Double Attributes	17.48%	34.50%	11.55%	11.25%	13.22%	4.56%	3.04%	4.41%
High Level Triple Attributes	7.60%	30.40%	9.73%	12.77%	13.07%	6.99%	8.21%	11.25%

low-level single attribute. For example, twenty-three percent of the participants are willing to pay S.50 or more for the high level single attribute product, as compared to seventeen percent for the low level single attribute product. For comparison, three percent of the participants were willing to pay a premium of $2.00 or more for the high-level single attribute product. This was eight percent of the participants for the high-level double attribute products and nineteen percent for the high-level triple attribute product. Hence, as the number of environmental attributes increased the percent of the participants increasing their bids also increased. A higher percent of the participants were willing to pay a premium for the triple environmental attribute than double attribute product, which was higher than for the single attribute product.

Willingness-to-pay with Unknown Ex Ante Expectations: Premium Vs. Non-Premium Payers

One method of defining a premium payer is one who increased his/her bid from the no information round, round three, to the information round, round four, for the most environmental package—the package with the high-level triple environmental attributes. It was discussed earlier that this relates to the consumers' willingness-to-pay for embedded environmental attributes with unknown ex ante expectations. By defining the premium in this manner, we avoid the problem that the Vickrey auction in laboratory settings can be biased. Cox et al. (1985) and Kagel et al. (1987) have shown that these biases remain somewhat constant across bidding rounds. Coursey and Smith have also found that the bias in absolute terms tends to be the same (1984). This would imply that if the participant has a tendency to over bid, this overbid would be constant across rounds in absolute terms. For

example, if a participant has a tendency to over bid for a product by five cents, then that participant will overbid by five cents in every round. Hence by calculating the willingness-to-pay by taking the difference from the no information round to the information round provides an unbiased true revelation of the premium a participant would be willing to pay.

Using this definition, there were approximately sixty-two percent of the 329 participants that increased their bid for the most environmental good; that product with all three attributes—air, ground water and surface water (Table 5.7). When evaluated by study location, the number of participants willing to pay a premium ranged from fifty-five to sixty-six percent—fifty-five percent at Burlington, Vermont and sixty-six percent at Manhattan, Kansas. The bottom line is that more than one-half of the participants indicated a willingness to pay for the pork product with all three environmental attributes.

Evaluation of the premium payers shows that their average premium was $1.60 for the most environmental package—a premium of thirty-seven percent (Table 5.8). The non-premium payers, for that same package, on average decreased their bids by $0.15 (Table 5.9).

Table 5.7: Premium Payers Versus Non-Premium Payers by Area when Considering Willingness-to-pay with Unknown Ex Ante Expectations

Experiment Area	Number of Premium Payers	Number of Non-Premium Payers	Percent Premium Payers
All areas	204	125	62
Ames, IA	30	19	61
Manhattan, KS	40	20	67
Raleigh, NC (6/28/97)	19	12	61
Burlington, VT	15	12	56
Iowa Falls, IA	35	23	60
Corvallis, OR	38	22	63
Raleigh, NC (6/27/98)	27	17	61

Table 5.8: Participant Bid Levels for Premium Payers*

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bid Level per Package ($)		Premium Bid	
	No Information	Environmental Attribute Added	Absolute Change**	Percentage Change
No Particular Environmental Attributes (Typical)	4.44	3.81	**-0.63** (-6.08)	-14.11%
Odor 30-40%	4.53	4.15	**-0.38** (-3.99)	-8.47%
Odor 80-90%	4.33	4.29	-0.04 (-0.48)	-0.91%
Ground water 15-25%	4.14	4.17	0.03 (0.30)	0.63%
Ground water 40-50%	4.34	4.40	0.06 (0.62)	1.28%
Surface Water 15-25%	4.41	4.31	-0.10 (-1.15)	-2.20%
Surface Water 40-50%	4.36	4.54	*0.18* (2.06)	4.11%
Odor 80-90%/Ground Water 40-50%	4.57	5.13	**0.56** (6.20)	12.20%
Odor 80-90%/Surface Water 40-50%	4.47	5.21	**0.74** (7.96)	16.47%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	4.37	5.98	**1.60** (14.79)	36.70%

* A premium payer is a participant who paid a premium for the most environmental product—the triple attribute package.
** Note that the numbers in **bold** and *italic* represent a significant difference in the bid level from zero at the 0.001 and 0.05 level, respectively. The numbers in parenthesis represent the t-statistics.

Table 5.9: Participant Bid Levels for Non-Premium Payers*

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bid Level per Package ($)		Premium Bid	
	No Information	Environmental Attribute Added	Absolute Change**	Percentage Change
No Particular Environmental Attributes (Typical)	3.62	3.28	**-0.34** (-3.33)	-9.36%
Odor 30-40%	3.82	3.42	**-0.40** (-4.39)	-10.57%
Odor 80-90%	3.60	3.32	**-0.28** (-3.29)	-7.78%
Ground water 15-25%	3.54	3.34	*-0.19* (-2.25)	-5.45%
Ground water 40-50%	3.51	3.20	**-0.32** (-3.54)	-8.99%
Surface Water 15-25%	3.73	3.46	**-0.27** (-2.73)	-7.30%
Surface Water 40-50%	3.56	3.37	*-0.19* (-2.25)	-5.31%
Odor 80-90%/Ground Water 40-50%	3.71	3.63	-0.08 (-1.05)	-2.22%
Odor 80-90%/Surface Water 40-50%	3.68	3.56	-0.12 (-1.38)	-3.20%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	3.88	3.73	**-0.15** (-3.07)	-3.82%

* A non-premium payer is a participant who did not pay a premium for the most environmental product—the triple attribute package.

** Note that the numbers in **bold** and *italic* represent a significant difference from zero at the 0.001 and 0.05 level, respectively. The numbers in parenthesis represent the t-statistics.

For a breakdown of bid changes for the premium payers and non-premium payers by location from round three to round four, see appendix C. It should be noted that by definition, the premium for the non-premium payers would always be at or below zero for the triple attribute product. Otherwise, they would not be included in this group. This would imply that the average premium for the most environmental package will be no greater than zero for the non-premium payers. However, this does not imply that all the other goods are capped at a maximum of zero. It is conceivable that participants might decrease their bid for the most environmental package and increase the value of a package with less environmental attributes. This decrease could be an indication that one of the attributes in the bundle is undesirable, or that there was a misunderstanding of the experimental process.

Both the premium payers and the non-premium payers decreased their bid for the typical package when the environmental information was released. The premium payers decreased their bid more both in absolute and percentage terms. This group followed the same consistent bidding pattern as the whole group, while the non-premium payers did not. As shown in Table 5.8, the single environmental attribute package ranged from an eight percent decline for the package with the low-level odor attributes to a four percent increase for the package with the high-level surface water attributes following release of information. Bids for the double attribute packages increased from twelve to sixteen percent while the bid for the triple attribute package increased by thirty-seven percent.

When analyzing the change in bids from round three to round four for the premium payers, the packages of pork chops with multiple attributes all increased significantly at the 0.001 significance level once the information was released. In contrast, the package with a low-level reduction of odor and the typical package significantly decreased in value at the

0.001 significance level. At the five-percent significance level, the package with a single high-level attribute related to surface water also increased significantly. As for the rest of the packages, their bids did not significantly change. For the non-premium payers, the only packages that did not decrease significantly at the five-percent level were the double attribute packages.

Of the 125 participants who are considered to be non-premium payers, twenty-five of these bidders decreased their bids for the most environmental package while the rest kept their bid the same. Since decreasing the bids for the most environmental package was an unexpected result it warrants further analysis. Table 5.10 provides information on the non-premium payers who did not change their bids from round three to round four for the most environmental package, while Table 5.11 examines the bids for the non-premium payers that decreased their value for this same package.

Examining Tables 5.9, 5.10, and 5.11, it is evident that the average bids for the non-premium payers who decreased their bids are strictly greater for each product in the no information round than what the bids were for either the premium payers or those that did not change their bids. This could imply that these participants had a high demand for the packages of pork chops. It might also imply that these participants are still adjusting to the market. Also, the fourth round average bids for the non-premium payers who decreased their bids are strictly greater for each product than the average bids for the non-premium payers who did not change their bids. This is not the case when comparing the premium payers to this group of negative bidders. Hence it would seem that this group of negative bidders for the most environmental chop had a high demand for the packages but less demand for environmental attributes.

Table 5.10: Participant Bid Levels for Non-Premium Payers (Zero Bid Change for the Most Environmental Package)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bid Level per Package ($)		Premium Bid	
	No Information	Environmental Attribute Added	Absolute Change	Percentage Change
No Particular Environmental Attributes (Typical)	3.30	3.01	-0.30	-9.04%
Odor 30-40%	3.56	3.26	-0.30	-8.35%
Odor 80-90%	3.33	3.10	-0.22	-6.74%
Ground water 15-25%	3.26	3.17	-0.09	-2.77%
Ground water 40-50%	3.20	2.97	-0.23	-7.16%
Surface Water 15-25%	3.39	3.23	-0.15	-4.52%
Surface Water 40-50%	3.33	3.19	-0.13	-4.05%
Odor 80-90%/Ground Water 40-50%	3.47	3.39	-0.08	-2.44%
Odor 80-90%/Surface Water 40-50%	3.39	3.33	-0.06	-1.78%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	3.51	3.51	0.00	0.00%

Table 5.11: Participant Bid Levels for Non-Premium Payers (Negative Bid Change for the Most Environmental Package)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bid Level per Package ($)		Premium Bid	
	No Information	Environmental Attribute Added	Absolute Change	Percentage Change
No Particular Environmental Attributes (Typical)	4.89	4.39	-0.50	-10.25%
Odor 30-40%	4.89	4.05	-0.83	-17.06%
Odor 80-90%	4.67	4.17	-0.50	-10.75%
Ground water 15-25%	4.63	4.03	-0.60	-12.97%
Ground water 40-50%	4.78	4.11	-0.66	-13.89%
Surface Water 15-25%	5.09	4.34	-0.75	-14.72%
Surface Water 40-50%	4.49	4.09	-0.41	-9.04%
Odor 80-90%/Ground Water 40-50%	4.69	4.62	-0.07	-1.58%
Odor 80-90%/Surface Water 40-50%	4.83	4.48	-0.35	-7.20%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	5.36	4.62	-0.74	-13.84%

There could be at least two reasons for these negative bidders. Either they did not understand the intuition of the auction method used, or they were adversely affected by the environmental information provided. This would imply that these participants had a higher prior expectation of the embedded environmental attributes than what was actually true. If the answer were the latter, then this would lead to a major implication for auction experiments. The implication would be that auctions that solicit willingness-to-pay directly without knowing the participants' prior expectations and not allow for negative bids are needlessly censoring an important group. This censoring of the data could cause false conclusions to be drawn.

Willingness-to-pay with a Known Basis

In the previous two sections of this chapter, willingness-to-pay with unknown ex ante expectations was investigated. An advantage of looking at the premium in this way is that it first assures that there are no physical differences in the packages being studied. The only difference comes from the release of environmental information. The major disadvantage to this particular definition is that the expectations of the consumers regarding environmental attributes are unknown in the naïve bidding round where there is no environmental information given. It was seen above that the product that was denoted the typical product went down in value when the information regarding the embedded environmental attributes was released in the fourth round. This would imply that the consumer's expectations of the packages could not be viewed as the typical package. Using the other definition of willingness-to-pay discussed in chapter three, knowing the consumer's expectations is not an issue. This is because the basis package is known with this other definition because the comparisons of the packages are within the same information set. Hence the advantage of

this definition is that the expectations are known. A minor disadvantage of this method is that it must account for the slightly different perceived physical attributes, i.e., it must estimate the value of the visual quality differences and adjust for it.

This section will investigate this other definition of willingness-to-pay when the basis for product comparison is known. If all the packages were perceived as visually identical in the third round, then the willingness-to-pay measure can be calculated by subtracting the bid for the typical package in round four from the bid of the package with embedded environmental attributes from round four. But it was seen above that all packages were not perceived as having exactly identical physical attributes. Otherwise, the bids for the packages in round three would all be equal. Examining Table 5.2 shows that this was obviously not the case. This implies that the willingness-to-pay with known basis needs to be adjusted for the perceived physical differences. To make this adjustment, the difference between the typical package in round three and the corresponding package with embedded environmental attributes in round three must be accounted for. This would imply that this willingness-to-pay measure could be defined mathematically as:

$$WTP_i = (p_{i4} - p_{14}) - (p_{i3} - p_{13}) \quad \text{for } i \in EP.$$

WTP_i represents the willingness-to-pay measure with a known basis adjusted for perceived visual differences for the i-th package of pork chops with embedded environmental attributes. The bid for the typical product in round t is represented by p_{1t}, while p_{it} represents the i-th package of pork chops with embedded environmental attributes in round t. EP is the set of packages of pork chops that have embedded environmental attributes.

Table 5.12 provides information on the willingness-to-pay measure with known basis. Except for the package with the high-level ground water impact, the willingness-to-pay for

embedded environmental attributes is increasing with both level and number of embedded environmental attributes. This would be expected if environmental attributes are desired attributes. The package that commanded the smallest premium, $0.13, was the package with the low-level of reduction in odor attribute. As expected, the package that commanded the highest premium, $1.46, was the triple attribute high-level environmental package. Unlike the previous definition, this definition indicates a positive willingness-to-pay for every bundle of embedded environmental attributes. When testing to see if these willingness-to-pay values are strictly greater than zero, only the package with a low-level reduction of odor is not significantly different than zero at the five-percent significance level.[4] The rest of the packages are significantly greater than zero. When examining whether the premiums differed across attribute levels, it was found that at the five-percent level of significance, all of the premiums for the single attribute packages, excluding the package related to low-level odor reduction, were not statistically different. Utilizing this same test, shows that the packages with double attributes are also not significantly different from each other. The premium for the triple attribute package was significantly different from all other packages.

Examining Table 5.12 closer shows another interesting finding. It appears that the attributes are additive. Additivity implies that if the premiums for the single high-level attributes are added together, then they would equal the premium for the product with those combinations of attributes. For example, if the premiums for the three single high-level attribute packages are added together, the combined premium value is $1.38. The actual premium given for the triple attribute product was $1.46—only an $0.08 difference. This also holds for the odor/groundwater combination but not necessarily for the odor/surface

[4] Note that this is a one sided t-test and has a critical value approximately equal to 1.65 for $n > 30$.

Table 5.12: Willingness-to-Pay with Known Basis (All Participants)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bids($) Willingness-to-Pay with Known Basis
No Particular Environmental Attributes (Typical)	Basis
Odor 30-40%	0.13 (1.55)
Odor 80-90%	**0.39** (5.21)[a]
Ground water 15-25%	**0.46** (6.10)[a]
Ground water 40-50%	**0.43** (5.07)[a]
Surface Water 15-25%	**0.35** (4.42)[a]
Surface Water 40-50%	**0.56** (6.40)[a]
Odor 80-90%/Ground Water 40-50%	**0.83** (8.58)[b]
Odor 80-90%/Surface Water 40-50%	**0.93** (9.22)[b]
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	**1.46** (12.56)[c]

Note: The number in parenthesis is the t-statistic for the test of whether the average bid is different from zero. Those numbers in **bold** were significantly different from zero. Also, the letter indicates that by doing a pairwise comparison between the premiums for the products, there was no statistical difference between the means being compared at the five-percent level of significance.

water combination. Testing to see if these two means are significantly different from each other reveals that the null hypothesis of equality can not be rejected at the five-percent level of significance. This type of result holds true for the double attribute packages. Assuming that marketing costs are same for single, double, and triple environmental attribute packages, this approach may suggest that there may not be premium gains from selling packages of pork chops with combined attributes. Offering single attribute products may be just as beneficial.

Table 5.13 provides the willingness-to-pay with a known basis for embedded environmental attributes by location. In general, premiums were similar across locations. All but one of the premiums were positive. The only exception was Oregon for the package with a low-level environmental attribute related to odor reduction. Upon further investigation, Oregon consistently has the lowest premiums for each package if the package with low-level surface water attribute is excluded. This might be explained by the fact that Oregon had consistently lower average bids overall. When testing to see if the premiums for the packages differed across location, there were only a few differences. Most occurred in Oregon where seventeen differences were shown. The other seven significant differences occurred between Ames, Iowa and Manhattan Kansas. Amongst all the other location comparisons, there were no statistically significant differences. When examining the package with triple attributes, the second experiment in Raleigh, North Carolina had the highest premium of $1.87, while the lowest occurred in Oregon at a premium of $1.19.

Willingness-to-pay with Known Basis: Premium Vs. Non-Premium Payers

In the last section, willingness-to-pay with a known basis was examined. It was found that this average premium over all participants was positive at the aggregate level for each package. This would imply that embedded environmental attributes are desirable attributes that consumers would pay for. In this section, the premium payers and the non-premium payers will be investigated under the known basis approach to measuring willingness-to-pay. In this case, a premium payer will be defined as a participant who has a positive willingness-to-pay for the package with the triple attributes, i.e., a participant who tendered a higher bid for the most environmental package over the typical package in the fourth round.

Table 5.13: Willingness-to-Pay for Embedded Environmental Attributes with a Known Basis by Product and Location

	Location						
Pork Chop Environmental Attributes (Level of Improvement over Typical)	**Ames, IA**	**Manhattan, KS**	**Raleigh, NC (97)**	**Burlington, VT**	**Iowa Falls, IA**	**Corvallis, OR**	**Raleigh, NC (98)**
No Particular Environmental Attributes (Typical)	Basis	Basis	Basis	Basis	Basis	Basis	Basis
Odor 30-40%	0.18[a]	0.09	0.12	0.21	0.21	-0.28[a,b]	0.52[b]
Odor 80-90%	0.57[c]	0.31[c,d]	0.37	0.35	0.38	0.09[d,e]	0.75[e]
Ground water 15-25%	0.61[f]	0.47[f,g]	0.56	0.66[h]	0.36	0.07[g,h,i]	0.75[i]
Ground water 40-50%	0.69[j]	0.39[j]	0.24	0.77	0.35	0.24	0.50
Surface Water 15-25%	0.54	0.09	0.30	0.50	0.42	0.24	0.52
Surface Water 40-50%	0.95[k,l]	0.54[o]	0.44	0.70[p]	0.54	0.10[k,l,o,p,q]	0.77[q]
Odor 80-90%/Ground Water 40-50%	1.18[r,s,t]	0.77[r,u]	0.76	0.93	1.10	0.23[s,t,u,v]	0.98[v]
Odor 80-90%/Surface Water 40-50%	1.04[w]	0.93[w]	0.74	1.15	1.03	0.48[x]	1.29[x]
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	1.62[y]	1.32[y]	1.27	1.63	1.44	1.19	1.87

* Corresponding letters indicate that at the five percent level of significance the null hypothesis of the two changes being equal across location for each product could not be rejected.

Table 5.14 presents the distribution of premium payers versus non-premium payers across the different locations. When comparing the two definitions used to define premium payers, there was an eighty-four percent overlap between the two definitions. Hence, of the 329 participants in the study, eighty-four percent were classified as making the same decision under both definitions—a premium payer was classified as a premium payer and a non-premium payer was classified as a non-premium payer. Using the present definition, on the aggregate level sixty-nine percent of the participants paid a premium. This percentage is seven percent higher than with the previous definition of willingness-to-pay. The percentage of premium payers ranged from fifty-seven percent to eighty-one percent in the different study areas. The location with the highest percentage of premium payers was Burlington, Vermont at eighty-one percent. This is in stark contrast to the previous definition where Vermont had the lowest percent of premium payers at fifty-six percent. The location with the lowest percentage of premium payers under this definition was Iowa Falls, Iowa at fifty-seven percent. Except for Iowa Falls, the percentage of premium payers increased for all other locations under this new definition.

Table 5.14: Premium Payers Versus Non-Premium Payers by Area when Considering Willingness-to-pay with a Known Basis

Experiment Area	Number of Premium Payers	Number of Non-Premium Payers	Percent Premium Payers
All areas	228	101	69
Ames, IA	34	15	69
Manhattan, KS	44	16	73
Raleigh, NC (6/28/97)	24	7	77
Burlington, VT	22	5	81
Iowa Falls, IA	33	25	57
Corvallis, OR	40	20	67
Raleigh, NC (6/27/98)	31	13	70

Table 5.15 presents the average premium paid for each package for only those who paid a premium for the most environmental package. The highest premium of $2.23 went to the package with the triple attributes while the package with a low-level of odor reduction only received a premium of $0.35 over the typical package. As expected, the average premium paid for each package is positive and significantly different from zero at the 0.001 significance level. As with aggregate data, when the package with a low-level attribute related to odor is excluded, the premiums for the packages with a single high and low-level attribute are not significantly different from each other at the five-percent level of

Table 5.15: Willingness-to-Pay with Known Basis (Premium Payers)

	Average Bids($)
Pork Chop Environmental Attributes (Level of Improvement over Typical)	**Willingness-to-Pay with Known Basis**
No Particular Environmental Attributes (Typical)	Basis
Odor 30-40%	0.35 (3.50)
Odor 80-90%	0.69 (7.71)[a]
Ground water 15-25%	0.74 (8.19)[a]
Ground water 40-50%	0.79 (7.91)[a]
Surface Water 15-25%	0.65 (7.09)[a]
Surface Water 40-50%	0.90 (8.35)[a]
Odor 80-90%/Ground Water 40-50%	1.31 (11.10)[b]
Odor 80-90%/Surface Water 40-50%	1.44 (11.90)[b]
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	2.23 (16.73)[c]

Note: The number in parenthesis is the t-statistic for the test of whether the average bid is different from zero. Also, the letter indicates that by doing a pairwise comparison between the premiums for the products, there was no statistical difference between the means being compared at the five-percent level of significance.

significance. Also, when comparing the two double attribute packages, their premiums are not significantly different from each other at the five-percent level of significance. All other comparisons are significantly different from each other. When examining premiums by package, it is easy to see that the premiums follow a consistent pattern of increasing by both level and number of attributes. This pattern includes the package with the high-level attribute related to ground water. This result would imply that the inconsistency in the pattern seen in the aggregate data, i.e., the low-level attribute package receiving a higher premium than the high-level attribute package, stems from the non-premium payers.

The aspect of additivity, while not as pronounced with the premium payers as it was with the aggregate data, is still evident. When adding the premiums of each single high-level attribute package together would indicate that the premium for the triple package should be $2.38. The actual premium paid for the triple attribute product was $2.23, a difference of only $0.15. Testing to see if the two means are equal gives a t-statistic of -0.51. This would imply that they are not significantly different from each other at the five-percent level of significance and that additivity holds for the premium payers.

Table 5.16 presents the information for the non-premium payers under the current definition of willingness-to-pay. These 101 non-premium payers made up thirty-one percent of the participants in the study. It should be kept in mind that by definition of being a non-premium payer, the triple attribute package must have a premium no greater than zero. This does not necessarily imply that all the other packages must have a negative premium. When examining this group, it is easy to see that the participants decreased the value for all packages over the typical. The greatest decrease of $0.39 came from the package with a high-level attribute related to ground water. This decrease explains the source of the

inconsistency seen in the aggregate data where the package with low-level ground water attribute received a higher premium than the package with the high-level attribute. Examining whether these decreases were significantly different from zero at the five-percent level of significance, two packages have premiums not statistically different from zero. These packages were the low-level ground water attribute package and the package related to having a both surface water and odor reduction attributes. Inspecting the data in the table for a reason why participants decreased their bids reveals no consistent pattern related to environmental attributes. The smallest decrease in premium of $0.18 was related to the

Table 5.16: Willingness-to-Pay with Known Basis (Non-Premium Payers)

	Average Bids($)
Pork Chop Environmental Attributes (Level of Improvement over Typical)	**Willingness-to-Pay with Known Basis**
No Particular Environmental Attributes (Typical)	Basis
Odor 30-40%	-0.38 (-3.09)[a]
Odor 80-90%	-0.29 (2.73)[a]
Ground water 15-25%	-0.18 (-1.62)[a]
Ground water 40-50%	-0.39 (-3.03)[a]
Surface Water 15-25%	-0.32 (-2.35)[a]
Surface Water 40-50%	-0.22 (-2.00)[a]
Odor 80-90%/Ground Water 40-50%	-0.24 (-2.12)[a]
Odor 80-90%/Surface Water 40-50%	-0.22 (-1.82)[a]
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	-0.30 (-3.29)[a]

Note: The number in parenthesis is the t-statistic for the test of whether the average bid is different from zero. Also, the letter indicates that by doing a pairwise comparison between the premiums for the products, there was no statistical difference between the means being compared at the five-percent level of significance.

package with a low-level ground water attribute. A test between a pairwise comparison of the premiums reveals that there is no significant difference between any of the premiums at the five-percent level of significance.

Of the 101 participants that are classified as non-premium payers based on the current definition of willingness-to-pay, twenty-seven decreased their value for the most environmental package. This number is equivalent to the twenty-five participants that decreased their bid under the previous definition of willingness-to-pay. Table 5.17 separates the non-premium payers into two groups—those participants that had the same value for typical and most environmental package and those participants that had a higher bid for the typical package over the most environmental package. As seen in the table, these two groups are very distinct. The participants that had a premium of zero for the most environmental goods also had a premium bid of zero for the rest of the packages. Some of these premiums were positive, while the rest were negative. Testing to see whether these premiums are statistically equal to zero, the null hypothesis of equality to zero cannot be rejected at the five-percent level of significance. This would imply that the environmental information had no effect on these participants.

When examining the negative bidders' premiums for each product, a different picture appears. All of the average premiums are significantly different from zero at the five-percent level of significance. In fact all of the premiums are strictly negative. This would imply that this group is negatively affected by embedded environmental attributes within the packages. Comparing both groups together shows that the zero bidders were not affected by the

Table 5.17: Zero Bidders Versus Negative Bidders when Considering Willingness-to-pay with Known Basis

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Average Bids($) Willingness-to-Pay with Known Basis (Zero Bidders) (N=74)	Willingness-to-Pay with Known Basis (Negative Bidders) (N=27)
No Particular Environmental Attributes (Typical)	Basis	Basis
Odor 30-40%	-0.12 (-1.31)	-1.09 (-3.09)
Odor 80-90%	-0.06 (-0.64)	-0.92 (-3.49)
Ground water 15-25%	0.09 (0.96)	-0.91 (-3.03)
Ground water 40-50%	-0.14 (-1.12)	-1.05 (-3.59)
Surface Water 15-25%	-0.02 (-0.12)	-1.15 (-3.54)
Surface Water 40-50%	0.02 (0.20)	-0.88 (-2.80)
Odor 80-90%/Ground Water 40-50%	-0.06 (-0.58)	-0.73 (-2.49)
Odor 80-90%/Surface Water 40-50%	-0.01 (-0.09)	-0.79 (-2.58)
Odor 80-90%/Ground Water 40-50% Surface Water 40-50%	0.00 (0.00)	-1.11 (-3.87)

Note: The number in parenthesis is the t-statistic for the test of whether the average bid is different from zero.

environmental information, while the negative bidders are extremely affected in a negative manner due to the environmental information. Finally, neither group shows a consistent pattern why they bid the level of premium they did based on environmental attributes.

CHAPTER SIX: RESULTS FROM PRE AND POST AUCTION SURVEYS

Chapter three presented a model of consumer behavior in a second-price sealed-bid auction with multiple rounds. Within chapter three, an interpretation of the bids from a second-price auction was given. Also in chapter three, two willingness-to-pay measures are defined. In chapter five, results are examined to determine whether consumers would pay a premium for pork products with embedded environmental attributes. The first definition of a premium payer considered a participant who increased their bid for the package with the most environmental attributes from round three to round four. In this case, it was found that approximately sixty-two percent of the participants could be considered premium payers. Another way of defining a premium payer is to consider a participant who bid a higher value for the environmental package over the typical package in the same information round, specifically round four. In this case, sixty-nine percent of the participants could be considered premium payers. In this chapter, the pre and post experiment surveys completed by the participants will be analyzed. The pre experiment survey will initially be analyzed at the aggregate level. Then results are provided by premium payers and non-premium payers to evaluate for differences between the two groups. Both of the definitions for a premium payer will be analyzed. The post survey, which relates to consumer's knowledge of production practices, is only analyzed at the aggregate level.

There were two surveys conducted during each experiment, one before the auctions and one after the auctions. The pre auction survey asked questions that related to socioeconomic factors, e.g., age, gender, and household income. It also asked questions related to issues of concern, e.g., the environment, food prices, and family farming. Furthermore, questions

were asked relating to the attributes that the participant consumed, e.g., eating quality, visual appeal, and price. See appendix B for the specific questions related to the pre auction survey. The post auction survey asked questions that pertained to knowledge about pork production. Questions were asked about the acceptability of different methods for reducing odor in production, reducing manure seepage into ground water, and reducing manure run-off or spills into surface water. Also asked on this survey were questions related to concerns about farm issues and livestock production methods. See appendix B for the post auction questions.

Pre Auction Survey

Table 6.1 provides general information of the socioeconomic characteristics for the participants in the study. This information is provided by study location in Appendix D. Of the participants in the study, about six in ten were female (59.88%). This reflects responsibility for food purchases, as when the household was initially contacted by telephone, the primary food purchaser was encouraged to come to the experiment if they were available. The average age of participants was forty-eight years with an average of 2.69 individuals per household. Average household income for the study participants was approximately $43,400, with an employment level of sixty-six percent.[1] Most participants consumed meat, poultry, and fish. Pork was consumed on average 5.83 times per month, while poultry was consumed nearly double that at 10.04 times per month. Beef consumption

[1] It should be noted that the question related to employment asked whether the participant was employed. Another question asked what was the occupation of the participant. Most of the participants that were homemakers labeled themselves as not employed which should be taken into consideration. When accounting for homemakers as being employed, this increases the employment level of the participants to seventy-seven percent.

Table 6.1: General Socioeconomic Information: All Participants

Item	All Participants (N = 329)
Females %	59.88
Age Years	47.74
Number Living in Household	2.69
Education Level Years[a]	13.98
Employed %	65.65
Household Income $[b]	$43,400
Consume Beef %	96.65
Consume Pork %	95.72
Consume Poultry %	97.86
Consume Fish %	89.30
Times Consume Beef per Month	9.90
Times Consume Pork per Month	5.83
Times Consume Poultry per Month	10.04
Times Consume Fish per Month	3.91
Number of Production Facilities Within One Mile	0.14
Number of Production Facilities Within Two Mile	0.41
Commercial Livestock and/or Crop Producers %	1.23
Read Food Labels[c]	2.38
Notice Environmental Attributes on Labels %	52.01
Consume More Beef Due to Advertising %	15.48
Consume More Pork Due to Advertising %	30.82
Want Environmental Labeling for Most Products %[d]	94.75
Would Pay a Premium for Meat Products with Environmental Attributes %[d]	64.80
Want Education for Pork Producers %[d]	89.54

[a] This was imputed from categorical responses using mean years with in the category as the observation.
[b] This was imputed from categorical responses using mean income within the category as the observation.
[c] 1=never; 2=sometimes; 3=always
[d] Note: these questions were asked on the post auction survey.

was closer to poultry at an average of 9.9 times per month, whereas fish consumption was below pork at an average of 3.91 times per month.

When asked the question "how many pork production facilities are within a one mile radius of your dwelling," the average participant response was 0.14 facilities. This number nearly tripled when this radius is taken to two miles (0.41 production facilities). It should be noted that a large proportion of the participants did not have any hog facilities within a two mile radius of their dwelling. Only a small percent of the participants considered themselves as commercial livestock and/or crop producers. Of the participants, 1.23 percent of them commercially produced livestock or crops.

Participants indicated that they read labels on the products they buy. The average value was 2.38 where a 2 denoted "sometimes read labels" and a 3 denoted "always read labels." All the participants in this study indicated they read labels at least sometimes. About one-half indicated that they had noticed environmental attributes on labels and ninety-five percent indicated they would like to have environmental information provided on product labels. Almost all of the participants indicated that they would buy a meat product that had environmental attributes specified on the label. It should be clarified that this question did not ask whether they would pay a premium, rather it asked if they would consume meat that had environmental attributes. This implies that there is not an aversion to meat products with environmental attributes. Hence environmental attributes are perceived as a good; so much so, that almost ninety-percent want pork producers to have environmental education on production practices. When participants were asked whether they would pay a

premium for meat products with environmental attributes, 64.8 percent indicated they would.[2] This is remarkably close to the number that actually did pay a premium.

It is interesting to note that about one-third of the participants indicated that they had purchased more pork as a result of advertisements they had seen in the media. Approximately fifteen percent of the participants felt they had consumed more beef as a result of advertisements. This might imply that the pork advertising campaign, *Pork, The Other White Meat*, may be more effective than the beef campaign, *Beef It is What's for Dinner*. This effect may also be due to the larger number of times beef was consumed per month as compared to pork.

Premium vs. Non-Premium Payer

Table 6.2 presents a comparison of socioeconomic factors of the premium payers and the non-premium payers when a premium payer is defined as a participant who increased her bid from round three to round four for the most environmental package. Table 6.3 represents a comparison of these same factors where a premium payer in this case is defined as a participant who provided a higher bid for the most environmental good compared to the typical package in the environmental information round, round four. Examining both tables carefully shows that the characteristics of premium payers across definitions are very similar. In fact, at the five-percent level of significance, they are not significantly different from each other.[3] This result also holds for the non-premium payers. Since there is no significant

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[2] It should be noted that this question was asked on the post auction survey. This was done for two reasons. First, it was in the post auction survey to reduce bias in the auction experiment. If this question had been asked before the experiment it may have created an expectation that environmental attributes were the focus of the study. Second, it allows for testing whether participants knew their own preferences.

[3] For the continuous variables, the t-test from chapter five was used. In the case of the proportional data, a test from Freund was used (1992, p. 481). In this case, it is assumed that these proportions are being drawn from a binomial distribution.

Table 6.2: Comparison of General Information: Premium Payers, Non-Premium Payers for Definition One of Willingness-to-Pay[a]

Item	Premium Payers (N = 204)	Non-Premium Payers (N = 125)
Females %	63.24	54.40
Age Years	46.83	49.23
Number Living in Household	2.76	2.57
Education Level Years[b]	14.36	13.28
Employed %	71.08	56.80
Household Income $[c]	$44,400	$41,700
Consume Beef %	97.06	95.97
Consume Pork %	97.06	93.50
Consume Poultry %	99.02	95.93
Consume Fish %	90.69	86.99
Times Consume Beef per Month	10.06	9.64
Times Consume Pork per Month	5.62	6.18
Times Consume Poultry per Month	9.98	10.13
Times Consume Fish per Month	3.66	4.33
Number of Production Facilities Within One Mile	0.11	0.19
Number of Production Facilities Within Two Mile	0.41	0.41
Commercial Livestock and/or Crop Producers %	0.99	1.61
Read Food Labels[d]	2.39	2.37
Notice Environmental Attributes on Labels %	54.68	47.50
Consume More Beef Due to Advertising %	13.33	19.13
Consume More Pork Due to Advertising %	28.36	35.04
Want Environmental Labeling for Most Products %[e]	96.06	92.56
Would Pay a Premium for Meat Products with Environmental Attributes %[e]	71.64	53.33
Want Education for Pork Producers %[e]	92.61	84.43

[a] A premium payer under this definition is a participant who increased her bid for the most environmental package from round three to round four.
[b] This was imputed from categorical responses using mean years with in the category as the observation.
[c] This was imputed from categorical responses using mean income within the category as the observation.
[d] 1=never; 2=sometimes; 3=always
[e] Note: these questions were asked on the post auction survey.

Table 6.3: Comparison of General Information: Premium Payers, Non-Premium Payers for Definition Two of Willingness-to-Pay[a]

Item	Premium Payers (N = 228)	Non-Premium Payers (N = 101)
Females %	65.35	47.52
Age Years	45.90	51.95
Number Living in Household	2.77	2.51
Education Level Years[b]	14.20	13.44
Employed %	70.18	55.45
Household Income $[c]	$44,700	$40,400
Consume Beef %	96.93	96.00
Consume Pork %	96.48	94.00
Consume Poultry %	98.68	96.00
Consume Fish %	89.87	88.00
Times Consume Beef per Month	9.88	9.94
Times Consume Pork per Month	5.55	6.45
Times Consume Poultry per Month	10.35	9.32
Times Consume Fish per Month	3.72	4.35
Number of Production Facilities Within One Mile	0.09	0.19
Number of Production Facilities Within Two Mile	0.31	0.24
Commercial Livestock and/or Crop Producers %	0.99	0.64
Read Food Labels[d]	2.37	2.40
Notice Environmental Attributes on Labels %	52.86	50.00
Consume More Beef Due to Advertising %	14.61	19.13
Consume More Pork Due to Advertising %	28.00	17.58
Want Environmental Labeling for Most Products %[e]	95.59	92.78
Would Pay a Premium for Meat Products with Environmental Attributes %[e]	71.68	48.42
Want Education for Pork Producers %[e]	92.07	83.67

[a] A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four.
[b] This was imputed from categorical responses using mean years with in the category as the observation.
[c] This was imputed from categorical responses using mean income within the category as the observation.
[d] 1=never; 2=sometimes; 3=always
[e] Note: these questions were asked on the post auction survey.

differences between socioeconomic characteristics between the two definitions, only the comparisons in Table 6.2, the first definition mentioned, shall be discussed.

For most comparisons in Table 6.2 there were no significant differences between the premium payers and the non-premium payers. Many of the tendencies were in the expected direction such as a larger percent of the premium payers noticed and wanted environmental labels. However, these differences were not significant at the five-percent level of significance. Three factors were significantly different at the five-percent significance level between the two groups. These dealt with employment, the desire for pork producers to have education in environmental awareness and production practices, and paying a premium for meat products with environmental attributes. The premium payers had a significantly higher percentage of employment. Premium payers also had a significantly higher percentage of participants who wanted pork producers to have environmental education.

As expected the non-premium payers had a significantly lower proportion saying they would pay a premium for meat products with environmental attributes than the premium payers would. For those who actually paid a premium nearly seventy-two percent said they would pay a premium, while fifty-three percent of the non-premium payers said they would pay a premium. These results also hold for the second definition of willingness-to-pay. It was expected that the premium payers should be closer to 100 percent giving a premium, while the non-premium payers should have been closer to zero. Using a binomial distribution test as in Freund (1992), the premium payers are significantly less than 100 percent at the .001 significance level, while the non-premium payers are significantly above zero at this same level of significance.

This result is very interesting because it came after the experiment where the participants had already bid according to their preferences. There may be at least two reasons for this result. The first reason could be that the information in the experiment, specifically from rounds four and five, changed the participants' preferences. Since the reported premiums for this study are due to the environmental information from round four, the information provided in round five may have changed the participants' preferences, e.g., the environmental information from round four became more or less important due to the information from round five. This might explain why the premium payers are not at one hundred percent, but it is highly unlikely that this would explain the non-premium payers. This was because the bids in round five did not change significantly as would be expected if the information from round five had been preference altering. Another explanation for this disparity is that there is a group of free-riders who are indicating that they would pay a premium when in actuality they would not. This result would be strictly related to the non-premium payers.

Since the rest of the comparisons are not statistically different, a general discussion of trends will be provided. Comparing the premium payers to the non-premium payers, females were more likely to pay a premium. Non-premium payers tended to be older on average by 2.5 years, while the education level was approximately the same with the premium payers only having on average a half a year more education. Household incomes were slightly higher for the premium payers by $2,700. Premium payers consumed more beef per month than poultry, pork, or fish. The number of production facilities within a one-mile radius of the participants dwelling tended to be higher for the non-premium payers, while extending this radius to two miles made the two groups equal. Due to the direct benefit received from

pork products produced with embedded environmental attributes, it was expected that a higher concentration hog production facilities would be directly associated with being a premium payer. It seems that this may not be true for people who live very close to these facilities. This may give some credence to the study done by Taff et al (1996). A plausible argument given by Taff et al. is that many people self–select themselves to the environment around which they live.

When it came to reading food labels premium payers and non-premium payers were nearly identical in the average response. The premium payers had a higher proportion noticing environmental attributes provided on the labels of the products they consume. Environmental information was important to both sets of participants. Over ninety-two percent of both groups indicated they wanted environmental labeling. The premium payers were at a slightly higher percentage. This may imply that industry programs focusing on providing environmental information and education are important and are looked upon favorably by consumers.

Information on participant response to issues of concern is shown in Table 6.4. These results are provided by study location in Appendix D. Like the previous results, there is very little difference between which definition is used for a premium payer. In the survey a 1 denoted "very concerned" and a 5 denoted "not concerned." In general, participants were "very concerned" to "somewhat concerned" about the environment, water quality, air quality, food prices and pollution. The level of concern was lower for family farming, production methods, animal welfare, confinement livestock systems, and changing farm structure. Under both definitions of a premium, premium payers were more concerned about air quality, food prices, family farming, and pollution than non-premium payers were. For the

Table 6.4: Issues of Concern: All Participants, Premium Payers, Non-Premium Payers

Item	All Participants (N = 329)	Premium Payers Definition 1[a] (N = 204)	Premium Payers Definition 2[b] (N = 228)	Non-Premium Payers Definition 1[a] (N = 125)	Non-Premium Payers Definition 2[b] (N = 101)
Issues of Concern[c]					
Water Quality	1.38	1.36	1.38	1.43	1.40
Pollution	1.48	1.45	1.45	1.52	1.55
Air Quality	1.55	1.50	1.53	1.62	1.59
Environment	1.64	1.60	1.64	1.71	1.64
Food Prices	1.93	1.88	1.85	2.00	2.10
Animal Welfare	2.37	2.39	2.39	2.33	2.32
Production Methods	2.44	2.44	2.47	2.45	2.38
Confinement	2.44	2.42	2.44	2.47	2.43
Family Farm	2.59	2.54	2.57	2.67	2.63
Structure Of Agriculture	2.94	2.87	2.96	3.05	2.87

[a] A premium payer under this definition is a participant who increased her bid for the most environmental package from round three to round four, whereas, a non-premium payer did not increase her bid.

[b] A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four; whereas, the non-premium-payer had a higher bid on the typical package.

[c] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

issues of production methods, animal confinement, and the changing structure of agriculture, there were no definitive preferences when examining the premium payers under both definitions of a premium.

Information in Table 6.5 focuses on participant's attitudes toward attributes of food products they consume. These results are provided by study location in Appendix D. For this information a 1 indicated "very important" while a 5 indicated "not important." All were

Table 6.5: Issues of Importance: All Participants, Premium Payers, Non-Premium Payers

Item	All Participants	Premium Payers	Non-Premium Payers
Issues of Importance Pertaining to Defintion 1[a,b]	**N = 329**	**N = 204**	**N = 125**
Freshness	1.18	1.19	1.16
Eating Quality	1.20	1.21	1.17
Visual Appeal	1.68	1.71	1.63
Price	1.75	1.73	1.78
Uniformity of Product	2.14	2.15	2.13
Production Methods	2.20	2.25	2.12
Issues of Importance Pertaining to Defintion 2[a,c]		**N = 228**	**N = 101**
Freshness		1.19	1.16
Eating Quality		1.21	1.18
Visual Appeal		1.70	1.62
Price		1.69	1.88
Uniformity of Product		2.18	2.06
Production Methods		2.26	2.05

[a] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

[b] A premium payer under this definition is a participant who increased her bid for the most environmental package from round three to round four; whereas, a non-premium payer did not increase her bid.

[c] A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four; whereas, the non-premium-payer had a higher bid on the typical package.

very concerned to somewhat concerned about food eating quality, visual appeal, freshness, and price. Production methods used in producing the food, and uniformity of product had lower levels of importance. There were no significant differences between the premium and non-premium payers under both definitions.

Post Auction Survey

The information in Table 6.6 provides participant responses to acceptability of methods producers use to reduce odors. Filtration of air from livestock buildings was an acceptable method for odor reduction; approximately sixty-seven percent indicated it was "very acceptable" to "somewhat acceptable." Microbial and enzyme additives to manure as a method for odor reduction had a slightly lower level of acceptability; slightly more than fifty percent indicated it was "very acceptable" to "somewhat acceptable." Another thirty-six to thirty-seven percent indicated they had a neutral or no opinion stance. Chemical additives to manure were less acceptable. Approximately one in five indicated that this was a "very acceptable" to "somewhat acceptable" method of odor control. Four in ten indicated it was "somewhat unacceptable" to "not acceptable." Only ten percent of the participants indicated that use of chemicals in a hog's diet as a means of odor control was "very acceptable" to "somewhat acceptable." In contrast, use of natural additives to a hog's diet was highly acceptable. Over seventy-five percent of the participants reported that this method was very to "somewhat acceptable." This would imply that consumers find it more desirable to have natural solutions to odor problems.

When considering manure storage and injection methods for controlling odor, participants' attitudes differed. The range of those indicating "somewhat acceptable" to "not acceptable" ranged from twenty-six percent for manure storage above ground, forty-one

Table 6.6: Distribution for Participant Responses on the Acceptability of Methods for Odor Reduction (N = 329)

	Percentage Of Participants					
Method	**Very Acceptable**	**Somewhat Acceptable**	**Neutral**	**Somewhat Unacceptable**	**Not Acceptable**	**No Opinion**
Filtration of air from building	46.95	21.04	16.46	2.74	4.57	7.32
Additives to manure:						
Chemical	6.23	12.79	21.64	17.38	23.93	18.03
Microbial	24.92	27.51	17.48	4.53	6.15	19.42
Enzyme	27.80	25.56	18.53	4.15	5.43	18.53
Additives to hog's diet:						
Chemical	2.37	7.46	14.92	14.92	48.14	11.86
Natural	49.38	26.85	9.88	2.47	4.63	6.79
Injection of manure into soil to a depth of 4-8 inches	6.12	11.93	29.05	13.76	22.02	17.13
Manure spread on top of soil with immediate incorporation	8.26	23.55	27.22	14.37	11.93	14.68
Manure storage above ground with cover	14.11	21.78	25.77	11.96	14.11	12.27
Manure storage below ground with cover	8.62	13.85	25.54	17.23	24.00	10.77
Manure storage under hog building	2.76	8.59	22.70	18.10	32.82	15.03
Composting with bedding material	16.16	27.13	22.87	8.84	9.15	15.85

percent for manure storage below ground, and fifty-one percent for manure storage under the hog building. Participants were more acceptable of manure storage systems that were above ground and away from the pigs. The highest level of acceptance was for composting with bedding material. Forty-three percent indicated that this was "very acceptable" to "somewhat acceptable."

It is important that about one-fourth of the participants were neutral with respect to the method of manure storage and incorporation method. Another ten to twenty percent had no opinion in these areas. Given this, there is an educational focus needed because a large number of participants provided a neutral to no opinion response.

Information in Table 6.7 provides participant acceptability of manure handling methods as they perceive it relates to ground water impacts. Again, there were a large number with a neutral (22-23%) or no opinion (12-16%). When groundwater was considered, injection had the lowest level of acceptability; twenty-seven percent indicating "not acceptable." It was "very acceptable" to "somewhat acceptable" for only one in five participants. Half indicated that manure storage above ground in steel/cement structures was acceptable. Below ground storage was acceptable for thirty-seven percent of the participants.

Table 6.8 provides information on participant acceptability of methods used for manure storage and application related to surface water impacts. Results are quite similar to Table 6.7 on ground water. Again, manure storage above ground was more acceptable. It was interesting that injection was less acceptable than surface application. It should be noted that when the injection method is used properly, it is a better method of getting your manure on fields than spreading the manure on the top soil from the point of view of odor reduction, and ground and surface water protection.

Table 6.7: Distribution for the Acceptability of Methods Used To Achieve A Reduction Of Manure Seepage Into Ground Water (N = 329)

	Percentage of Participants					
Method	Very Acceptable	Somewhat Acceptable	Neutral	Somewhat Unacceptable	Not Acceptable	No Opinion
Injection of manure into the soil to a depth of 4 to 8 inches	4.91	14.72	21.78	15.34	27.61	15.64
Manure storage above ground in steel/cement structure	18.71	31.60	23.31	5.52	8.90	11.96
Manure storage below ground in steel/cement Structure	15.38	23.38	22.46	12.00	14.46	12.31

Table 6.8: Distribution of the Acceptability of Methods Used To Achieve A Reduction In Run-off Or Spill Of Manure Into Surface Water (N = 329)

	Percentage of Participants					
Method	Very Acceptable	Somewhat Acceptable	Neutral	Somewhat Unacceptable	Not Acceptable	No Opinion
Injection of manure into the soil to a depth of 4 to 8 inches	5.21	15.34	23.62	14.11	26.99	14.72
Manure spread on top of soil with immediate incorporation	6.13	24.54	23.62	16.26	18.10	11.35
Manure storage above ground in steel/cement structure	19.02	32.52	20.86	5.83	8.90	12.88
Manure storage below ground in steel/cement structure	14.11	23.62	22.09	11.04	15.64	13.50

Participant concerns about farm issues and type of production facilities are presented in Tables 6.9 and 6.10. Information in Table 6.9 shows that most of the participants (82%) are "very concerned" to "somewhat concerned" about the impact of livestock production on the environment. Eight in ten are concerned about the worker environment, while seven in ten are concerned about the animal environment. About half the participants indicate a concern about the structure of the farm industry. For this, thirty-percent had no opinion or were neutral.

About half the participants indicated they were "somewhat favorable" to "not favorable" toward total confinement production; thirteen percent indicated they were very to somewhat favorable (Table 5.10). Pasture production was indicated as "very favorable" to "somewhat favorable" by fifty-six percent of the participants. Approximately three in ten participants rated partial confinement as "very favorable" to "somewhat favorable." It is interesting to note that sixty-five percent of the participants had no opinion on a hoop pork

Table 6.9: Distribution of Participant Concerns About Farm Issues

	Percentage of Participants					
Issue of Concern	**Very Concerned**	**Somewhat Concerned**	**Neutral**	**Somewhat Unconcerned**	**Not Concerned**	**No Opinion**
Environmental impact from livestock production	46.15	36.00	11.38	2.15	1.54	2.77
Worker environment	42.33	36.50	13.80	2.76	1.23	3.37
Animal environment	32.62	34.15	20.00	6.15	3.69	3.08
Farm Structure	23.55	30.07	23.19	6.52	4.35	12.32

production method. This indicates they were not familiar with this production method. This result was not too surprising due to the relative newness of this technology. In general, attitudinal responses on level of acceptability and favorability did not differ between premium and non-premium payers. Hence they will not be discussed.

Table 6.10: Distribution of Participant Concerns About Livestock Production Methods (N = 329)

	Percentage of Participants					
Issue of Concern	**Very Favorable**	**Somewhat Favorable**	**Neutral**	**Somewhat Unfavorable**	**Not Favorable**	**No Opinion**
Hoop	2.18	4.67	16.20	2.80	8.41	65.42
Partial Confinement	5.61	23.05	29.28	13.71	9.35	19.00
Pasture	36.39	22.02	17.43	4.59	4.28	14.98
Total Confinement	4.05	9.35	15.58	10.59	42.68	17.76

CHAPTER SEVEN: ECONOMETRIC ANALYSIS

In chapter three, a model was developed to explain consumer behavior in a multiple round second-price sealed-bid auction with different information sets. In one of the rounds there was no information pertaining to embedded environmental attributes in the products being auction. This round was known as a naïve bidding round. In a later round, information was released pertaining to the embedded environmental attributes of each product being auctioned. This round was considered an information round. To handle these different information rounds, an assessment function, which relates quality attributes to utility, was developed and incorporated into the consumer maximization problem. This function maps both visual quality and environmental quality of the product into utility.

Within chapter three, it was discussed that there were two ways of deriving willingness-to-pay for embedded environmental attributes in a product. The first definition of willingness-to-pay investigated the difference in prices from the naïve round to the information round for the same product. For the remainder of this chapter, this definition of willingness-to-pay will be known as definition one of willingness-to-pay. It was discussed that the main advantage of this definition is that the products across rounds have the same visual attributes. Hence, only the embedded environmental attributes are being valued in this measure of willingness-to-pay. The major disadvantage to this definition is that the ex ante expectations in the naïve bidding round for the embedded environmental attributes within each product is unknown.

The second definition of willingness-to-pay investigated the price differences between a basis product with no particular environmental attributes with a product that had embedded environmental attributes. These products were taken from the information round.

Hence, unlike the previous definition the basis of the consumer's expectation is known for the environmental product. For the remainder of this chapter, this definition of willingness-to-pay will be known as definition two of willingness-to-pay. The disadvantage of this measure is that it does not directly account for visual quality differences within each product. This means that this definition must account for the visual quality difference in the products. To do this, it was suggested that the difference in prices of the basis product and the environmental product in the naïve bidding round be used as an adjustment factor for the visual quality differences.

In chapter five, participants' bids for differing environmental attributes were analyzed to see whether consumers would be willing to pay a premium for pork products with embedded environmental attributes. Both of the definitions developed in chapter three were investigated. A premium payer was defined as a participant who had a positive willingness-to-pay for the most environmental product, i.e., the product with a high-level reduction in odor, surface water impact, and ground water impact. Under the first definition, it was found that approximately sixty-two percent of the participants in the experimental study did have a positive willingness-to-pay for a product that reduced the impact from production to air, ground water, and surface water. For the second definition of willingness-to-pay, sixty-nine percent of the participants were willing to pay a premium for the most environmental product.

Chapter six investigated the socioeconomic and attitudinal characteristics of premium payers and non-premium payers for both definitions. It was found that there were only three significantly different characteristics between the two groups—employment, willingness to pay a premium (yes/no type of answer), and wanting environmental education for pork

producers. All of these significant differences followed a priori intuition. The rest of the characteristics between the two groups were not significantly different—age, gender, income, monthly consumption of different meat products, etc.

This chapter utilizes econometric techniques to investigate the relationship between willingness-to-pay for embedded environmental attributes, specifically for the triple attribute product, and socioeconomic characteristics. There are three objectives in this chapter. The first objective is to try to predict who are the premium payers from those who are not premium payers for each definition of willingness-to-pay using socioeconomic characteristics that are typically used in the willingness-to-pay literature. It should be noted that the non-premium payers are separated into two groups. The first group was the set of participants who were not affected by the environmental information, while the second group was the set of participants who were adversely affected by the information. The second objective is to predict the magnitude of the willingness-to-pay for the premium payers using the same variables that were used to predict who were the premium payers and who were not.[1] The third objective is to compare the two willingness-to-pay definitions to see if one definition can be better predicted than the other can.

There have been many econometric methods used to analyze the relationship between willingness-to-pay and socioeconomic characteristics. Menkhaus et al. (1992) and Melton et al. (1996a) used ordinary least squares (OLS), while Roosen et al. (1998) and Fox (1994) used more advance models that incorporated a two-stage analysis. Specifically, Roosen et al. (1998) used a double hurdle model developed by Cragg (1971) to investigate the relationship

[1] Since there is such a small number of non-premium payers who were negatively affected by the information, no attempt will be made to predict the magnitude of the willingness-to-pay for this group. A larger sample size would be needed for this task.

between willingness-to-pay for apples with reductions in pesticide use and product and socioeconomic characteristics. Fox (1994) relied on a Heckman (1976, 1979) two-stage procedure to evaluate willingness-to-pay for milk with no trace of bovine somatotropin and socioeconomic relationships.

There are two related reasons Roosen et al. (1998) and Fox (1994) use these more advance modeling techniques over OLS. The first is associated with the method they used to collect their data. In both of their studies, they used a second-price sealed-bid multi-round auction for collecting willingness-to-pay for food safety attributes. In their experiment, they initially endowed each participant with a product. Using the auction, they then asked the participants to bid on a product with food safety attributes. This bid reflected the participants willingness-to-pay to upgrade from their initial endowment to a product that had higher food safety attributes. Since Fox and Roosen et al. assumed that the product being bid on was no worse than the initial endowment, they placed a lower limit on the bids of zero. The information they collected was the willingness-to-pay for the attribute. Hence, causing a censoring or limiting point at zero for those whom did not want to upgrade. The drawback to using OLS for censored data of this sort stems from the qualitative difference between the limit bids and the positive bids (Fox 1994). In this case, OLS tends to provide biased results because it ignores the self-selection by the participants.

This leads into the second reason to use more advances two-stage techniques. Fox notes that "even in the absence of selection bias, the two stage method facilitates an intuitively appealing decomposition of the bidding decision (1994, p. 133)." By setting the lower limit for bids at zero, Roosen et al. (1998) and Fox (1994) caused the participants to self-select themselves into groups—those who want to pay a premium and those who do not.

This would imply that the modeling techniques they use needed to incorporate some aspect of self-selection. Standard OLS analysis cannot accommodate for this in a one-stage procedure. In terms of the model provided in chapter three, the first stage of this two-stage technique could be considered the assessment function.

The method used for collecting the willingness-to-pay information, as described in chapter four, would allow for OLS estimation because it elicits continuous values. Since the first definition of willingness-to-pay was calculated from the change in bids from the no information round, round three, and the information round, round four, it is not restricted to a lower or upper bound. This also holds true for the second definition of willingness-to-pay. Hence it would first appear that OLS estimation would be appropriate and advanced modeling techniques may not be necessary. This would imply that the following equation could be estimated:

(7.1) $WTP = \beta' x + \varepsilon.$

WTP is a vector of willingness-to-pay for the environmental attribute(s) being studied, x is a matrix of explanatory variables with coefficient vector β, and ε is the disturbance vector.

There is an issue in chapter five that makes OLS inappropriate for analysis of the present data. This issue stems from the one hundred participants in this study from the first definition of willingness-to-pay, approximately thirty-percent of the bids, which had a willingness-to-pay of zero. For the second definition there were seventy-four participants, approximately twenty-two percent, who had a zero willingness-to-pay. While the method of data collection allowed for a continuous distribution of the bids, the nature of the information given caused a similar discrete cluster point that is seen in censored or truncated data, such as Fox (1994) and Roosen et al. (1998). Typically, censored data has an upper and/or lower

bound on the distribution. The data from chapter four is, in essence, censored within the distribution at zero. Hence using the OLS method to model this data will cause a bias in the estimates because the point zero will be weighted to heavily.

As mentioned above Fox (1994) and Roosen et al. (1998) handled the issue of censoring by using a two-stage method for estimating the relationship between the dependant and independent variables. Since the models they use are very similar, only the method by Fox will be described. Fox (1994) employs a Heckman (1976, 1979) two-stage procedure to handle the censoring problem in his data. Heckman's approach considers the bias that arises to be a case of a specification error or a missing data problem. To handle this bias, he proposes to estimate the missing variable in the first stage, and then include the estimates of the regressors in the second-stage. In a sense, his method provides a measure of the degree of self-selection (Fox 1994). Fox explains that one of the advantages of this method is that it allows different variables to influence each decision, as well as it allows a single variable to have different effects for different groups.

Fox considers the following equations to estimate:

(7.2) $Y_{1i} = X_{1i}\beta_1 + U_{1i} \qquad i \in I',$

(7.3) $Y_{2i} = X_{2i}\beta_2 + U_{2i} \qquad i \in I,$

where I' is the subset of participants with non-zero bids. He notes that equation 7.2 can be viewed as an inverse demand equation and equation 7.3 is a choice function where Y_{2i} is a qualitative variable that takes on the value one when the participants pays a premium and zero otherwise.

If U_{1i} and U_{2i} are independent from each other and U_{1i} has a conditional expectation of zero, then OLS can be used to estimate equation 7.2. But these error terms are usually not

independent when self-selection is occurring. Fox reports that equation 7.2 is typically biased. To account for the bias, he estimates the following equation:

$$(7.4) \quad E(Y_{1i} \mid X_{1i}, U_{2i} \geq -X_{2i}\beta_2) = X_{1i}\beta_1 + (\lambda_i)\frac{\sigma_{12}}{(\sigma_{22})^{1/2}},$$

where σ_{12} and σ_{22} represent the covariance between U_{1i} and U_{2i} and the variance of U_{2i}, respectively. λi is defined to be the inverse Mill's Ratio.[2] It should be noted that Fox assumed that the joint distribution of U_{1i} and U_{2i} is bivariate normal.

To estimate this model, Fox (1994) employs Heckman's two-stage procedure. He first estimates equation 7.3 as a probit equation on the full sample to obtain the probability that the bid will be positive. From this, he is able to estimate the inverse Mill's Ratio for each observation. Finally, he estimates equation 7.4 by OLS for the subset of participants who bid a positive amount. This final equation he estimates gives a consistent estimate of β_1.

While useful for standard censored data with a lower bound, the two-stage methods that both Roosen et al. (1998) and Fox (1994) used are not totally appropriate for modeling the willingness-to-pay data from chapter five. The double hurdle method and the two-stage Heckman method are inappropriate for the data from chapter five because the censoring in this study rests within the distribution rather than being a lower or upper bound. Also their method allows for only two choices. In contrast, the data from chapter five for both definitions of willingness-to-pay has three choices.

Lee (1983) offers a way of modeling this type of data using a two-stage procedure similar to the Heckman (1976, 1979) and double hurdle models. He suggests using a two-stage procedure that incorporates using an initial polychotomous choice function, e.g.,

[2] See Fox (1994) for the calculation of the inverse Mill's Ratio.

multinomial probit, in the first stage to estimate the discrete dependent variables. In the second stage, standard OLS procedures can be used to estimate the continuous dependent variables with the discrete variables factored out. One of the advantages of using the Lee model is that it can account for more than two choices in the selection process, whereas, the Double Hurdle model and the two-stage Heckman procedure used cannot. It should be noted that Heckman's model is just a special case of Lee's procedure.

Lee's Polychotomous Choice Selectivity Models

The model Lee proposes for handling dependent variables with mixed discrete and continuous variables can be set up as follows (1983). Suppose there is a polychotomous choice model with M categories and M regression equations. These equations can be written as:

(7.5) $y_s = x_s\beta_s + \sigma_s u_s$

(7.6) $y^*_s = z_s\gamma_s + \eta_s$ $\qquad (s = 1, \ldots, M),$

where x_s and z_s are both exogenous explanatory variables. In equation 7.5, σ_s is the standard deviation for a non-standardized distribution. Note that this is equal to one when u_s is normally distributed. Equation 7.6 can be viewed as the choice equation, whereas, equation 7.5 is the observed dependent variable when category s is chosen. Lee assumes the error terms, u_s and η_s, in equations 7.5 and 7.6 each have mean zero given the explanatory variables x_s and z_s for all s. All the distributions of the error terms in equation 7.5 are assumed to have completely specified absolutely continuous marginal distributions. Also, the joint distributions of the error terms in equation 7.6 have been specified.

Lee's model assumes that the dependent variables y_s are observed if and only if category s is chosen (1983). The choice of category s follows the rule

(7.7) $y_s^* > \max_{j=1,\ldots,M} y_j^* \quad where j \neq s.$

Letting the polychotomous variable I take on the values 1 to M, variable I takes the value of s if category s is chosen. Hence 7.7 would imply that

(7.8) $I = s \quad iff \quad z_s\gamma_s > \varepsilon_s$

where

(7.9) $\varepsilon_s \equiv \max_{j=1,\ldots,M} y_j^* - \eta_s \quad where j \neq s.$

For each pair (u_s, ε_s), Lee defines the marginal distribution of u_s as $G_s(u)$ and the marginal distribution of ε_s as $F_s(\varepsilon)$. He states that by using the translation method, a bivariate distribution of (u_s, ε_s) can be specified. Note that ρ_s can be defined as the correlation between u_s and ε_s. By letting $g_s(\cdot)$ be the density function of $G_s(\cdot)$, and defining the dummy variable D_s such that

(7.10) $D_s = 1 \quad iff \quad I = s,$

for s = 1, ...M, the log likelihood function can be specified. This log likelihood function for a polychotomous choice model with random sample of size N can be written as

$$(7.11)\quad \ln L = \sum_{t=1}^{N}\sum_{s=1}^{M}\left\{\begin{array}{l} D_{st}\ln g_s((y_{st}-x_{st}\beta_s)/\sigma_s) - D_{st}\ln\sigma_s \\ \quad + D_{st}\ln\Phi\left((J_{1s}(z_{st}\gamma_s)-\rho_s J_{2s}(y_{st}-x_{st}\beta_s))/(1-\rho_s^2)^{1/2}\right)\end{array}\right\}$$

where J_{1s} is equal to the inverse of the cumulative distribution evaluated at $F_s(\cdot)$ and J_{2s} is equal to the inverse of the cumulative distribution evaluated at $G_s(\cdot)$. By assuming that $\gamma_s = \gamma$, i.e., the set of explanatory variables across choices are the same, for all s and the marginal distribution of u_s are normally distributed N(0,1), a two stage method can be used to estimate the equations

(7.12) $y_s = x_s\beta_s - \sigma_s\rho_s\phi(J_{1s}(z_s\gamma))/F_s(z_s\gamma) + \eta_s \qquad (s = 1, \ldots, M).$

where $\phi(\cdot)$ is the standard normal distribution function and the expectation of η_s given that choice s is selected equals zero. The conditional variance of η_s given that choice s is chosen is

$$\text{var}(\eta_s | s \text{ is chosen}) = \sigma_s^2 - (\sigma_s \rho_s)^2 \left[J_{1s}(z_s,\gamma) + \phi(J_{1s}(z_s,\gamma)) / F_s(z_s,\gamma) \right] * \phi(J_{1s}(z_s,\gamma)) / F_s(z_s,\gamma) \tag{7.13}$$

It should be noted that the estimation of this variance would need correction for heteroscedasticity because the errors are correlated across sample observations.

There are two main reasons why the use of Lee's model is the appropriate way to model the data from chapter five and six. First, due to the nature of the attribute that is being valued, there is a definite anchoring point within the distributions of bids. As mentioned above, this anchoring point causes a discrete point within a continuous distribution. The model by Lee is general enough to handle this issue by estimating the discrete variables first. Once these discrete variables have been estimated, they can be factored out leaving a continuous distribution with the appropriate probability structure, i.e., no discrete points with a large probability mass.

The second reason Lee's model is appropriate is it is intuitively appealing to think of the assessment function explained in chapter three as a separate stage to developing a willingness-to-pay measure. Thus in the first stage the participant assesses what effect the released information has on the participant. In the second stage, the participant chooses the magnitude of the effect. This is especially pronounced in the first definition of willingness-to-pay. Since this willingness-to-pay was calculated from the difference between a naïve bidding round and a round with information, there arises a subjective classification of how the information affects the participant. This can be viewed as the assessment function from

the behavioral model presented in chapter three. Hence, the derivation of willingness-to-pay from the participant's standpoint can be viewed as a two-stage procedure similar to the double hurdle model where there is self-selection. The participants first decide what effect the information had on them, then they choose the intensity of the effect. This decision causes a self-selection process that also can be handled by Lee's generalized model.

It should be noted that Lee's model is general enough to allow different explanatory variables for determining the magnitude of each category. Hence the explanatory variables used to explain the magnitude of the willingness-to-pay for the premium payers can be different from the explanatory variables for the negative premium payers.

There is a great advantage to modeling the data using Lee's model from a marketing point of view. By using this two-stage modeling method of Lee, not only is the magnitude of the premium being predicted, but also the classification of the magnitudes. From a marketing point of view, even though you may not be able to predict the magnitude of the premium well, you might be able to predict the direction of the magnitude shift with greater accuracy, i.e., predicting premium payers versus non-premium payers. This would allow marketers to focus their marketing efforts on the group that matters to them.

Two-Stage Estimation with an Ordered Probit Selection Rule

Information shocks pertaining to product attributes can have a natural self-selection aspect to them. When maximizing consumers are given new information on a product, they must decide on how that new information impacts their purchase decision. They decide whether the information has a positive, neutral, or negative effect. In this sense, the consumers can be viewed as self-selecting themselves into a group. Once they have decided which group they belong, they can reallocate their resources to maximize their utilities.

Since this self-selection process has a natural ordering to it, an appropriate selection rule would be an ordered probit rule that has three choices—a negative premium, no premium, and a positive premium.

Let z equal the ex post categorical realization of whether the consumer was negatively affected, denoted by a zero, not affected, denoted by a one, or positively affected, denoted by a two. The ordered probit part of the model can be written as:

(7.14) $z^* = \alpha' W + u$

where, $z = 0$ if $z^* < 0$, i.e., the participants negatively affected by the information;

1 if $0 \leq z^* \leq \mu_1$, i.e., the participants not affected by the information;

2 if $z^* > \mu_1$, i.e., the participants positively affected by the information.

Equation 7.14 can be considered a latent utility function where z^* is the unobserved utility. This would imply that z is the observed choice that is made by the consumer. It is assumed that the error term u is distributed as standard normal. μ_1 is an unknown threshold parameter that is estimated along with the explanatory values. The matrix W is a set of explanatory variables and the vector α is the set of corresponding coefficients. While Lee's model can account for the explanatory variables being different for each category, it is also assumed that the explanatory variables for the ordered probit model are the same for each category. The willingness-to-pay equation can be written as:

(7.15) $WTP_s = \beta_s' X_s + \varepsilon_s$,

where s represents one of the three categories chosen—premium payers, negative premium payers, or those unaffected. WTP_s is the willingness-to-pay vector of the subset of participants that fall into category s. ε_s is assumed to be normally distributed with mean zero, has a standard deviation of σ_s, and has a correlation of ρ_s with u from the ordered probit

model. X_s is the matrix of explanatory variables including LAMBDA, which is the estimated bias that occurs due to the self-selection process. β_s is the corresponding coefficient vector for the matrix of explanatory variables.

To estimate this model, Greene describes this two-stage procedure as having four steps in the process (1993). The first step is to estimate the ordered probit equation using maximum likelihood estimation on all the observations. This allows for factoring out the discrete variable. The second step is to select the subset of observations to use in the OLS regression, in this case, the negative premium payers or the positive premium payers. The third step is to estimate this equation by OLS including the correction term that takes into account the choice that was selected. The final step is to correct the asymptotic covariance matrix for the estimates of this subset of observations. The econometric software LIMDEP was used to estimate this model. Appendix E gives the LIMDEP commands to estimate this model. This model and its program are discussed in more depth in the LIMDEP manual.

Empirical Results

It shall be assumed that the explanatory variables are the same for equation 7.14 and 7.15 for each definition. The model estimated has two willingness-to-pay equations with a trichotomous choice function to be estimated. Equation 7.14 is estimated first for both definitions of willingness-to-pay. From each equation, the bias from the self-selection process is estimated for each participant and then used as a regressor in the corresponding OLS estimation. Then equation 7.15 is estimated for s equal to two, i.e., the positive premium payers. Due to the small number of negative premium payers, this group will not be estimated. It should be noted that the group whose willingness-to-pay was zero does not need to be estimated by the OLS procedure. By estimating the ordered probit model, in

essence, this group has already been estimated. Since the zeros have been estimated, they become factored out of the estimation of equation 7.14.

The explanatory variables for both equations for each definition of willingness-to-pay is a subset of the socioeconomic characteristics and derived variables from the attitudinal questions analyzed in chapter six. The choice of the subset of explanatory variables has two sources. The first source of the variables comes from the behavioral model developed in chapter three. This model suggests that income and socioeconomic factors should be used as explanatory variables. While the model suggests that socioeconomic factors should be used as explanatory variables, it does not give direction on what variables should be used from chapter six.

The second source of explanatory variables is from the literature on willingness-to-pay for attributes. Specifically, the papers by Roosen et al. (1998), Menkhaus et al. (1992), and Melton et al. (1996a) are the major sources of the socioeconomic factors that will enter equations 7.14 and 7.15. Menkhaus et al. and Melton et al. were discussed in chapter two, while Roosen et al. was briefly discussed above. There are four socioeconomic characteristics that are common in all three papers. These are participant's age, household income, participant's education, and participant's gender. Each paper also incorporates a variable that relates to the experiment and/or location depending on whether the experiment was conducted in more than one location. For this model, location of the experiment is also used as a variable. Both Melton et al. and Roosen et al. incorporate a variable that accounts for consumption of the product being tested, while Menkhaus et al. and Melton et al. use the number of people living in the household as an explanatory value. Hence, both pork consumption and number of people living in the household are used in this model for both

definitions. These variables are outlined in Table 7.1. These variables include both continuous variables, such as pork consumption per month, and discrete variables, such as number of people in the household. The data also consists of categorical data including location, income, and education.

Table 7.1: Variable Description for Each Estimated Equation

Variable	Description
NOINHOUS	Number of people living in the household
PORKM	Number of times per month pork is consumed by participant
GENDER	1 if female, 0 otherwise
AGE	Age of the participant
LOC1	1 if the experiment was conducted in Ames, IA; 0 otherwise
LOC2	1 if the experiment was conducted in Manhattan, KS; 0 otherwise
LOC3	1 if the experiment was conducted in Raleigh, NC in 1997; 0 otherwise
LOC4	1 if the experiment was conducted in Burlington, VT; 0 otherwise
LOC5	1 if the experiment was conducted in Iowa Falls, IA; 0 otherwise
LOC6	1 if the experiment was conducted in Corvallis, OR; 0 otherwise
LOC7	1 if the experiment was conducted in Raleigh, NC in 1998; 0 otherwise
INC1	1 if household income is less than $10,000; 0 otherwise
INC2	1 if household income is between $10,000 and $20,000; 0 otherwise
INC3	1 if household income is between $20,000 and $30,000; 0 otherwise
INC4	1 if household income is between $30,000 and $40,000; 0 otherwise
INC5	1 if household income is between $40,000 and $50,000; 0 otherwise
INC6	1 if household income is between $50,000 and $60,000; 0 otherwise
INC7	1 if household income is between $60,000 and $70,000; 0 otherwise
INC8	1 if household income is between $70,000 and $80,000 ; 0 otherwise
INC9	1 if household income is between $80,000 and $90,000; 0 otherwise
INC10	1 if household income is over $90,000; 0 otherwise
EDU1	1 if highest level of education achieved was eight grade
EDU2	1 if highest level of education achieved was eleventh grade
EDU3	1 if highest level of education achieved was high school or G.E.D.
EDU4	1 if highest level of education achieved was some technical, trade, or business school
EDU5	1 if highest level of education achieved was some college, no degree
EDU6	1 if highest level of education achieved was a Bachelors degree
EDU7	1 if highest level of education achieved was some graduate work, no degree
EDU8	1 if highest level of education achieved was Masters degree
EDU9	1 if highest level of education achieved was a Doctorate degree

The first equations to be estimated are the ordered probit equation for each definition. The explanatory variables used in these ordered probit equations are a constant term and all of the explanatory variables in Table 7.1 excluding EDU1, EDU2, INC1, INC2, and LOC7.[3] The exclusion of these variables is necessary to avoid the dummy variable trap.[4] In this case, the first two responses in education and income and the location of the second experiment done in Raleigh, North Carolina are being used as the bases of comparison for their respective categories. Since the behavioral model does not explain what effects the socioeconomic factors should have on willingness-to-pay, Roosen et al. (1998), Menkhaus et al. (1992), and Melton et al. (1996a) are used to hypothesize the sign of the explanatory coefficients.

There are three multi-response categories used in this model. The first two are education and income. It is hypothesized that a higher education level will increase the probability of the participant being a premium payer. It is also expected that the coefficients increase in magnitude as the education level goes up. These hypotheses come from the fact that the three papers mentioned above all received a positive effect on willingness-to-pay from education. Like education, income will also be hypothesized as positive and having higher coefficients for higher income levels. There are two major reasons for these hypotheses. First, environmental attributes tend to be regarded as a luxury type good. In this case, a person will not buy a luxury good until they can afford it. Another reason for these hypotheses is income tends to have a positive effect for normal goods.

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[3] Due to the extremely small number of participants falling into EDU1 and INC1, EDU2 and INC2 were also excluded to assure that there was not a problem of collinearity between the constant term and the income and education category.

[4] The dummy variable trap is a situation where there is perfect collinearity between the constant term and the category being analyzed. To avoid this problem, one of the responses within a category is dropped.

The other multi-response categorical variable in this model is related to where the experiment was conducted. Since there is nothing in the literature which gives an a priori expectation to the effect a location can have on willingness-to-pay, a benefit hypothesis will be investigated. Within this benefit hypothesis, it is expected that locations closer to high concentrations of hog production will tend to have a higher benefit received from consuming pork with embedded environmental attributes. It was stated above that the second experiment in Raleigh, North Carolina is being used as the basis for location. This being the case, it is expected that the location variable associated with Iowa Falls, Iowa will have a positive effect on the probability of willingness-to-pay. This is because this location would receive more benefits from environmental production of hogs than the Raleigh location. For Manhattan, Kansas, Burlington, Vermont, and Corvallis, Oregon, it is expected that these variables would have a negative coefficient because they are farther away from the high concentrations of hog production compared to Raleigh. Hence, these three areas would receive less benefit than Raleigh would. It is unclear what sign Ames, Iowa and the first Raleigh, North Carolina experiment would have based on the second Raleigh experiment.

There are three explanatory variables that are predicted to have negative coefficients. These are the monthly pork consumption of the participant, PORKM, the number of people living in the participant's household, NOINHOUS, and the participant's age, AGE. Pork consumption and number in household are hypothesized to have a negative coefficient because when either of these increase, it becomes more costly for the household to purchase products with environmental attributes. The negative coefficient predicted for participant's age comes from a benefits argument. A person who is younger will receive more of the benefits from pork that is produced with environmental attributes over someone who is older

because the younger person is expected to live longer. Hence, she will be able to consume the benefits for a longer period of time than someone who is older will.

The final variable that is standard in the literature is the participant's gender, GENDER. There has been some work done in the experimental literature on how gender and altruistic behavior relate to each other. Andreoni and Vesterland point out that there has been conflicting results on whether men are more altruistic than women are (2001). In their paper they investigate this issue by looking at how costs affects a genders altruistic nature. In their results they find that women tend to be more altruistic when the cost of altruism is high, while men tend to be more altruistic when the cost to altruism is low. This result would imply for this model that women should be willing to give more than men would because the participants in this study get to choose the cost. While this is a magnitude effect, it does not explain which gender would be more likely to give, i.e., have a higher probability of giving. Another result of Andreoni and Vesterland is that woman tend to want things equal while men tend to be either perfectly selfish or perfectly selfless. This would imply that there should be more women willing-to-pay a premium than men do. Hence, it shall be hypothesized in this paper that women will have a higher probability of paying a premium. This would imply a positive coefficient on gender.

Table 7.2 provides the result of the ordered probit model for the first definition of willingness-to-pay. For this definition, there were only three estimated parameters that were significant at the five or ten percent level of significance. The constant term and the estimated threshold parameter were significant at the five-percent level. At the ten-percent level of significance was gender. For this definition, gender had the expected sign of

Table 7.2: Ordered Probit Estimates for the Ex Post Categorical Realization of Whether the Participant Was Negatively Affected, Not Affected, or Positively Affected Using the First Definition of Willingness-to-Pay[a]

Variable	Coefficient[b]	Standard Error	Mean of Variable
Constant	1.2780*	0.6138	
NOINHOUS	0.0076	0.0485	2.6869
PORKM	-0.0113	0.0150	5.8290
GENDER	0.2443**	0.1502	0.5988
AGE	-0.0052	0.0049	47.7362
LOC1	0.0609	0.2763	0.1489
LOC2	0.2136	0.2716	0.1824
LOC3	-0.0079	0.2911	0.0942
LOC4	-0.2573	0.3030	0.0821
LOC5	0.0691	0.2764	0.1763
LOC6	0.1422	0.2660	0.1824
INC3	-0.2859	0.2620	0.1376
INC4	0.1669	0.2544	0.1865
INC5	0.0851	0.2614	0.1407
INC6	0.3906	0.3334	0.1040
INC7	0.0780	0.3180	0.0703
INC8	-0.2289	0.3309	0.0599
INC9	-0.0184	0.4273	0.0398
INC10	-0.1795	0.3265	0.0734
EDU3	0.2925	0.4754	0.1220
EDU4	0.0831	0.4792	0.0854
EDU5	0.3063	0.4439	0.2530
EDU6	0.3873	0.4668	0.2409
EDU7	0.1871	0.5056	0.0732
EDU8	0.2939	0.4694	0.1220
EDU9	0.3326	0.5416	0.0579
Threshold parameter for index			
μ_1	1.1847*	0.1168	
N = 329			

(a) A premium payer under this definition is a participant who increased her bid for the most environmental package from round three to round four.

(b) An asterisk * implies that the coefficient is significant at the five-percent level of significance and a double asterisk ** implies significance at the ten-percent level.

positive. This implies that being a woman increased the likelihood of being a premium payer. All of the other estimated variables were not significant.

Examining Table 7.2 shows that the variables for education have consistent signs with the a priori expectations, i.e., positive sign. It should be kept in mind that all of these education levels are being compared to the group of participants with less than a high school degree. This implies that a person who had at least a high school diploma has a higher likelihood of being a premium payer. While the sign was consistent with expectations, the magnitude of the effect was not. It was hypothesized that the magnitude of the effect would increase as education level increased. This is not the case. A participant with a Bachelors degree had the highest magnitude effect for being a premium payer. A participant with a Doctorate degree has the second highest likelihood of being a premium payer, while a person with some college has the third highest magnitude effect. The group of participants that had the lowest magnitude effect was the group that has some technical, trade, or business schooling.

Excluding income and location, two other variables have consistent signs, while one does not. The other variables that were not significant but had consistent signs were age and number of times pork is consumed in a month. Both of these variables had a negative effect on the likelihood of being a premium payer. Hence a participant who was older had a lesser likelihood of being a premium payer. Also, the likelihood that a participant was a premium payer decreases as he/she consumes more pork in a month. The variable that had an inconsistent sign and was insignificant was number in household. It was hypothesized that this variable would have a negative effect. But for definition one of willingness-to-pay, this variable took on a positive and very small value.

When looking at income for definition one, some of the variables took on consistent signs of being positive, while others were inconsistent. The basis of comparison for the income levels were the participants whose income was less than or equal to $20,000. The variables for the income levels from $30,000 to $70,000 all have the expected positive coefficient. While this group of variables has the consistent signs, they do not have the hypothesized increasing magnitudes. This implies that if the participant fell in one of these income categories, he/she would have a higher likelihood of being a premium payer compared to someone who makes $20,000 or less. The income variables for the income levels over $70,000 have the inconsistent sign of being negative. Hence, having a high income implies that the participant was less likely to be a premium payer compared to someone who makes $20,000 or less. The group of participants who fell in the income range of $20,000 to $30,000 also were less likely to be premium payers compared to those participant who made less than $20,000.

As with income, all of the location variables have insignificant signs. Some of the variables have consistent signs, while others do not. The two location variables that have consistent signs are those that designate the participants from Iowa Falls, Iowa, and Burlington, Vermont. Iowa Falls has the expected positive sign, while Burlington has the expected negative sign. It was expected that both Manhattan, Kansas and Corvallis, Oregon would have a negative coefficient. Both of these variables had the unexpected positive sign. This would imply that the benefits hypothesis used to sign these coefficients may not be enough to explain the effect of environmental pork on willingness-to-pay. For the two variables whose sign was a priori indeterminate, Ames, Iowa has a positive coefficient, while the first experiment in Raleigh, North Carolina has a negative coefficient. This implies that

participants in Ames are more likely to be premium payers compared to participants from Raleigh. It should be noted that while the first Raleigh experiment has a positive coefficient, it is extremely close to zero.

Table 7.3 provides the result of the ordered probit model for the second definition of willingness-to-pay. Under this second definition of willingness-to-pay, four estimated parameters are significant at the five-percent level. As with definition one, the constant term and the threshold parameter are significant at the five-percent level. For definition two, gender is also significant at the five-percent level and has the expected sign of being positive. The fourth parameter that is significant at the five-percent level is age. This parameter also has the expected sign of being negative. The rest of the estimated parameters in Table 7.3 are not significant at the five or even ten-percent level of significance.

Similar to definition one, all the education variables for the second definition of willingness-to-pay have the expected sign of positive. Also, the magnitudes for these parameters do not follow the hypothesis of increasing as education increases. The magnitudes of the education variables have no consistent pattern. For this second definition, the group with the highest likelihood of being premium payers is the group who has some technical, trade, or business schooling. This is completely opposite of the first definition. The group with the lowest likelihood of being premium payers is the group with some graduate education.

Excluding the income and location variables, the two variables that have consistent signs to a priori belief but not significant are number in household and monthly pork consumption. Both of these variables have the expected negative sign. While monthly pork consumption is consistently negative under both definitions of willingness-to-pay, the number of people in the participant's household is not.

Table 7.3: Ordered Probit Estimates for the Ex Post Categorical Realization of Whether the Participant Was Negatively Affected, Not Affected, or Positively Affected Using the Second Definition of Willingness-to-Pay[a]

Variable	Coefficient[b]	Standard Error	Mean of Variable
Constant	1.7623*	0.5868	
NOINHOUS	-0.0352	0.0515	2.6869
PORKM	-0.0157	0.0173	5.8290
GENDER	0.5076*	0.1647	0.5988
AGE	-0.0113*	0.0054	47.7362
LOC1	-0.0716	0.3173	0.1489
LOC2	0.0048	0.3073	0.1824
LOC3	0.0095	0.3720	0.0942
LOC4	0.1900	0.3692	0.0821
LOC5	-0.1980	0.3208	0.1763
LOC6	-0.1423	0.1106	0.1824
INC3	-0.2833	0.2896	0.1376
INC4	-0.1158	0.2652	0.1865
INC5	-0.1252	0.2884	0.1407
INC6	0.0413	0.3410	0.1040
INC7	0.1458	0.3706	0.0703
INC8	-0.2878	0.3812	0.0599
INC9	-0.0052	0.5193	0.0398
INC10	0.3620	0.4014	0.0734
EDU3	0.2264	0.4216	0.1220
EDU4	0.4820	0.4557	0.0854
EDU5	0.4656	0.3750	0.2530
EDU6	0.1698	0.3813	0.2409
EDU7	0.0119	0.4440	0.0732
EDU8	0.1189	0.4176	0.1220
EDU9	0.4374	0.5496	0.0579
Threshold parameter for index			
M_1	0.9575*	0.1106	
N = 329			

(a) A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four.

(b) An asterisk * implies that the coefficient is significant at the five-percent level of significance.

The income variables under definition two perform even more dismally than for the first definition of willingness-to-pay. Under this second definition only three income levels carry the consistent sign. These are the variables representing the income levels from $50,000 to $70,000 and the variable representing income level over $90,000. The rest of the

income variables have the unexpected negative sign. This result coupled with the results from definition one suggest that the likelihood of being a premium payer is not necessarily defined by income.

There is only one location variable that is consistent with a priori beliefs, while the rest of the location variables are inconsistent with the prior beliefs. The location that has the consistent expected sign is Corvallis, Oregon. This variable has a negative sign. Manhattan, Kansas, Burlington, Vermont, and Iowa Fall, Iowa all have the opposite signs as expected. Comparing Ames, Iowa across definitions gives conflicting results. Under this second definition of willingness-to-pay, the sign of the coefficient for Ames is negative. This is in contrast to being positive from the previous definition. As for the first Raleigh experiment, this group also has opposite signs across the different definitions. For this second definition, the first Raleigh experiment is positive. Like the previous definition, the coefficient on this first Raleigh experiment is very close to zero.

Tables 7.4 and 7.5 provide the frequencies of actual and predicted outcomes for participant group placement from the estimated ordered probit equation for each definition of willingness-to-pay. The columns show the predicted outcomes from the model, while the rows show the actual outcomes from the data. The major result to notice is that the probit equation for each definition failed to predict which participants were negatively affected by the environmental information. Each equation also has difficulty predicting who was not affected by the environmental information.

Table 7.4: Frequencies of Actual and Predicted Outcomes from the Estimated Ordered Probit for Definition 1 of Willingness-to-Pay[a]

	Predicted Outcome			
Actual Outcome	Negatively Affected	Not Affected	Positively Affected	**Total**
Negatively Affected	0	4	21	25
Not Affected	0	8	92	100
Positively Affected	0	6	198	204
Total	0	18	311	329

[a] A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four.

Table 7.5: Frequencies of Actual and Predicted Outcomes from the Estimated Ordered Probit for Definition 2 of Willingness-to-Pay[a]

	Predicted Outcome			
Actual Outcome	Negatively Affected	Not Affected	Positively Affected	**Total**
Negatively Affected	0	0	27	27
Not Affected	0	6	68	74
Positively Affected	0	2	226	228
Total	0	8	321	329

[a] A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four.

The probit equations for both definitions of willingness-to-pay had a high tendency to predict premium payers over the other two groups. Of the 329 participants, the equation for the first definition picked 311 of them to be premium payers. Of this group selected to be premium payers, ninety-two participants were not actually affected by the information and

twenty-one participants were negatively affected. For the second definition, the probit equation chose 321 participants to be premium payers. Twenty-seven of these participants were actually negatively affected by the information, while sixty-eight participants were actually not affected by the environmental information.

Comparing Tables 7.4 and 7.5, it is easy to see that the probit equation for the second equation did a slightly better job predicting than the probit equation for the first definition. Both probit equations were not able to predict any negative premium payers correctly. Furthermore, both probit equations had trouble predicting the participants who were not affected by the environmental information. Both equations predicted this group with approximately eight-percent accuracy. Given that a prediction fell in the category of the participants not affected, the probit equation for the second definition did a better job of predicting these participants correctly. This probit definition for the second definition also predicted the premium payers with slightly higher accuracy.

There are two conclusions that can be drawn from Tables 7.4 and 7.5. The first conclusion is that neither probit equation for each definition does a very good job predicting the three different categories using the core variables used in the willingness-to-pay literature. The second conclusion that can be drawn is that the probit equation for the second definition of willingness-to-pay does a slightly better job in predicting compared to the first definition of willingness-to-pay.

Table 7.6 presents the results from the conditional OLS model for predicting the magnitude of the premium for those who were affected positively by the environmental information under the first definition for willingness-to-pay. In the second column, the uncorrected standard error for heteroscedasticity is presented, while in the third column, the

corrected standard error for heteroscedasticity is presented. The explanatory variables used to predict the magnitude for this group are assumed to be the same as the variables used to predict which category each participant falls into, i.e., the variables from Tables 7.2 and 7.3. The predicted signs and magnitudes for this equation will be the same as for the probit equations. Hence, it is expected that income and education will have positive signs with increasing magnitudes. The number in household, monthly pork consumption, and age are all expected to have negative coefficients. Gender is expected to have a positive coefficient. The location variables are also expected to have the same signs as the signs from the probit equation. Also included with these explanatory variables is LAMBDA, which is an adjustment factor for the biased caused by the clustering of zeros.

The first thing to notice in Table 7.6 is that the number in household, age, gender, and monthly pork consumption all have consistent a priori signs. Age has the expected negative coefficient and is significant at the five-percent level of significance. At the ten-percent level of significance, both gender and monthly pork consumption are significant. Gender has the expected positive coefficient, while monthly pork consumption has a negative coefficient. While the number in household parameter is not significant, it has the expected sign of being negative.

When examining the category of education, there are many education coefficients that are significant at either the five or ten-percent level of significance. The only education variable that is not significant is the one pertaining to having some technical, trade, or business schooling. At the ten-percent level of significance, the variable related to a Bachelors degree is significant. For all of the other education levels, all the parameters are significant at the five-percent level of significance. Examining the magnitudes on education

Table 7.6: Second-Stage OLS Analysis of the Positive Premium Payers for Definition 1 of Willingness-to-Pay[a]

Variable	Coefficient[b]	Standard Error (Uncorrected)	Standard Error (Corrected)	Mean of Variable
Constant	-5.2814	6.1650	4.9218	
NOINHOUS	-0.0201	0.0924	0.0713	2.7598
PORKM	-0.0755**	0.0577	0.0458	5.6193
GENDER	1.6749**	1.1205	0.9156	0.6324
AGE	-0.0567*	0.0255	0.0230	46.8369
LOC1	0.5133	0.5235	0.5429	0.1471
LOC2	0.9499	1.0290	0.8407	0.1961
LOC3	-0.6417	0.4547	0.4226	0.0931
LOC4	-1.3752	1.3421	1.1100	0.0735
LOC5	0.6058	0.5299	0.5265	0.1716
LOC6	0.9225	0.7621	0.6748	0.1863
INC3	-2.5784*	1.4503	1.2601	0.1141
INC4	0.2129	0.8331	0.6922	0.2028
INC5	-0.3956	0.5728	0.4428	0.1484
INC6	1.2828	1.6751	1.4142	0.1285
INC7	-0.3034	0.6158	0.6836	0.0791
INC8	-2.2129*	1.1993	0.9553	0.0495
INC9	-0.7742	0.6465	0.6357	0.0396
INC10	-1.7473*	1.0130	0.8748	0.0644
EDU3	2.6061*	1.6032	1.2314	0.1225
EDU4	0.7413	0.8735	0.5234	0.0784
EDU5	2.5661*	1.6343	1.2564	0.2500
EDU6	2.8897**	1.9599	1.5745	0.2647
EDU7	3.5634*	1.2595	1.1795	0.0686
EDU8	2.8889*	1.6236	1.2557	0.1324
EDU9	2.9007*	1.7731	1.4013	0.0539
LAMBDA	10.9237**	8.2374	6.7337	0.5898
N	204			
R^2	0.2041			
Log-Likelihood	-355.0125			
Log-Likelihood (Restricted)	-378.2970			

(a) A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four.

(b) An asterisk * implies that the coefficient is significant at the five-percent level of significance and a double asterisk ** implies significance at the ten-percent level.

shows that the higher education levels tend to have higher magnitudes over the lower education levels.

Similar to the probit equations above, the variables for income in the OLS model tend to not have the expected signs. In Table 7.6, there are only two income levels that have the expected positive sign. These are the income level associated with $30,000 to $40,000 and the income level associated with $50,000 to $60,000. The rest of the income variables are negative. There are three income levels that are significantly negative at the five-percent level of significance—the income level associated with $20,000 to $30,000, the income level associated with $70,000 to $80,000, the income level associated with the highest income.

Examining the location variables in Table 7.6 show that all the variables for location are not significant at either the five or ten-percent level of significance. Among these variables, only two have the hypothesized sign. Burlington, Vermont has the expected negative coefficient, while Iowa Falls, Iowa has the expected positive coefficient. Both Manhattan, Kansas and Corvallis, Oregon have the unexpected sign of positive. Ames, Iowa has a positive coefficient, while the first Raleigh, North Carolina has a negative coefficient.

Examining the LAMBDA coefficient shows the level of bias due to the zeros has a positive and significant effect at the ten-percent level of significance. Hence, deleting the zeros and running OLS on the remaining observations would cause a serious bias to occur in the estimates on the coefficients. Using a likelihood ratio test, the null hypothesis that all coefficients are zero for this model can be rejected at the five-percent level of significance. The critical value for this test at the five-percent level of significance is 38.89, while the calculated likelihood ratio from the model is 46.56. Hence, the variables in this model do have explanatory power.

The results from the conditional OLS model for predicting the magnitude of the premium for those who were affected positively by the environmental information under the second definition for willingness-to-pay are presented in Table 7.7. The second column in this table presents the uncorrected standard error for heteroscedasticity, while in the third column has the corrected standard error. The explanatory variables used to predict the magnitude for this group are assumed to be the same as the variables used to predict the previous OLS model for the first definition. The predicted signs and magnitudes for this equation will be the same as for the probit equations. Hence, it is expected that income and education will have positive signs with increasing magnitudes. The number in household, monthly pork consumption, and age are all expected to have negative coefficients, while gender is expected to have a positive coefficient. The location variables are also expected to have the same signs as the signs from the probit equation as well as the previous OLS equation for the first definition of willingness-to-pay. Again, the variable LAMBDA is included to account for the bias.

Examining Table 7.7 shows that the core values used in the willingness-to-pay literature does not do a good job explaining the magnitude for the second definition of willingness-to-pay. In this case there are only two significant variables at the five or ten-percent level of significance. The first significant variable is the variable denoting the first Raleigh experiment, which is significant at the five-percent level. The other significant variable is the one denoting the group of participants who have some graduate education. This variable was significant at the ten-percent level and had the expected positive sign. As for the rest of the variables, they were not significant at the five or ten-percent level.

Table 7.7: Second-Stage OLS Analysis of the Positive Premium Payers for Definition 2 of Willingness-to-Pay[a]

Variable	Coefficient[b]	Standard Error (Uncorrected)	Standard Error (Corrected)	Mean of Variable
Constant	3.5842	2.4698	2.5717	
NOINHOUS	-0.1056	0.1413	0.1303	2.7675
PORKM	0.0046	0.0580	0.0510	5.5583
GENDER	-0.1246	1.3847	1.3343	0.6535
AGE	-0.0215	0.0316	0.0306	45.9067
LOC1	-0.0055	0.5859	0.6072	0.1491
LOC2	-0.5924	0.5206	0.5132	0.1930
LOC3	-1.0280*	0.5613	0.5076	0.1053
LOC4	-0.4070	0.7706	0.7493	0.0965
LOC5	0.5736	0.7959	0.8348	0.1447
LOC6	-0.4531	0.6414	0.6368	0.1754
INC3	-0.4482	0.9212	0.9077	0.1196
INC4	-0.4691	0.5876	0.4888	0.1771
INC5	-0.3448	0.6015	0.5265	0.1460
INC6	0.0212	0.5679	0.6028	0.1106
INC7	-0.0338	0.7059	0.7619	0.0796
INC8	-0.5427	1.0189	0.9052	0.0531
INC9	0.0663	0.7974	0.7422	0.0398
INC10	-06162	1.0674	1.0834	0.0840
EDU3	0.5894	1.2278	1.1208	0.1102
EDU4	0.1522	1.6987	1.6125	0.0881
EDU5	0.5023	1.6083	1.5929	0.2687
EDU6	0.7030	1.0958	0.9964	0.2554
EDU7	1.9387**	1.0106	1.0705	0.0705
EDU8	1.0669	1.0413	0.8774	0.1190
EDU9	0.4900	1.6291	1.4849	0.1196
LAMBDA	-0.3747	5.4082	5.4224	0.4673
N	228			
R^2	0.1276			
Log-Likelihood	-467.1391			
Log-Likelihood (Restricted)	-482.6947			

(a) A premium payer under this second definition is a participant who had a higher bid for the most environmental package compared to the typical package within round four.

(b) An asterisk * implies that the coefficient is significant at the five-percent level of significance and a double asterisk ** implies significance at the ten-percent level.

Under this second definition of willingness-to-pay, all of the location variables and all of the education variables have the expected signs even though they are not significant. The variable for the number in household and the variable for age both have the expected sign of being negative. On the other hand, the variable for monthly pork consumption and the variable for gender have the opposite of the expected sign. For this model gender had a negative effect on magnitude, while monthly pork consumption had a positive effect.

There are only two income levels that have the expected sign of being positive. These are the variable that denote income level of $50,000 to $60,000 and the variable that denotes the income level of $80,000 to $90,000. Both of these variables are close to zero relative to the income variables. All other income variables under this second definition have the unexpected sign of being negative.

Using a likelihood ratio test, the null hypothesis that all coefficients are zero for this model cannot be rejected at the five-percent level of significance. The critical value for this test at the five-percent level of significance is 38.89, while the calculated likelihood ratio from this second definitions model is 31.12. Thus, this model does not have explanatory power for predicting the magnitude of the positive premium payers. Looking at the variable LAMBDA, which accounts for the bias, an opposite conclusion is drawn compared to the previous model for the premium payers under the first definition. The bias for this second definition is negative but insignificant at the ten-percent level of significance. Hence by dropping the zeros and estimating this model with standard OLS for the premium payers for this second definition will not cause significant bias.

Comparing the two different models leads to several conclusions. For the second definition of willingness-to-pay, the socioeconomic factors was able to predict slightly better

the directional effect environmental information has on the participant. On the other hand, the first definition does a better job explaining the magnitude of the premium for the premium payers. The second definition has a much better R^2, i.e., explanatory power, than the first for the conditional OLS using the same core variables used in the willingness-to-pay literature. The second definition coefficients did not do better statistically than a model with all coefficients equal to zero. This implies that the coefficients for the second definition had no significant explanatory power over a model with just an intercept term. In both models under both stages, the income levels rarely had the expected sign or magnitudes and were usually not significant explanatory variables. This result was unexpected because income usually shows up as a significant variable in most willingness-to-pay studies. Finally, the bias due to the zero bidders is an important factor for the first definition, while it does not seem to effect the second model significantly. This result is not too surprising considering there were less zeros in the second definition of willingness-to-pay.

CHAPTER EIGHT: SUMMARY AND CONCLUSIONS

Summary and Conclusions

In chapter one a brief overview of the pork industry and related environmental concerns were provided. These environmental concerns included odors from production, as well as, surface and ground water impacts. This overview motivated the need to value environmental attributes related to production from a consumer's point of view. This can assist the development of adjustments in the industry and development of policy. Knowing the value consumers place on environmental attributes can also help producers make decisions about incorporating new technologies which decrease environmental impacts from production.

Within chapter one, four primary objectives of this dissertation were outlined. The first objective was to present a theoretical model that explained the behavior of a consumer in a second-price sealed-bid auction when there are embedded environmental attributes contained in the item being auctioned. From this behavioral model, two willingness-to-pay measures for environmental attributes were discussed. The second objective was to outline an experimental setting in which willingness-to-pay measures for embedded environmental attributes can be collected from consumers. Examining consumer's willingness-to-pay for pork products with embedded environmental attributes, which was derived from the experimental setting outlined in the second objective, was the third objective. The final objective was to investigate the relationship between socioeconomic factors and respondent's willingness-to-pay for embedded environmental attributes.

A major objective of this dissertation was to interpret bids from a second-price auction when embedded environmental attributes exist in the product being auctioned. It was

shown in chapter three that when embedded environmental attributes do not exist, the second-price auction has the property that it is in the best interest of the participants to truthfully reveal their preferences, i.e., their true value for the item being auctioned. This true value was defined as the maximum amount of income the bidder is willing to give up to obtain a new set of attributes from the product being auction. When embedded environmental attributes exist in the product being auctioned and the bidder has some degree of free-riding capabilities, it is no longer a dominant strategy for the bidders in a second-price auction to bid their true value. Rather, the dominant strategy of the bidder is to bid her true value minus any part of her true value that can be obtained from someone else, i.e., minus the value that can be associated from free-riding.

From the behavioral model developed in chapter three, two definitions for willingness-to-pay were derived. The first definition compares the bids across information sets for the same product. These information sets range from the naïve set of the physical traits visually observed to those where environmental attributes are provided. In the initial information set, only the observed physical attributes of the products are known. This first information set was known as a naïve information set. This was followed by information being released relating to the environmental attributes of each product. This second information set was known as the environmental information set. This measure was called consumer's willingness-to-pay with unknown ex ante expectations. It was also known as definition one. The second definition of willingness-to-pay examines the difference between bids in the same environmental information set for a product with embedded environmental attributes compared to a product that has no particular environmental attributes, i.e., a typical product. This definition was modified to account for any perceived physical quality

differences between the two products. This measure was known as the consumer's willingness-to-pay for environmental attributes with a known basis. This measure was also known as definition two. This second definition for willingness-to-pay was argued to be a better approximation to a person's true valuation for environmental attributes because it takes a long-run approach to examining willingness-to-pay.

The second major objective of this dissertation was to develop a consumer experiment to collect information from consumers about their preferences for pork products with embedded environmental attributes. In chapter four, a second-price sealed-bid multiple-round (five rounds) auction was presented as a method to obtain willingness-to-pay information. This auction was conducted in six locations across the country—Ames, Iowa; Iowa Falls, Iowa; Raleigh, North Carolina; Manhattan, Kansas; Burlington, Vermont; and Corvallis, Oregon. In the first three rounds of each experiment, the participants were allowed to visually inspect ten different packages of pork chops and offer bids for each. These packages contained four pork loin chops, uniformly cut. Each package weighed approximately two pounds. In round four, they were provided information that pertained to the environmental attributes embedded in the respective packages of pork chops and allowed to bid again. These attributes dealt with a reduction in odor, a reduction in ground water impact, and a reduction in surface water impact from production. For odor, a low (high) reduction level was defined as a thirty to forty-percent (eighty to ninety-percent) reduction in odor from production as compared to odor from a typical pork production system. In the case of surface and ground water, the low-level (high-level) impact reduction was defined as a reduction of fifteen to twenty-five percent (forty to fifty percent) when compared to a pork chop from a typical production system. Not only were single low-level and high-level

attribute packages of pork chops presented, but also differing combinations (air, water quality, surface water) of the high-level attributes were also presented. The information in round four only dealt with the improved environmental attributes. Societal health implications from the attributes were provided in round five.

The third objective of this dissertation was to examine consumer's willingness-to-pay for environmental attributes collected from the experiments discussed in chapter four. Chapter five examines three major aspects of the data collected from the experiments. The first part examined the bids for each product for each round. The next part examined the data in light of the first definition, definition one, of willingness-to-pay. The final part examines the second definition of willingness-to-pay.

It is seen in chapter five that in the first three naïve bidding rounds of the experiment, average participant bids increased at a decreasing rate. When analyzing the changes in bids, it was found that the bids for at least eighty-percent of the packages did not increase significantly between round two and round three. Five out of the seven locations had one hundred percent of the packages not significantly changing value between these two bid rounds. Hence, bids were stabilizing. This provided further support to the findings of Coppinger et al. (1980) and Cox et al. (1985) that participants eventually discover their preferences when a second-price sealed-bid auction is used with multiple trials.

After information was released in round four, the average bid for each package took on a consistent pattern where the most environmental package received the highest bid, the packages with less environmental attributes received lower bids, and the typical package with no particular environmental attributes received the lowest average bid. Between round three, the naïve bidding round, and round four, the environmental information round, half of the ten

packages significantly changed in value at the .001 significance level. The typical package and the low-level odor reduction packages significantly decreased in value while both of the double attribute packages and the triple attribute package increased significantly in value. With no significant changes occurring for the products with a single high-level environmental attribute, it can be inferred that participants' prior expectations were that the products they were bidding on had some level of environmental attributes. Thus, before any environmental information was provided on the products, the participants believed that the products had some embedded environmental attributes, specifically, single high-level environmental attributes. This would imply that environmental information does affect consumers' willingness-to-pay for a good. It also suggests that a product that does not have environmental characteristics will likely decrease in value when a similar product with embedded environmental attributes is released on the market.

With the release of the societal human health implications of the environmental attributes in round five, bid levels did not change significantly from round four. The participants' evaluation of the societal health implications from the information released in round four was confirmed by the information released in the fifth round, i.e., their expectations on health implications formed in round four were in line with what was released in round five. The changes in the bids from round three to round four demonstrated that the participants' initial expectations were not being met.

Chapter three presents a behavioral model that explains how consumers make decisions when they are in a multiple-round second-price sealed-bid auction with different information sets. In this chapter two ways of defining willingness-to-pay were developed. One method is to observe bids between bidding rounds with two different information sets.

This allows for the visual attributes to be constant, but from the point of view of the researcher there is no ex ante information on the consumer's prior expectation of embedded environmental attributes. This method of looking at willingness-to-pay was established as definition one of willingness-to-pay. Another method of measuring willingness-to-pay relates to comparing a typical good to one that has an environmental improvement over the typical good in the same bidding round. This willingness-to-pay measure assures that the expectation of the environmental attributes for the consumer is known to the researcher, but it does not directly account for any visual quality differences between the two products being considered. In chapter three, a method of adjusting for visual quality differences between two packages was developed. Throughout the dissertation, this approach was known as the second definition of willingness-to-pay.

A premium payer under the first definition of willingness-to-pay was defined as a participant who increased her bid from the last no information round, round three, to the information round, round four, for the most environmental product—that product with a high-level reduction in odor, surface water impact, and ground water impact compared to a product from a typical system. It was found that of the 329 participants in the study, approximately sixty-two percent paid a premium for the package of pork chops with the triple high-level embedded environmental attributes. By location, this ranged from fifty-six percent in Burlington, Vermont to sixty-seven percent in Manhattan, Kansas. The average premium paid by the premium payers for this product was $1.60. This premium was significantly different from zero. When examining across regions, there was no significant difference at the five-percent level in the premiums paid for the most environmental product. The value of the typical package decreased by $0.63. Using this definition, there is a group

of consumers who will pay a premium for pork products with embedded high-level environmental attributes.

When analyzing the non-premium payers for the first definition of willingness-to-pay, it was found that when the environmental information was released, all the packages of pork chops decreased in value, some by a significant amount. A non-premium payer is someone who did not increase her bid between round three and round four for the pork product with the triple high-level embedded environmental attributes. Of the 125 participants who were considered non-premium payers, twenty-five actually decreased their bids for the most environmental package. It should be noted that, while the bids decreased for this group of twenty-five between round three and four, the most environmental package was still valued higher than the typical package.

When the second definition of willingness-to-pay was investigated, a similar result to the first definition was found. For this second definition, a premium payer is defined as a participant who had a higher bid for the environmental package in round four over the typical package after adjusting for visual differences. Of the 329 participants, approximately sixty nine percent of the participants could be classified as premium payers. On average, the premium under this definition for the premium payers was $2.23 for the most environmental package. This premium was significantly greater than zero.

When examining the non-premium payers under the second definition of willingness-to-pay, there were 101 participants that did not pay a premium for the most environmental good. Of this group, twenty-seven participants had a negative willingness-to-pay due to the information provided in the experiment in round four. This implies that there was a small group who was negatively affected by the release of the environmental information. One

explanation for this is that the participants in this group had higher environmental expectations of the products before the release of environmental information or they did not understand the system of bidding.

When analyzing the differences in socioeconomic characteristics and attitudes between the premium payers and the non-premium payers using standard statistical tests for both definitions of willingness-to-pay, it was found that there were very few significant differences. The three characteristics that showed up as significantly different between the two groups with the expected outcome were if employed, willingness-to-pay a premium for meat products with environmental attributes (yes/no type of question), and the desire for producers to have environmental education about production practices. Characteristics such as age, gender, and household income did not show up as significantly different. Attitudes about the environment, product attributes, and production methods also did not show up as significantly different between the two groups.

The fourth major objective of this dissertation was to examine the relationship between willingness-to-pay and socioeconomic characteristics and attitudes. To investigate this relationship, chapter seven utilized a two-stage polychotomous choice model. The necessity for using this model comes from the fact that under both definitions of willingness-to-pay there were a large number of participants having zero willingness-to-pay. In essence, this group causes a discrete cluster point in the middle of continuous distribution. This can be viewed as a censoring issue within a distribution. By using standard OLS techniques, estimated coefficients for this data would be biased. The explanatory variables used in this model were the core variables developed in the willingness-to-pay literature.

To estimate this model, the first stage used an ordered probit model to predict whether the environmental information provided affected the participants positively, negatively, or not at all. It was found that with both definitions the model did not perform well in predicting whom the negative and zero bidders were. Additionally, of the core variables developed in the literature, very few were significant under either definition. Under definition one, the constant term was significant at the five-percent level, while gender (female = 1, male = 0) was significant and positive at the ten-percent level. Using definition two, the constant term, gender (female = 1, male = 0), and age are all significant at the five-percent level of significance. Gender had a positive effect on willingness-to-pay, while age had a negative effect. Under both definitions, income usually had a negative sign but it was insignificant.

In the second stage, OLS was used to predict the magnitude of the change that was caused by the release of environmental information. An equation was estimated separately for the premium payers under both definitions of willingness-to-pay. It was found that this model was able to predict the magnitude of the willingness-to-pay better for definition one as compared to the second definition. The first definition had statistically significant explanatory power, while the second definition of willingness-to-pay did not. Under the first definition of willingness-to-pay, monthly pork consumption and gender (female = 1, male = 0) were both significant at the ten-percent level of significance. Monthly pork consumption had a negative impact on willingness-to-pay, while gender had a positive effect. Many of the categorical education variables were significant and had the expected sign. Education was divided into ten categorical levels. It was also found that under definition one the bias

caused by the zero bids did have a significant effect on the estimation process. This was not the case for the second definition.

From this work it is clear that some proportion of consumers are willing to pay a premium for pork products with embedded environmental attributes. Under both definitions of willingness-to-pay, over sixty percent of the participants paid a premium for pork products with embedded environmental attributes. Furthermore, these consumers want producers to have environmental education and produce in an environmentally sound fashion.

Future Research And Issues

There are three areas where this research can be expanded. The first area is related to the theory of auctions when the product being auctioned has embedded environmental attributes. One study that needs to be done is related to consumer behavior in the other three major auctions (Dutch auction, first-price auction, English auction) discussed in this dissertation when the product being auctioned has embedded environmental attributes. Another study that can be done is one that examines the properties of an optimal auction when environmental attributes exist from both the sellers and buyers viewpoint.

The second area pertains with the experiment process. It would be useful to examine the effects of introducing a substitute product, like beef or chicken, that would have no environmental attributes into this auction experiment. Also it would be interesting to see what would happen if there were only two or three products rather than ten. If consumers are using a particular product as an anchor for the ecolabeling value, then by having many products convolutes which product is the anchor. Another extension to this experiment is to develop a tool that will measure the level of free-riding.

The next logical step to this research is to do an in-store study for pork products with environmentally embedded attributes. Participants indicated they would pay a premium for pork products with embedded environmental attributes, but it is unknown whether the level of premium given in this study would hold over time where consumers make repeated purchases. There are many examples of products that are introduced into the market but fail after a few months. While this study was able to impose some market discipline, it was not able to evaluate purchases over time. An in-store study would help gauge the level of market share a product with embedded environmental attributes could gain.

The pork production industry is well positioned to address environmental issues and develop products with embedded environmental attributes. The industry has already developed a program which focuses on environmental audits. Under this program pork producers can have their pork production systems undergo an environmental audit. This, in effect, provides a certification process built around environmentally safe production methods.

Study participants indicated they felt producer education on environmental issues was important and encouraged. The industry is already doing this. It is important to inform consumers about what the industry is doing. Industry education packages need to focus on producers and consumers alike. The industry has done an excellent job at focusing these types of programs on producers. These efforts need to be expanded to consumers.

APPENDIX A: INTRODUCTORY LETTER

6 June, 1997

Dear:

The Economics Department at Iowa State University is conducting a national study regarding knowledge and concerns related to pork production. Your household was scientifically selected to be included in this study and we would be grateful for your help.

Within the next two weeks you will be contacted by telephone and the person who is most responsible for food purchases in your home will be asked if they would be interested in participating in a consumer experiment at Iowa State. This session will take about 2 hours of your time and would take place on a Saturday. It would involve no risk to you and you would be paid $40.00 for participating. The experiment will be located on the Iowa State campus in room 162 Heady Hall. A map is included to assist you with finding this building.

To date, we have had over 400 people from the Ames and Story County area participate in similar sessions and we have received positive comments from almost all of those participants. Most people said they found the experience to be interesting and informative.

If you have any questions regarding the study, please call Sean Hurley at 515-294-2177, and he will be happy to help you. Thank you for your consideration.

Sincerely,

James B. Kliebenstein, Ph.D.
Professor

APPENDIX B: EXPERIMENTAL DIRECTIONS, BID SHEETS, AND PRE AND POST AUCTION SURVEYS

Consent Form

You are about to participate in a consumer experiment in willingness-to-pay for a food product. This experiment will take approximately two hours.

We need your signed consent if you are to act as a subject. Your participation in the experiment is completely voluntary and you may withdraw from the experiment at any time without prejudice to you. Results from the experiment will be strictly confidential. Any name associated with the experiment will be deleted upon completion of the experiment.

If you consent to participate in the experiment, please sign the consent form below.

#____

I have read the consent form statement and agree to act as a subject in the experiment, with the understanding that I can withdraw from the experiment at any time without prejudice to me.

_____ Signature

____/____/____ Date

Experimental Instructions

General Instructions

You are about to participate in an experiment in market decision making. Please follow all instructions carefully.

The experiment will consist of 2 stages and will last approximately 2 hours. In stage 1 you will be asked to decide how much you would be willing to pay for different candy bars. This stage is designed to familiarize you with the auction procedure we will be using. In stage 2 you will be asked how much you would be willing to pay for pork products with different attributes.

You will submit your bidding price on a recording sheet. You cannot reveal your bids to any other participant. Any communication between participants will result in an automatic penalty of $3. Please do not complete any form until instructed to do so by the monitor.

You will receive $40 for participating in this experiment. Because you actually pay for any product you choose to purchase, your take home income will consist of $40 minus the price paid for any products purchased.

Please pay attention to the monitors at all times and do not hesitate to ask questions about any of the instructions.

Pre-Auction Survey

About You #_____

1. Your sex: _____Female _____Male

2. As of your last birthday, how old were you?

3. How many individuals live in your household, including yourself? _____
If you have children, how old are they?_____ _____ _____ _____ _____

4. Please indicate the highest level of education you have completed:
   _____ Grade 8
   _____ Grade 9-11
   _____ H. S., G. E. D.
   _____ Some technical, trade, or business school
   _____ Some college, no degree
   _____ B.S., B.A., etc.
   _____ Some graduate work, no degree
   _____ M.S., M.A., etc.
   _____ Ph.D., D.V.M., D.D.S., M.D., etc.

5. Are you currently employed? _____Yes _____No

6. What is your occupation, e.g., homemaker, police officer, doctor, teacher, etc.?
   _____

7. Please indicate the approximate household income for 1996:

   _____ Less than $10,000
   _____ $10,000 - $20,000
   _____ $20,000 - $30,000
   _____ $30,000 - $40,000
   _____ $40,000 - $50,000
   _____ $50,000 - $60,000
   _____ $60,000 - $70,000
   _____ $70,000 - $80,000
   _____ $80,000 - $90,000
   _____ More than $90,000

8. Do you eat beef? _____Yes _____No
Do you eat pork? _____Yes _____No
Do you eat poultry? _____Yes _____No
Do you eat fish? _____Yes _____No

9. How often do you eat beef, pork, poultry, fish?

	per week	per month
Number of times you eat beef?	_____	_____
Number of times you eat pork?	_____	_____
Number of times you eat poultry?	_____	_____
Number of times you eat fish?	_____	_____

10. How far do you live from a pork production facility?
_____ Under one quarter of a mile
_____ One quarter of a mile to one half of a mile
_____ One half of a mile to one mile
_____ One mile to one and a half miles
_____ One and a half miles to two miles
_____ Two miles to three miles
_____ Three miles to four miles
_____ Four miles to five miles
_____ Over five miles
_____ Don't know

11. How many pork production facilities are within a one mile radius of your dwelling?
_____

12. How many pork production facilities are within a two mile radius of your dwelling?
_____

13. Do you produce livestock for commercial use? _____ Yes _____No

If yes, what livestock do you produce?

Livestock	Number of animals

14. Do you produce crops for commercial use? _____Yes _____No

If yes, what crops do you produce?

Crop	Typical number of acres allocated to the crop

15. Do you read the information on the labels of the products you buy?
_____Never
_____Sometimes
_____Always

14. Have you ever noticed any information labeling on the products you buy that portray environmental attributes or qualities?
_____Yes
_____No

If yes, please give an example:

_____
_____
_____
_____

15. Do you think you have purchased more beef or pork as a direct result of the beef and pork advertisements you have seen in the media; e.g., "Pork the other white meat", etc.?

more beef? _____Yes _____No
more pork? _____Yes _____ No

16. On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

Issue	Very Concerned				Not Concerned
Environment	1	2	3	4	5
Water quality	1	2	3	4	5
Air Quality	1	2	3	4	5
Food prices	1	2	3	4	5
Family Farming	1	2	3	4	5
Production methods in livestock farming	1	2	3	4	5
Animal welfare	1	2	3	4	5
Pollution	1	2	3	4	5
Livestock confinement systems	1	2	3	4	5
Changing farming structure	1	2	3	4	5

17. On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

Issue	Very Important				Not Important
Eating quality	1	2	3	4	5
Visual appeal	1	2	3	4	5
Freshness	1	2	3	4	5
Price	1	2	3	4	5
Environmental	1	2	3	4	5
Production methods used in producing the good	1	2	3	4	5
Uniformity of product	1	2	3	4	5

Experimental Instructions and Forms

Stage One Instructions

Step 1: Notice that there are 10 varieties of candy bars displayed:

1. Almond Joy
2. Baby Ruth
3. KitKat
4. M&M's
5. Mars
6. Milky Way
7. Skittles
8. Snickers
9. Starburst
10. Twix

You will be asked to indicate your willingness to pay for each of these candy bars.

Step 2: Please write your bid for each of the 10 candy bars on the recording sheet provided. Place a horizontal mark across the vertical price line at the point that corresponds to the vertical price line at the point that corresponds to your bid for each respective candy bar. Next to the mark write the dollar amount of your bid.

Start by placing a bid for:

1. Your most preferred candy bar.

2. Your least preferred candy bar.

3. Fill in the remaining bids in any order you choose.

For each of the 10 candy bars the monitor will announce the highest bidder and display the second-highest bidding price of the candy bar on the blackboard. In this auction, the highest bidder will pay the second highest bidding price.

This auction will have one bidding round. After the bidding round is completed, one of the 10 candy bars will be selected randomly to be the candy bar auctioned.

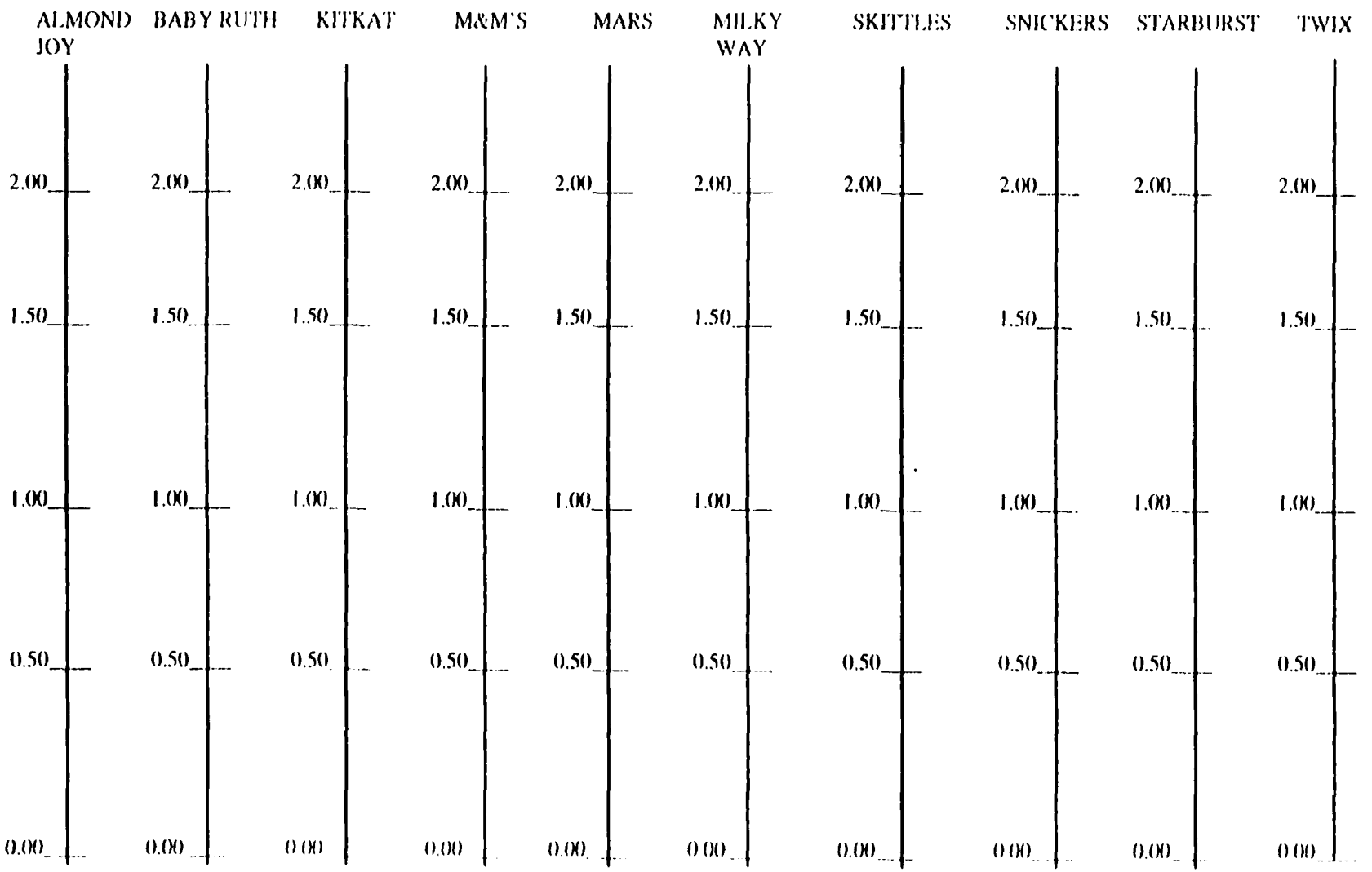
For example, if the twix is the candy bar randomly selected to be auctioned and if the highest bid for the Twix is $0.35 and the second highest bid is $0.20, then the highest bidder will purchase the Twix and must pay $0.20.

Note: In the event there is a tie for the highest bid, the winner will be determined by a coin toss. In this case, the second highest bid would also be the same as your bid.

Note: In this auction it is in your best interest to bid the amount you are truly willing to pay for the candy bar. If you bid more than your true willingness-to-pay, then you increase your chances of purchasing the candy bar but you may have to pay a price that is greater than your valuation of that candy bar. On the other hand, if you bid less than the amount that you are truly willing to pay, you may lose the chance to purchase the candy bar at a price that you would be willing to pay.

ID# _____

Example Candy Bar Bids



#_____

Quiz

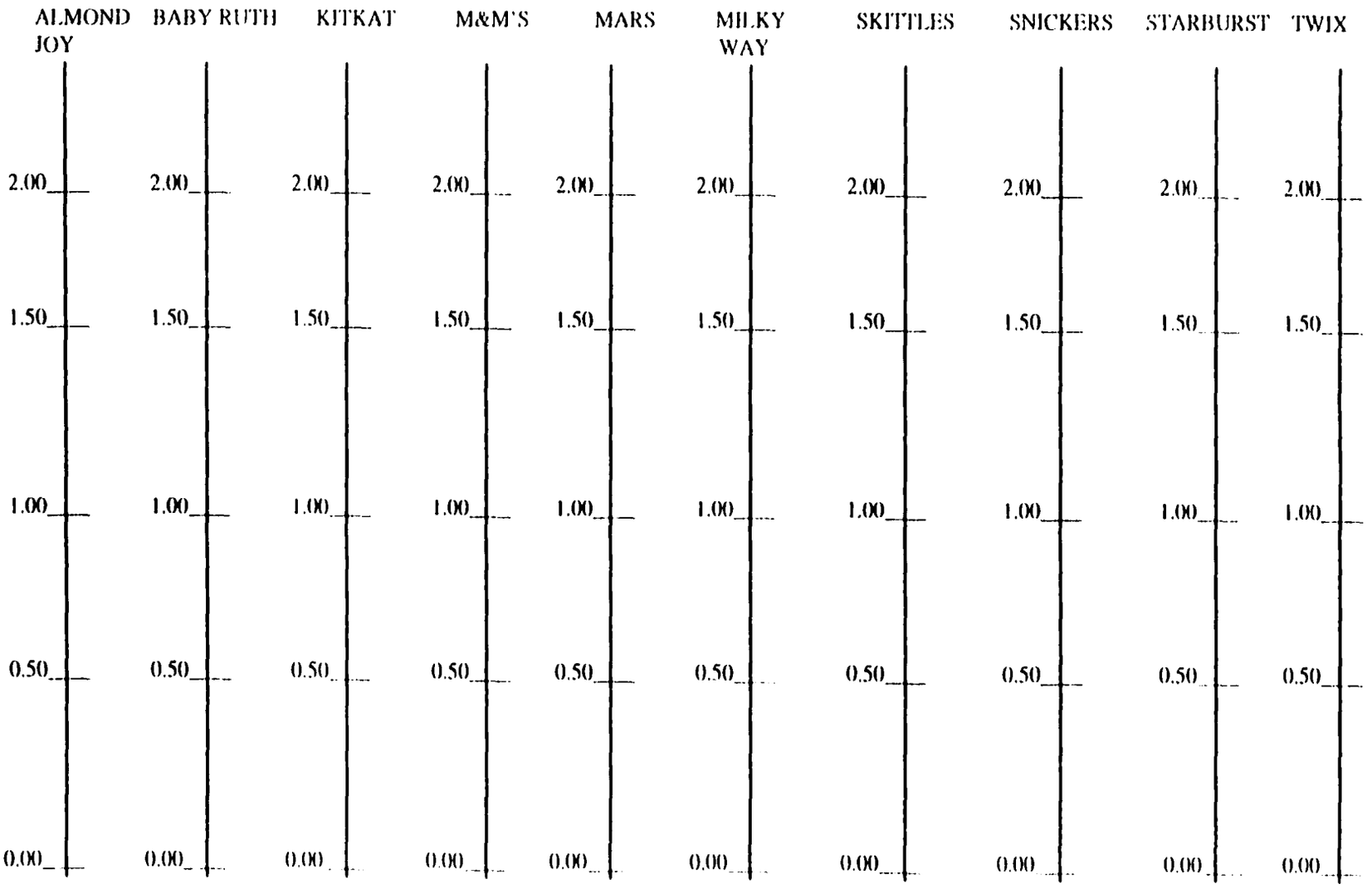
Please fill in the blank for each of the following questions.

1. The example bidding sheet indicates that the bidder is willing to pay S____ for a Mars bar and is willing to pay S____ for a Snickers.

2. Suppose your bid of S0.35 is the highest bid for the Skittles and the Skittles were randomly selected to be the candy bar auctioned. Also suppose that the second highest bid for the skittles is S0.21. What price will you pay for the Skittles? S____

ID# ___

Candy Bar Bids



Recording Sheet for Candy Bar Round

Bidder #	Almond Joy	Baby Ruth	Kitkat	M&M`s	Mars	Milky Way	Skittles	Snickers	Starburst	Twix

=_____

Stage Two Instructions

Step 1: You will be asked to bid on 10 packages of pork loin chops. Each package contains four pork loin chops and weighs approximately 2 pounds. These packages are labeled as the following:

1. Pork loin chop package 1.
2. Pork loin chop package 2.
3. Pork loin chop package 3.
4. Pork loin chop package 4.
5. Pork loin chop package 5.
6. Pork loin chop package 6.
7. Pork loin chop package 7.
8. Pork loin chop package 8.
9. Pork loin chop package 9.
10. Pork loin chop package 10.

You will be asked to indicate your willingness to pay for each of these packages of pork loin chops.

Step 2: Please write your bid for each of the packages on the recording sheet. Place a horizontal mark across the vertical price line at the point that corresponds to your bid for each package of pork loin chops. Next to the mark write the dollar amount of your bid.

For each of the 10 packages, the monitor will announce the highest bidder's number and display the second-highest bidding price of the package on the blackboard. In this auction, the highest bidder will pay the second highest bidding price.

This auction will have five bidding rounds. After the fifth bidding round is completed, one of the bidding rounds will be selected by the monitor to be the

binding round. Then one of the 10 pork loin chop packages will be selected randomly to be the package auctioned.

Note: In the event there is a tie for the highest bid, the winner will be determined by a coin toss. In this case the second-highest bid will be the same as the highest bid.

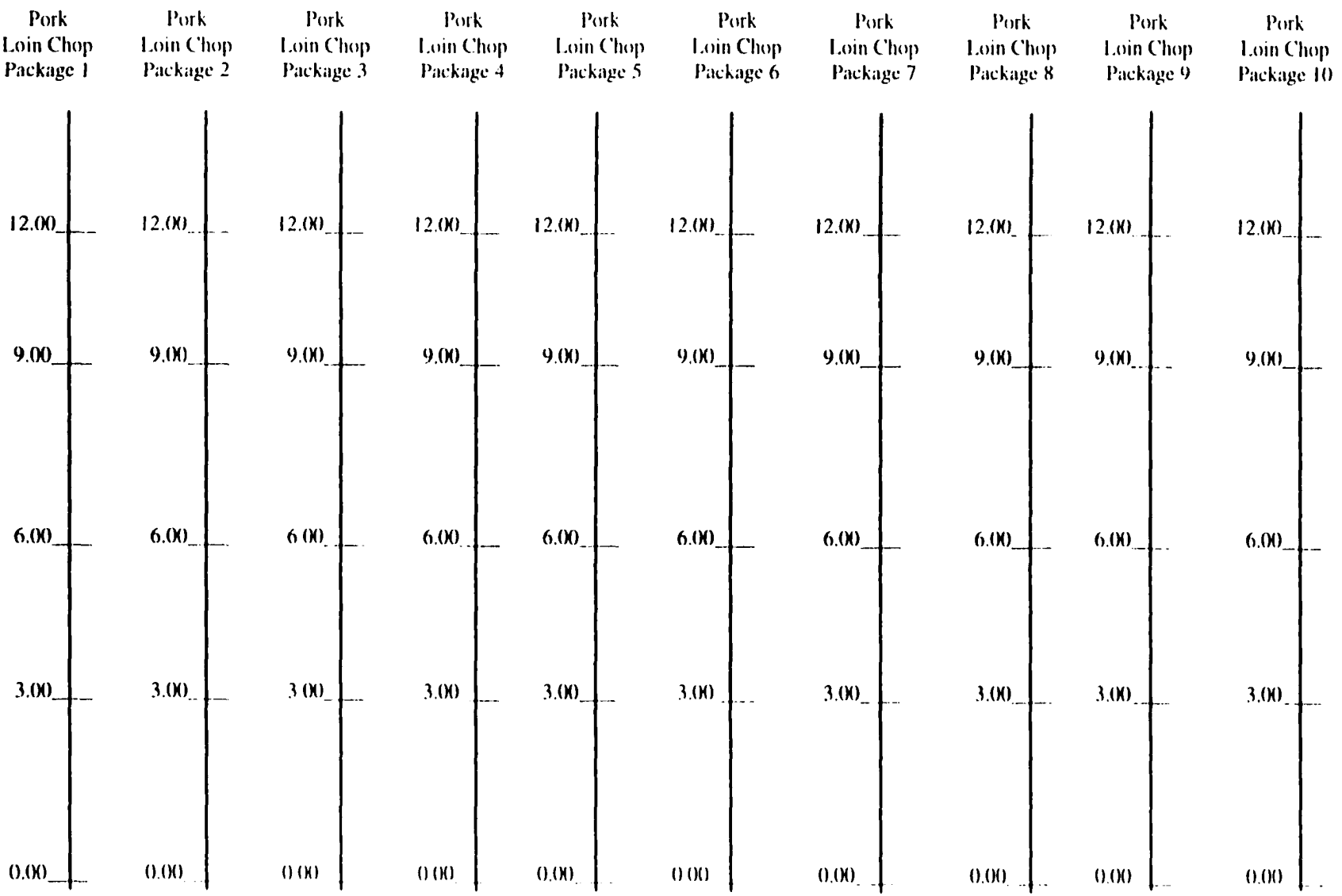
Note: In this auction it is in your best interest to bid the amount you are truly willing to pay to purchase each package. If you bid more than your true willingness-to-pay, you increase your chances of purchasing the package but you may have to pay a price greater than what you are willing to pay. On the other hand, if you bid less than the amount you are truly willing to pay, you may lose the chance to purchase the package at a price that you would be willing to pay.

Recording Sheet for Pork Experiment: Bidding Round ____

Bidder #	Package 1	Package 2	Package 3	Package 4	Package 5	Package 6	Package 7	Package 8	Package 9	Package 10

ID#_____

Pork Loin Chop Bids: Round 1



=_____

Attributes of the Pork Loin Chop Packages (9:00 Session)

Package 1 has no particular environmental attributes. It is the typical pork loin chops which can be bought at any local store.

Package 2 has the environmental attribute of a pig production system using technology that **reduces odor by 30 to 40%** below the typical (package 1).

Package 3 has the environmental attribute of a pig production system using technology that **reduces odor by 80 to 90%** below the typical (package 1).

Package 4 has the environmental attribute of a pig production system using technology that **reduces seepage** of nutrients, etc., from swine manure **into the groundwater by 15 to 25%** below the typical (package 1).

Package 5 has the environmental attribute of a pig production system using technology that **reduces seepage** of nutrients, etc., from swine manure **into the groundwater by 40 to 50%** below the typical (package 1).

Package 6 has the environmental attribute of a pig production system using technology that **reduces run-off** of phosphorus, etc., from manure **into surface water by 15 to 25%** below the typical (package 1).

Package 7 has the environmental attribute of a pig production system using technology that **reduces run-off** of phosphorus, etc., from manure **into surface water by 40 to 50%** below the typical (package 1).

Package 8 has a combination of two environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** and the other using technology that **reduces seepage into the groundwater by 40 to 50%** below the typical (package 1).

Package 9 has a combination of two environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** and the other using technology that **reduces run-off into surface water by 40 to 50%** below the typical (package 1).

Package 10 has a combination of three environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** the second using technology that **reduces seepage into the groundwater by 40 to 50%,** and the third using technology that **reduces run-off into surface water by 40 to 50%** below the typical (package 1).

=_____

Attributes of the Pork Loin Chop Packages (11:30 Session)

Package 1 has the environmental attribute of a pig production system using technoiogy that **reduces odor by 30 to 40%** below the typical (package 5).

Package 2 has the environmental attribute of a pig production system using technology that **reduces odor by 80 to 90%** below the typical (package 5).

Package 3 has the environmental attribute of a pig production system using technology that **reduces seepage** of nutrients, etc., from swine manure **into the groundwater by 15 to 25%** below the typical (package 5).

Package 4 has the environmental attribute of a pig production system using technology that **reduces seepage** of nutrients, etc., from swine manure **into the groundwater by 40 to 50%** below the typical (package 5).

Package 5 has no particular environmental attributes. It is the typical pork loin chops which can be bought at any local store.

Package 6 has the environmental attribute of a pig production system using technology that **reduces run-off** of phosphorus, etc., from manure **into surface water by 15 to 25%** below the typical (package 5).

Package 7 has the environmental attribute of a pig production system using technology that **reduces run-off** of phosphorus, etc., from manure **into surface water by 40 to 50%** below the typical (package 5).

Package 8 has a combination of two environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** and the other using technology that **reduces seepage into the groundwater by 40 to 50%** below the typical (package 5).

Package 9 has a combination of two environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** and the other using technology that **reduces run-off into surface water by 40 to 50%** below the typical (package 5).

Package 10 has a combination of three environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** the second using technology that **reduces seepage into the groundwater by 40 to 50%,** and the third using technology that **reduces run-off into surface water by 40 to 50%** below the typical (package 5).

=_____

Attributes of the Pork Loin Chop Packages (2:00 Session)

Package 1 has the environmental attribute of a pig production system using technology that **reduces odor by 30 to 40%** below the typical (package 10).

Package 2 has the environmental attribute of a pig production system using technology that **reduces odor by 80 to 90%** below the typical (package 10).

Package 3 has the environmental attribute of a pig production system using technology that **reduces seepage** of nutrients, etc., from swine manure **into the groundwater by 15 to 25%** below the typical (package 10).

Package 4 has the environmental attribute of a pig production system using technology that **reduces seepage** of nutrients, etc., from swine manure **into the groundwater by 40 to 50%** below the typical (package 10).

Package 5 has the environmental attribute of a pig production system using technology that **reduces run-off** of phosphorus, etc., from manure **into surface water by 15 to 25%** below the typical (package 10).

Package 6 has the environmental attribute of a pig production system using technology that **reduces run-off** of phosphorus, etc., from manure **into surface water by 40 to 50%** below the typical (package 10).

Package 7 has a combination of two environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** and the other using technology that **reduces seepage into the groundwater by 40 to 50%** below the typical (package 10).

Package 8 has a combination of two environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** and the other using technology that **reduces run-off into surface water by 40 to 50%** below the typical (package 10).

Package 9 has a combination of three environmental attributes in a pig production system: one using technology that **reduces odor by 80 to 90%,** the second using technology that **reduces seepage into the groundwater by 40 to 50%,** and the third using technology that **reduces run-off into surface water by 40 to 50%** below the typical (package 10).

Package 10 has no particular environmental attributes. It is the typical pork loin chops which can be bought at any local store.

#_____

The Production Systems

Typical Production System

The typical pork loin chops in this experiment come from a pig production system using an earthen manure storage system with manure applied on the top (surface) of the land. Odor in this system is allowed to flow freely.

Attributes of the typical pork production system with respect to odor, seepage and run-off is as follows:

Odor

A typical swine production system emits odor for a time period which is equivalent to about 11-18 days per year (3-5% of the time). This odor is produced primarily by sulfur compounds due to animal waste decomposition. For a 90% reduction, the swine production emits odor for a period of time which is equivalent to about 1-2 days per year, while for a 40% reduction, the swine production emits odor for a period of time which is equivalent to about 7-11 days per year.

Odor emissions from pork production facilities can have many effects to the surrounding area and its residents. They can cause unpleasant living conditions and loss of property values for surrounding neighbors; some psychological duress, as well as health effects of coughing, wheezing, vomiting, etc., and a more depressed general outlook on life. It creates uncertainty about planning social events by neighbors and can be a nuisance to both neighbors and those passing by.

Pig production systems with reduced odors (i.e., 40% and 90%) involve combinations of differing manure storage technologies and manure application methods along with air filtration devices attached to the production facilities to reduce odor emissions.

Groundwater seepage

The primary problem that can arise is leeching of nitrogen or nitrates from swine manure into the groundwater supply. This groundwater contamination can affect anyone using the underground aquifer for water consumption, e.g., surrounding neighbors, communities, etc.

One of the major health concerns with this seepage into an aquifer is Blue Baby disease resulting from lack of oxygen. This disease affects infants under the age of 6 months and can possibly lead to death.

Once an aquifer has been polluted, it can take months and even years to clean itself.

Pig production systems with reduced seepage (i.e., 40% and 90%) into the groundwater involve combinations of differing manure storage technologies and manure application methods.

Surface Water

The primary problem is from nutrient run-off from manure or manure spills that winds up in the surface water, i.e, stream, rivers, lakes, marshes, etc. The principal nutrient contaminant from swine manure is phosphorus.

This contamination can lead to oxygen depletion in the surface water supplies and the death of aquatic life such as fish. It can also lead to excessive algae growth in surface water supplies further depleting the oxygen supply in the affected water. Depending upon water flow of the contaminated area and level of run-off or spill, aquatic life can be affected over a short distance or cover many miles. Contamination can impact recreational use of surface water, i.e., boating, fishing, swimming, aesthetics, etc..

The amount of time for clean up depends upon surface water flow and can vary from a few days to weeks.

Pig production systems with reduced surface water contamination (i.e., 40% and 90%) involve combinations of differing manure storage technologies and manure application methods.

#=_____

Post Auction Survey

18. On a scale of 1 through 6 with 1 being 'very acceptable,' 3 being 'neutral,' 5 being 'not acceptable,' and 6 being 'no opinion' how acceptable to you are the following methods to achieve a reduction in odor?

Method	Very Acceptable		Neutral		Not Acceptable	No Opinion
Filtration of air from building	1	2	3	4	5	6
Additives to manure:						
Chemical	1	2	3	4	5	6
Microbial	1	2	3	4	5	6
Enzyme	1	2	3	4	5	6
Additives to hogs diet:						
Chemical	1	2	3	4	5	6
Natural	1	2	3	4	5	6
Manure storage above ground with cover	1	2	3	4	5	6
Manure storage below ground with cover	1	2	3	4	5	6
Injection of manure into the soil to a depth of 4 to 8 inches	1	2	3	4	5	6
Manure spread on top of soil with immediate incorporation	1	2	3	4	5	6
Manure storage under hog building	1	2	3	4	5	6
Composting with bedding material	1	2	3	4	5	6
Other: Please Specify_____	1	2	3	4	5	6

19. On a scale of 1 through 5 with 1 being 'very acceptable', 3 being 'neutral', and 5 being 'not acceptable', how acceptable to you are the following methods to achieve a reduction of manure seepage into groundwater?

Method	Very Acceptable		Neutral		Not Acceptable	No Opinion
Injection of manure into the soil to a depth of 4 to 8 inches	1	2	3	4	5	6
Manure storage above ground in steel/cement structure	1	2	3	4	5	6
Manure storage below ground in steel/cement structure	1	2	3	4	5	6
Other: Please Specify _____	1	2	3	4	5	6

20. On a scale of 1 through 5 with 1 being 'very acceptable', 3 being 'neutral', and 5 being 'not acceptable', how acceptable to you are the following methods to achieve a reduction in run-off or spill of manure into surface water?

Method	Very Acceptable		Neutral		Not Acceptable	No Opinion
Injection of manure into the soil to a depth of 4 to 8 inches	1	2	3	4	5	6
Manure spread on top of soil with immediate incorporation	1	2	3	4	5	6
Manure storage above ground in steel cement structure	1	2	3	4	5	6
Manure storage below ground in steel cement structure	1	2	3	4	5	6
Other: Please Specify _____	1	2	3	4	5	6

21. On a scale from 1 through 6 with 1 being 'very concerned', 5 being 'not concerned,' and 6 being 'no opinion' how concerned are you about the following issues:

Issue	Very Concerned				Not Concerned	No Opinion
Environmental impact from livestock production	1	2	3	4	5	6
Worker Environment	1	2	3	4	5	6
Animal Environment	1	2	3	4	5	6
Farm Structure	1	2	3	4	5	6

22. On a scale from 1 through 6 with 1 being 'very favorable', 5 being 'not favorable,' and 6 being 'no opinion,' how favorable to you are the following livestock production practices?

Type of Facility	Very Favorable				Not Favorable	No Opinion
Hoop	1	2	3	4	5	6
Partial Confinement	1	2	3	4	5	6
Pasture	1	2	3	4	5	6
Total Confinement	1	2	3	4	5	6

23. Would you buy a meat product that has environmental attributes specified on the label?

_____ Yes _____No

24. Would you pay a premium for a meat product that has environmental attributes specified on the label?

_____ Yes _____No

25. Is it important to you that the pork you consume was produced by a producer who has received education in environmental awareness and production practices?

_____ Yes _____No

APPENDIX C: EXPERIMENTAL RESULTS BY LOCATION

Table C1: Bid Premiums ($) per Package by Area for Premium Payers (Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Location			
	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT
No Particular Environmental Attributes (Typical)	-0.79	-0.47	-0.32	-0.52
Odor 30-40%	-0.61	-0.22	-0.33	-0.05
Odor 80-90%	-0.05	0.01	0.09	0.17
Ground water 15-25%	0.02	0.01	0.36	0.53
Ground water 40-50%	0.16	0.06	-0.19	0.68
Surface Water 15-25%	0.01	-0.16	0.11	0.39
Surface Water 40-50%	0.46	0.20	0.10	0.55
Odor 80-90%/Ground Water 40-50%	0.97	0.56	0.54	0.80
Odor 80-90%/Surface Water 40-50%	0.73	0.76	0.44	1.12
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	1.74	1.38	1.33	1.89

Table C2: Bid Premiums ($) per Package by Area for Premium Payers (Iowa Falls, IA; Corvallis, OR; Raleigh, NC (98))

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Location		
	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
No Particular Environmental Attributes (Typical)	-0.63	-0.44	-1.22
Odor 30-40%	-0.39	-0.55	-0.36
Odor 80-90%	-0.18	-0.12	-0.01
Ground water 15-25%	-0.19	-0.08	-0.02
Ground water 40-50%	-0.01	0.21	-0.38
Surface Water 15-25%	-0.37	0.04	-0.38
Surface Water 40-50%	0.19	-0.02	-0.05
Odor 80-90%/Ground Water 40-50%	0.78	-0.03	0.51
Odor 80-90%/Surface Water 40-50%	0.95	0.45	0.84
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	1.60	1.59	1.84

Table C3: Bid Premiums ($) per Package by Area for Non-Premium Payers (Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Location			
	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT
No Particular Environmental Attributes (Typical)	-0.27	-0.34	-0.71	-0.89
Odor 30-40%	-0.10	-0.58	-0.37	-1.01
Odor 80-90%	0.01	-0.37	-0.40	-0.96
Ground water 15-25%	0.03	0.10	-0.34	-0.71
Ground water 40-50%	-0.01	-0.23	-0.28	-0.66
Surface Water 15-25%	-0.14	-0.67	-0.60	-0.89
Surface Water 40-50%	0.21	-0.05	-0.24	-0.65
Odor 80-90%/Ground Water 40-50%	0.00	-0.06	-0.10	-0.44
Odor 80-90%/Surface Water 40-50%	0.01	-0.01	0.00	-0.35
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	-0.10	-0.08	-0.05	-0.23

Table C4: Bid Premiums ($) per Package by Area for Non-Premium Payers

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Location		
	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
No Particular Environmental Attributes (Typical)	-0.69	0.25	-0.05
Odor 30-40%	-0.53	-0.32	-0.08
Odor 80-90%	-0.42	-0.07	-0.03
Ground water 15-25%	-0.45	-0.17	0.00
Ground water 40-50%	-0.75	-0.22	-0.08
Surface Water 15-25%	-0.04	0.08	-0.05
Surface Water 40-50%	-0.58	-0.19	0.08
Odor 80-90%/Ground Water 40-50%	-0.08	0.17	-0.27
Odor 80-90%/Surface Water 40-50%	-0.51	0.03	0.03
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	-0.44	-0.02	-0.07

Table C5: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Ames, IA)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	46.94%	34.69%	4.08%	6.12%	4.08%	2.04%	2.04%	0.00%
Odor 30-40%	26.53%	53.06%	10.20%	6.12%	4.08%	0.00%	0.00%	0.00%
Odor 80-90%	26.53%	32.65%	12.24%	14.29%	10.20%	2.04%	0.00%	2.04%
Ground water 15-25%	30.61%	38.78%	6.12%	12.24%	6.12%	0.00%	2.04%	4.08%
Ground water 40-50%	26.53%	32.65%	12.24%	16.33%	8.16%	2.04%	0.00%	2.04%
Surface Water 15-25%	26.53%	44.90%	12.24%	8.16%	4.08%	0.00%	4.08%	0.00%
Surface Water 40-50%	24.49%	30.61%	12.24%	12.24%	8.16%	2.04%	2.04%	8.16%
Odor 80-90%/Ground Water 40-50%	14.29%	34.69%	12.24%	12.24%	14.29%	4.08%	0.00%	8.16%
Odor 80-90%/Surface Water 40-50%	20.41%	38.78%	10.20%	8.16%	10.20%	2.04%	0.00%	10.20%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	6.12%	32.65%	10.20%	10.20%	22.45%	2.04%	4.08%	12.24%
By Tier:								
No Particular Environmental Attributes (Typical)	46.94%	34.69%	4.08%	6.12%	4.08%	2.04%	2.04%	0.00%
Low Level Single Attribute	27.89%	33.33%	9.52%	12.24%	7.48%	2.04%	0.68%	1.36%
High Level Single Attribute	25.85%	31.97%	12.24%	14.29%	8.84%	2.04%	0.68%	4.08%
High Level Double Attributes	17.35%	36.73%	11.22%	10.20%	12.24%	3.06%	0.00%	9.18%
High Level Triple Attributes	6.12%	32.65%	10.20%	10.20%	22.45%	2.04%	4.08%	12.24%

Table C6: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Manhattan, KS)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	45.00%	36.67%	6.67%	3.33%	5.00%	1.67%	0.00%	1.67%
Odor 30-40%	35.00%	38.33%	8.33%	8.33%	6.67%	3.33%	0.00%	0.00%
Odor 80-90%	28.33%	35.00%	6.67%	16.67%	8.33%	5.00%	0.00%	0.00%
Ground water 15-25%	25.00%	38.33%	8.33%	15.00%	8.33%	1.67%	0.00%	3.33%
Ground water 40-50%	30.00%	35.00%	8.33%	6.67%	10.00%	8.33%	1.67%	0.00%
Surface Water 15-25%	26.67%	40.00%	5.00%	13.33%	10.00%	3.33%	0.00%	1.67%
Surface Water 40-50%	20.00%	36.67%	10.00%	13.33%	8.33%	8.33%	0.00%	3.33%
Odor 80-90%/Ground Water 40-50%	16.67%	28.33%	6.67%	11.67%	21.67%	5.00%	8.33%	1.67%
Odor 80-90%/Surface Water 40-50%	15.00%	31.67%	6.67%	10.00%	20.00%	3.33%	6.67%	6.67%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	6.67%	26.67%	10.00%	16.67%	10.00%	8.33%	13.33%	8.33%
By Tier:								
No Particular Environmental Attributes (Typical)	45.00%	36.67%	6.67%	3.33%	5.00%	1.67%	0.00%	1.67%
Low Level Single Attribute	28.89%	38.89%	7.22%	12.22%	8.33%	2.78%	0.00%	1.67%
High Level Single Attribute	26.11%	35.56%	8.33%	12.22%	8.89%	7.22%	0.56%	1.11%
High Level Double Attributes	15.83%	30.00%	6.67%	10.83%	20.83%	4.17%	7.50%	4.17%
High Level Triple Attributes	6.67%	26.67%	10.00%	16.67%	10.00%	8.33%	13.33%	8.33%

Table C7: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Raleigh, NC 6/28/97)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	54.84%	29.03%	3.23%	6.45%	3.23%	0.00%	0.00%	3.23%
Odor 30-40%	38.71%	38.71%	9.68%	6.45%	0.00%	0.00%	6.45%	0.00%
Odor 80-90%	35.48%	41.94%	9.68%	6.45%	3.23%	3.23%	0.00%	0.00%
Ground water 15-25%	38.71%	45.16%	3.23%	6.45%	0.00%	3.23%	0.00%	3.23%
Ground water 40-50%	35.48%	38.71%	12.90%	9.68%	0.00%	0.00%	3.23%	0.00%
Surface Water 15-25%	38.71%	32.26%	16.13%	6.45%	0.00%	3.23%	3.23%	0.00%
Surface Water 40-50%	29.03%	38.71%	9.68%	6.45%	12.90%	0.00%	3.23%	0.00%
Odor 80-90%/Ground Water 40-50%	22.58%	32.26%	16.13%	9.68%	12.90%	3.23%	0.00%	3.23%
Odor 80-90%/Surface Water 40-50%	19.35%	32.26%	16.13%	16.13%	9.68%	6.45%	0.00%	0.00%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	6.45%	32.26%	12.90%	12.90%	16.13%	6.45%	3.23%	9.68%
By Tier:								
No Particular Environmental Attributes (Typical)	54.84%	29.03%	3.23%	6.45%	3.23%	0.00%	0.00%	3.23%
Low Level Single Attribute	38.71%	38.71%	9.68%	6.45%	0.00%	2.15%	3.23%	1.08%
High Level Single Attribute	33.33%	39.78%	10.75%	7.53%	5.38%	1.08%	2.15%	0.00%
High Level Double Attributes	20.97%	32.26%	16.13%	12.90%	11.29%	4.84%	0.00%	1.61%
High Level Triple Attributes	6.45%	32.26%	12.90%	12.90%	16.13%	6.45%	3.23%	9.68%

Table C8: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Burlington, VT)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	55.56%	29.63%	11.11%	0.00%	3.70%	0.00%	0.00%	0.00%
Odor 30-40%	48.15%	22.22%	18.52%	3.70%	3.70%	0.00%	0.00%	3.70%
Odor 80-90%	40.74%	22.22%	18.52%	11.11%	3.70%	0.00%	0.00%	3.70%
Ground water 15-25%	37.04%	14.81%	18.52%	11.11%	11.11%	3.70%	3.70%	0.00%
Ground water 40-50%	37.04%	29.63%	11.11%	11.11%	3.70%	0.00%	0.00%	7.41%
Surface Water 15-25%	44.44%	22.22%	11.11%	11.11%	7.41%	0.00%	0.00%	3.70%
Surface Water 40-50%	40.74%	25.93%	11.11%	7.41%	7.41%	3.70%	0.00%	3.70%
Odor 80-90%/Ground Water 40-50%	25.93%	25.93%	18.52%	3.70%	11.11%	3.70%	7.41%	3.70%
Odor 80-90%/Surface Water 40-50%	22.22%	29.63%	11.11%	7.41%	14.81%	3.70%	3.70%	7.41%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	14.81%	29.63%	11.11%	3.70%	7.41%	3.70%	14.81%	14.81%
By Tier:								
No Particular Environmental Attributes (Typical)	55.56%	29.63%	11.11%	0.00%	3.70%	0.00%	0.00%	0.00%
Low Level Single Attribute	43.21%	19.75%	16.05%	8.64%	7.41%	1.23%	1.23%	2.47%
High Level Single Attribute	39.51%	25.93%	13.58%	9.88%	4.94%	1.23%	0.00%	4.94%
High Level Double Attributes	24.07%	27.78%	14.81%	5.56%	12.96%	3.70%	5.56%	5.56%
High Level Triple Attributes	14.81%	29.63%	11.11%	3.70%	7.41%	3.70%	14.81%	14.81%

Table C9: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Iowa Falls, IA)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	44.83%	31.03%	10.34%	3.45%	8.62%	0.00%	0.00%	1.72%
Odor 30-40%	37.93%	37.93%	10.34%	6.90%	6.90%	0.00%	0.00%	0.00%
Odor 80-90%	32.76%	37.93%	13.79%	3.45%	8.62%	1.72%	1.72%	0.00%
Ground water 15-25%	29.31%	39.66%	15.52%	6.90%	6.90%	0.00%	1.72%	0.00%
Ground water 40-50%	32.76%	34.48%	15.52%	1.72%	8.62%	3.45%	1.72%	1.72%
Surface Water 15-25%	32.76%	36.21%	13.79%	5.17%	10.34%	0.00%	0.00%	1.72%
Surface Water 40-50%	29.31%	34.48%	8.62%	8.62%	12.07%	1.72%	3.45%	1.72%
Odor 80-90%/Ground Water 40-50%	12.07%	31.03%	17.24%	12.07%	13.79%	6.90%	5.17%	1.72%
Odor 80-90%/Surface Water 40-50%	13.79%	29.31%	12.07%	12.07%	15.52%	6.90%	5.17%	5.17%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	10.34%	29.31%	8.62%	10.34%	13.79%	10.34%	6.90%	10.34%
By Tier:								
No Particular Environmental Attributes (Typical)	44.83%	31.03%	10.34%	3.45%	8.62%	0.00%	0.00%	1.72%
Low Level Single Attribute	33.33%	37.93%	13.22%	6.32%	8.05%	0.00%	0.57%	0.57%
High Level Single Attribute	31.61%	35.63%	12.64%	4.60%	9.77%	2.30%	2.30%	1.15%
High Level Double Attributes	12.93%	30.17%	14.66%	12.07%	14.66%	6.90%	5.17%	3.45%
High Level Triple Attributes	10.34%	29.31%	8.62%	10.34%	13.79%	10.34%	6.90%	10.34%

Table C10: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Corvallis, OR)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	31.67%	50.00%	8.33%	0.00%	6.67%	0.00%	0.00%	3.33%
Odor 30-40%	43.33%	36.67%	8.33%	6.67%	3.33%	1.67%	0.00%	0.00%
Odor 80-90%	26.67%	45.00%	6.67%	13.33%	5.00%	1.67%	1.67%	0.00%
Ground water 15-25%	25.00%	50.00%	13.33%	8.33%	1.67%	0.00%	0.00%	1.67%
Ground water 40-50%	23.33%	46.67%	5.00%	13.33%	8.33%	0.00%	0.00%	3.33%
Surface Water 15-25%	18.33%	41.67%	16.67%	11.67%	10.00%	0.00%	1.67%	0.00%
Surface Water 40-50%	26.67%	41.67%	15.00%	10.00%	1.67%	3.33%	1.67%	0.00%
Odor 80-90%/Ground Water 40-50%	25.00%	36.67%	11.67%	8.33%	13.33%	1.67%	1.67%	1.67%
Odor 80-90%/Surface Water 40-50%	13.33%	38.33%	13.33%	20.00%	8.33%	1.67%	1.67%	3.33%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	3.33%	33.33%	11.67%	15.00%	8.33%	10.00%	5.00%	13.33%
By Tier:								
No Particular Environmental Attributes (Typical)	31.67%	50.00%	8.33%	0.00%	6.67%	0.00%	0.00%	3.33%
Low Level Single Attribute	28.89%	42.78%	12.78%	8.89%	5.00%	0.56%	0.56%	0.56%
High Level Single Attribute	25.56%	44.44%	8.89%	12.22%	5.00%	1.67%	1.11%	1.11%
High Level Double Attributes	19.17%	37.50%	12.50%	14.17%	10.83%	1.67%	1.67%	2.50%
High Level Triple Attributes	3.33%	33.33%	11.67%	15.00%	8.33%	10.00%	5.00%	13.33%

Table C11: Percent of Participants Paying Premiums by Premium Level for Both Products and Tiers (Raleigh, NC 6/27/98)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	Premium Level (Interval) per Package							
	Below $0.00	$0.00	$0.01-$0.49	$0.50-$0.99	$1.00-$1.49	$1.50-$1.99	$2.00-$2.49	Over $2.50
By Product:								
No Particular Environmental Attributes (Typical)	54.55%	34.09%	2.27%	4.55%	4.55%	0.00%	0.00%	0.00%
Odor 30-40%	29.55%	54.55%	0.00%	9.09%	2.27%	0.00%	2.27%	2.27%
Odor 80-90%	20.45%	59.09%	0.00%	9.09%	6.82%	0.00%	0.00%	4.55%
Ground water 15-25%	22.73%	54.55%	0.00%	11.36%	9.09%	0.00%	0.00%	2.27%
Ground water 40-50%	34.09%	40.91%	6.82%	6.82%	4.55%	6.82%	0.00%	0.00%
Surface Water 15-25%	27.27%	56.82%	9.09%	0.00%	4.55%	0.00%	2.27%	0.00%
Surface Water 40-50%	20.45%	50.00%	9.09%	6.82%	9.09%	2.27%	0.00%	2.27%
Odor 80-90%/Ground Water 40-50%	20.45%	47.73%	9.09%	9.09%	4.55%	4.55%	0.00%	4.55%
Odor 80-90%/Surface Water 40-50%	13.64%	43.18%	6.82%	11.36%	9.09%	11.36%	0.00%	4.55%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	9.09%	29.55%	4.55%	15.91%	13.64%	4.55%	11.36%	11.36%
By Tier:								
No Particular Environmental Attributes (Typical)	54.55%	34.09%	2.27%	4.55%	4.55%	0.00%	0.00%	0.00%
Low Level Single Attribute	26.52%	55.30%	3.03%	6.82%	5.30%	0.00%	1.52%	1.52%
High Level Single Attribute	25.00%	50.00%	5.30%	7.58%	6.82%	3.03%	0.00%	2.27%
High Level Double Attributes	17.05%	45.45%	7.95%	10.23%	6.82%	7.95%	0.00%	4.55%
High Level Triple Attributes	9.09%	29.55%	4.55%	15.91%	13.64%	4.55%	11.36%	11.36%

APPENDIX D: POST AUCTION SURVEY RESULTS BY LOCATION

Information on Participant Response to General Information by Location

Table D1: Comparison of General Information on Participants from the Pre Survey Auction (All Participants: Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

	Location			
	Ames, IA	**Manhattan, KS**	**Raleigh, NC (97)**	**Burlington, VT**
Females %	63.27	53.33	61.29	62.96
Age Years	45.49	42.33	38.03	47.78
Number Living in Household	2.69	2.70	2.94	3.19
Education Level Years	15.88	14.74	15.48	14.60
Employed %	63.27	71.67	77.42	62.96
Household Income $	44,200	35,500	46,300	39,100
Consume Beef %	97.96	98.33	100.00	92.59
Consume Pork %	97.96	90.00	96.77	96.15
Consume Poultry %	100.00	98.33	100.00	96.15
Consume Fish %	91.84	85.00	93.55	92.31
Times Consume Beef per Month	10.43	12.60	9.45	6.70
Times Consume Pork per Month	5.87	5.27	5.05	6.15
Times Consume Poultry per Month	10.14	10.14	13.13	9.30
Times Consume Fish per Month	4.06	2.98	4.98	4.30
Number of Production Facilities Within One Mile	0.22	0.10	0.06	0.07
Number of Production Facilities Within Two Miles	0.59	0.22	0.13	0.08
Commercial Producers %	0.00	1.67	0.00	0.00
Read Food Labels[a]	2.41	2.39	2.35	2.26
Notice Environmental Attributes on Labels %	46.94	47.46	45.16	55.56
Consume More Beef Due to Advertising %	10.20	15.52	31.03	11.54
Consume More Pork Due to Advertising %	16.33	32.20	33.33	30.77
Want Environmental Labeling for Most Products %	100.00	93.22	87.10	92.59
Would Pay a Premium for Meat Products with Environmental Attributes %	55.10	66.10	61.29	70.37
Want Education for Pork Producers %	81.63	89.83	90.32	96.30

[a] 1=never; 2=sometimes; 3=always

Table D2: Comparison of General Information on Participants from the Pre Survey Auction (All Participants: Iowa Fall, IA; Corvallis, OR; Raleigh, NC (98))

	Location		
	Iowa Falls, IA	**Corvallis, OR**	**Raleigh, NC (98)**
Females %	62.07	66.67	50.00
Age Years	58.30	52.47	44.61
Number Living in Household	2.52	2.53	2.61
Education Level Years	14.72	15.50	16.50
Employed %	50.00	55.00	88.64
Household Income $	36,800	45,500	59,900
Consume Beef %	100.00	91.67	95.45
Consume Pork %	100.00	91.67	100.00
Consume Poultry %	96.49	95.00	100.00
Consume Fish %	85.96	88.33	93.18
Times Consume Beef per Month	12.70	7.17	8.09
Times Consume Pork per Month	7.60	5.11	5.55
Times Consume Poultry per Month	7.51	9.31	12.39
Times Consume Fish per Month	3.86	3.16	5.09
Number of Production Facilities Within One Mile	0.45	0.00	0.00
Number of Production Facilities Within Two Miles	1.54	0.02	0.00
Commercial Producers %	3.64	0.00	2.27
Read Food Labels[a]	2.36	2.43	2.41
Notice Environmental Attributes on Labels %	52.83	60.00	54.55
Consume More Beef Due to Advertising %	21.15	14.29	7.50
Consume More Pork Due to Advertising %	39.22	37.29	25.00
Want Environmental Labeling for Most Products %	89.09	100.00	97.73
Would Pay a Premium for Meat Products with Environmental Attributes %	54.55	75.00	72.73
Want Education for Pork Producers %	89.29	91.53	90.91

[a] 1=never; 2=sometimes; 3=always

Table D3: Comparison of General Information on Participants from the Pre Survey Auction (Premium Payers: Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

	Location			
	Ames, IA	**Manhattan, KS**	**Raleigh, NC (97)**	**Burlington, VT**
Females %	76.67	55.00	57.89	53.33
Age Years	45.03	42.65	41.37	43.60
Number Living in Household	2.73	2.75	2.95	3.00
Education Level Years	15.4	14.7	15.78	15.46
Employed %	66.67	72.50	89.47	80.00
Household Income $	42,200	35,000	50,800	41,000
Consume Beef %	96.67	100.00	100.00	93.33
Consume Pork %	100.00	95.00	94.74	100.00
Consume Poultry %	100.00	100.00	100.00	100.00
Consume Fish %	93.33	82.50	100.00	93.33
Times Consume Beef per Month	10.33	12.38	10.67	7.07
Times Consume Pork per Month	5.97	5.73	5.28	6.33
Times Consume Poultry per Month	10.20	10.80	13.28	10.00
Times Consume Fish per Month	3.87	2.91	4.78	3.87
Number of Production Facilities Within One Mile	0.23	0.00	0.00	0.00
Number of Production Facilities Within Two Miles	0.73	0.10	0.05	0.10
Commercial Producers %	0.00	0.00	0.00	0.00
Read Food Labels[a]	2.40	2.35	2.42	2.33
Notice Environmental Attributes on Labels %	43.33	50.00	47.37	66.67
Consume More Beef Due to Advertising %	10.00	15.00	29.41	0.00
Consume More Pork Due to Advertising %	20.00	25.00	31.58	40.00
Want Environmental Labeling for Most Products %	100.00	95.00	84.21	93.33
Would Pay a Premium for Meat Products with Environmental Attributes %	70.00	70.00	68.42	73.33
Want Education for Pork Producers %	86.67	90.00	94.74	100.00

[a] 1=never; 2=sometimes; 3=always

Table D4: Comparison of General Information on Participants from the Pre Survey Auction (Premium Payers: Iowa Fall, IA; Corvallis, OR; Raleigh, NC (98))

	Location		
	Iowa Falls, IA	**Corvallis, OR**	**Raleigh, NC (98)**
Females %	74.29	65.79	51.85
Age Years	54.83	51.84	43.44
Number Living in Household	2.77	2.63	2.70
Education Level Years	12.54	15.9	16.88
Employed %	60.00	60.53	85.19
Household Income $	37,900	49,300	60,000
Consume Beef %	100.00	92.11	96.30
Consume Pork %	100.00	92.11	100.00
Consume Poultry %	97.14	97.37	100.00
Consume Fish %	94.29	86.84	92.59
Times Consume Beef per Month	12.94	7.18	7.89
Times Consume Pork per Month	6.57	4.62	5.07
Times Consume Poultry per Month	7.83	8.30	11.48
Times Consume Fish per Month	3.66	3.09	4.44
Number of Production Facilities Within One Mile	0.47	0.00	0.00
Number of Production Facilities Within Two Miles	1.61	0.03	0.00
Commercial Producers %	6.06	0.00	0.00
Read Food Labels[a]	2.34	2.45	2.44
Notice Environmental Attributes on Labels %	58.82	60.53	59.26
Consume More Beef Due to Advertising %	15.63	16.67	4.00
Consume More Pork Due to Advertising %	31.25	34.21	22.22
Want Environmental Labeling for Most Products %	97.14	100.00	96.30
Would Pay a Premium for Meat Products with Environmental Attributes %	65.71	77.14	77.78
Want Education for Pork Producers %	94.29	94.59	92.59

[a] 1=never; 2=sometimes; 3=always

Table D5: Comparison of General Information on Participants from the Pre Survey Auction (Non-Premium Payers: Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

	Location			
	Ames, IA	**Manhattan, KS**	**Raleigh, NC (97)**	**Burlington, VT**
Females %	42.11	50.00	66.67	75.00
Age Years	46.21	41.70	32.75	53.00
Number Living in Household	2.63	2.60	2.92	3.42
Education Level Years	16.64	14.8	15	13.75
Employed %	57.89	70.00	58.33	41.67
Household Income $	42,100	36,500	38,600	36,700
Consume Beef %	100.00	95.00	100.00	91.67
Consume Pork %	94.74	80.00	100.00	90.91
Consume Poultry %	100.00	95.00	100.00	90.91
Consume Fish %	89.47	90.00	83.33	90.91
Times Consume Beef per Month	10.58	13.05	7.63	6.25
Times Consume Pork per Month	5.71	4.31	4.71	5.92
Times Consume Poultry per Month	10.04	8.74	12.92	8.42
Times Consume Fish per Month	4.36	3.14	5.32	4.83
Number of Production Facilities Within One Mile	0.21	0.30	0.17	0.33
Number of Production Facilities Within Two Miles	0.37	0.45	0.25	0.00
Commercial Producers %	0.00	5.00	0.00	0.00
Read Food Labels[a]	2.42	2.47	2.25	2.17
Notice Environmental Attributes on Labels %	52.63	42.11	41.67	41.67
Consume More Beef Due to Advertising %	10.53	16.67	33.33	27.27
Consume More Pork Due to Advertising %	10.53	47.37	36.36	18.18
Want Environmental Labeling for Most Products %	100.00	89.47	91.67	91.67
Would Pay a Premium for Meat Products with Environmental Attributes %	31.58	57.89	50.00	66.67
Want Education for Pork Producers %	73.68	89.47	83.33	91.67

[a] 1=never; 2=sometimes; 3=always

Table D6: Comparison of General Information on Participants from the Pre Survey Auction (Non-Premium Payers: Iowa Fall, IA; Corvallis, OR; Raleigh, NC (98))

	Location		
	Iowa Falls, IA	**Corvallis, OR**	**Raleigh, NC (98)**
Females %	43.48	68.18	47.06
Age Years	64.10	53.55	46.47
Number Living in Household	2.13	2.36	2.47
Education Level Years	13.09	14.82	15.88
Employed %	34.78	45.45	94.12
Household Income $	35,000	39,100	59,700
Consume Beef %	100.00	90.91	94.12
Consume Pork %	100.00	90.91	100.00
Consume Poultry %	95.45	90.91	100.00
Consume Fish %	72.73	90.91	94.12
Times Consume Beef per Month	12.32	7.14	8.41
Times Consume Pork per Month	9.23	6.00	6.29
Times Consume Poultry per Month	7.00	11.14	13.82
Times Consume Fish per Month	4.19	3.27	6.12
Number of Production Facilities Within One Mile	0.42	0.00	0.00
Number of Production Facilities Within Two Miles	1.42	0.00	0.00
Commercial Producers %	0.00	0.00	5.88
Read Food Labels[a]	2.39	2.41	2.35
Notice Environmental Attributes on Labels %	42.11	59.09	47.06
Consume More Beef Due to Advertising %	30.00	10.00	13.33
Consume More Pork Due to Advertising %	52.63	42.86	29.41
Want Environmental Labeling for Most Products %	75.00	100.00	100.00
Would Pay a Premium for Meat Products with Environmental Attributes %	35.00	71.43	64.71
Want Education for Pork Producers %	80.95	86.36	88.24

[a] 1=never; 2=sometimes; 3=always

Participant Response to Issues of Concern by Location

Table D7: Issues of Concern and Importance to Participants by Location (All Participants: Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

Item	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT
General Issues of Concern[a]				
Environment	1.69	1.84	1.58	1.48
Water Quality	1.42	1.50	1.35	1.37
Air Quality	1.60	1.72	1.52	1.37
Food Prices	1.90	1.78	1.81	1.74
Family Farms	2.54	2.53	2.81	2.63
Livestock Production Methods	2.60	2.53	2.55	2.37
Animal Welfare	2.54	2.34	2.45	1.96
Pollution	1.58	1.60	1.55	1.19
Livestock Confinement	2.27	2.76	2.90	2.22
Changing Farm Structure	2.85	3.05	3.23	2.59
Product Attribute: Issues of Importance[b]				
Eating Quality	1.15	1.32	1.19	1.15
Visual Appeal	1.81	1.74	1.68	1.67
Freshness	1.19	1.19	1.26	1.19
Price	1.79	1.63	1.84	1.74
Production Methods	2.27	2.33	2.77	1.96
Uniformity of Product	2.38	2.21	2.19	2.04

[a] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

[b] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

Table D8: Issues of Concern and Importance to Participants by Location (All Participants: Iowa Fall, IA; Corvallis, OR; Raleigh, NC (98))

Item	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
General Issues of Concern[a]			
Environment	1.57	1.62	1.59
Water Quality	1.26	1.35	1.43
Air Quality	1.53	1.50	1.49
Food Prices	2.02	2.02	2.12
Family Farms	2.21	2.67	2.86
Livestock Production Methods	2.22	2.35	2.52
Animal Welfare	2.52	2.20	2.43
Pollution	1.42	1.48	1.41
Livestock Confinement	1.75	2.57	2.70
Changing Farm Structure	2.57	3.10	3.11
Product Attribute: Issues of Importance[b]			
Eating Quality	1.25	1.16	1.14
Visual Appeal	1.63	1.58	1.66
Freshness	1.18	1.19	1.09
Price	1.68	1.81	1.77
Production Methods	2.09	1.97	2.14
Uniformity of Product	1.86	2.24	2.07

[a] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

[b] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

Table D9: Issues of Concern and Importance to Participants by Location (Premium Payers: Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

Item	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT
General Issues of Concern[a]				
Environment	1.83	1.78	1.42	1.27
Water Quality	1.45	1.48	1.26	1.33
Air Quality	1.66	1.65	1.32	1.27
Food Prices	1.83	1.75	1.84	1.80
Family Farms	2.55	2.53	2.74	2.20
Livestock Production Methods	2.66	2.40	2.47	2.33
Animal Welfare	2.38	2.33	2.68	2.13
Pollution	1.66	1.55	1.47	1.13
Livestock Confinement	2.34	2.68	3.16	2.20
Changing Farm Structure	2.69	2.93	3.26	2.13
Product Attribute: Issues of Importance[b]				
Eating Quality	1.17	1.31	1.21	1.07
Visual Appeal	1.86	1.79	1.79	1.60
Freshness	1.14	1.21	1.26	1.20
Price	1.62	1.64	1.89	1.80
Production Methods	2.14	2.38	2.89	2.07
Uniformity of Product	2.17	2.15	2.16	2.07

[a] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

[b] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

Table D10: Issues of Concern and Importance to Participants by Location (Premium Payers: Iowa Fall, IA; Corvallis, OR; Raleigh, NC (98))

Item	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
General Issues of Concern[a]			
Environment	1.50	1.61	1.52
Water Quality	1.17	1.39	1.37
Air Quality	1.46	1.50	1.46
Food Prices	1.91	2.00	2.00
Family Farms	2.24	2.74	2.67
Livestock Production Methods	2.26	2.45	2.48
Animal Welfare	2.62	2.24	2.37
Pollution	1.37	1.45	1.37
Livestock Confinement	1.65	2.55	2.52
Changing Farm Structure	2.41	3.26	3.11
Product Attribute: Issues of Importance[b]			
Eating Quality	1.31	1.22	1.07
Visual Appeal	1.68	1.55	1.67
Freshness	1.20	1.26	1.07
Price	1.74	1.76	1.74
Production Methods	2.26	1.89	2.30
Uniformity of Product	1.97	2.29	2.19

[a] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

[b] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

Table D11: Issues of Concern and Importance to Participants by Location (Non-Premium Payers: Ames, IA; Manhattan, KS; Raleigh, NC (97); Burlington, VT)

Item	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT
General Issues of Concern[a]				
Environment	1.47	2.00	1.83	1.75
Water Quality	1.37	1.56	1.50	1.42
Air Quality	1.53	1.89	1.83	1.50
Food Prices	2.00	1.83	1.75	1.67
Family Farms	2.53	2.56	2.92	3.17
Livestock Production Methods	2.53	2.83	2.67	2.42
Animal Welfare	2.79	2.39	2.08	1.75
Pollution	1.47	1.71	1.67	1.25
Livestock Confinement	2.16	2.94	2.50	2.25
Changing Farm Structure	3.11	3.33	3.17	3.17
Product Attribute: Issues of Importance[b]				
Eating Quality	1.11	1.33	1.17	1.25
Visual Appeal	1.74	1.61	1.50	1.75
Freshness	1.26	1.17	1.25	1.17
Price	2.05	1.61	1.75	1.67
Production Methods	2.47	2.22	2.58	1.83
Uniformity of Product	2.68	2.33	2.25	2.00

[a] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

[b] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

Table D12: Issues of Concern and Importance to Participants by Location (Non-Premium Payers: Iowa Fall, IA; Corvallis, OR; Raleigh, NC (98))

Item	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
General Issues of Concern[a]			
Environment	1.68	1.64	1.71
Water Quality	1.41	1.27	1.53
Air Quality	1.64	1.50	1.53
Food Prices	2.18	2.05	2.29
Family Farms	2.15	2.55	3.18
Livestock Production Methods	2.14	2.18	2.59
Animal Welfare	2.36	2.14	2.53
Pollution	1.50	1.55	1.47
Livestock Confinement	1.90	2.59	3.00
Changing Farm Structure	2.82	2.82	3.12
Product Attribute: Issues of Importance[b]			
Eating Quality	1.14	1.05	1.24
Visual Appeal	1.55	1.62	1.65
Freshness	1.14	1.05	1.12
Price	1.59	1.90	1.82
Production Methods	1.81	2.10	1.88
Uniformity of Product	1.68	2.14	1.88

[a] The question was: On a scale from 1 through 5 with 1 being 'very concerned' and 5 being 'not concerned,' how concerned are you about the following issues:

[b] The question was: On a scale from 1 through 5 with 1 being 'very important' and 5 being 'not important,' indicate how important the following attributes are for the products you consume:

APPENDIX E: LIMDEP COMMANDS FOR RUNNING ECONOMETRIC MODEL

Program for Estimating the Magnitudes of the Premium for the Premium Payers

```
RESET

READ;file="C:\Program Files\ES\Limdep\leodata_6_17.xls";format=xls;namesS

SKIPS

        NAMES   ; W  =  ONE, NOINHOUS, NOINHSQ, EMPLY, INC3060, INC60UP,
PORKM, PORKMSQ, ATTRIB, PREM1,GENHINCS


  CREATE  ; Z  =  ORDPRO S

        NAMES   ; X  =   ONE, AGE, GRADCOL, GRADGRAD,INC3060, INC60UP,
ATTRIB, MRPRK, ENVLV1, PRKEDU1S


  CREATE  ; Y  =  R4939  S

  CALC    ; j  =  2  S

  ORDERED PROBIT  ; Lhs = Z  ;  Rhs = W  ;  Par S

      CALC    ; Nolist ; JP = Max(Z)  +  1  ;  JP1 = JP + 1
              ; KP = Col(W) ; KP1 = KP+1 ; M = JP-2 ; L=KP+M S

      MATRIX  ; list  ; ALPHA=Part(B,1,KP)

                ; U1= [-10000 / 0 ]
                ; U2= Part(B,KP1,1)
                ; U3= [10000]
                ; MUA=[U1/U2/U3]
            ; Z11 = Part(VARB,1,KP,1,KP)
            ; Z21 = Init(2,KP,0)
            ; Z22 = [0,0/0,0]
            ; Z31 = Part(VARB,KP1,L,1,KP)
            ; Z32 = Init(M,2,0)
            ; Z33 = Part(VARB,KP1,L,KP1,L)
```

```
     : Z41 = Init(1,KP,0)
     : Z42 = [0,0]
     : Z43 = Init(1,M,0)
     : Z44 = [0]
     : V=[Z11 /  Z21,Z22 /  Z31,Z32,Z33 /  Z41,Z42,Z43,Z44]S

INCLUDE :  New  ;  Z  =  J  S

CALC    ;  J1  = J + 1
     ;  J2  = J + 2 S

CREATE  ;  AJ1 = MUA(J1) - W'ALPHA
     :  AJ  = MUA(J2) - W'ALPHA
     :  DJ1 = N01(AJ1)
     ;  DJ  = N01(AJ)
     ;  FJ1 = Phi(AJ1)
     ;  FJ  = Phi(AJ)
     ;  LAMBDA = (DJ1-DJ)/(FJ-FJ1)
     :  DELTA = (AJ1*DJ1 - AJ*DJ)/(FJ-FJ1) - LAMBDA ^ 2 S

NAMES   :  XL        = X,LAMBDA S

REGRESS ;  Lhs       = Y
     :  Rhs      = X, LAMBDA  S

CALC    :  P    = Col(XL)
     :  C        = B(P)
     :  S2       = SUMSQDEV/NREG - C^2 * Xbr(DELTA)
     :  RHOSQD =  c^2/s2  S

CREATE ;  PJ1 = (J>1) * DJ1/(FJ-FJ1) * (LAMBDA-AJ1)
    :  PJ  = 0S

MATRIX  ;list; XP1 = XL'* PJ1
     ; XP  = XL'* PJ
     ; ZERO= Init(P,1,0)
     ; R   = Init(3,JP1,0)
     ; R(1,J1)=1
     ; R(2,J2)=1
     ; XPP = [XP1,XP,ZERO]
     : XG1 = XL'[DELTA]W
     ; XG2 = XPP * R
     ; XG  = [XG1,XG2]  S

CREATE  ;  H   =  1 - RHOSQD * DELTA S
```

```
MATRIX  ; list: VC  =  XL'[H]XL - RHOSQD * XG * V * XG'
        ; VC  =  S2 * <XL'XL> * VC * <XL'XL>
        ; Stat  ( B , VARB)
        : Stat  ( B , VC ) S
```

Program for Estimating the Magnitudes of the Premium for the Non-Premium Payers

```
RESET

READ;file="C:\Program Files\ES\Limdep\leodata_6_17.xls";format=xls;namesS

SKIPS

        NAMES   ;  W  =  ONE, NOINHOUS, NOINHSQ, EMPLY, INC3060, INC60UP,

PORKM,  PORKMSQ, ATTRIB, PREM1,GENHINCS


  CREATE  ;  Z  =  ORDPRO  S

        NAMES   ;  X  =  ONE, AGE, NOINHOUS, NOINHSQ, EMPLY, INC3060

,INC60UP, WNTLAB, PREM1, PRKEDU1, GENHINCS


  CREATE  ;  Y  =  R4939  S

  CALC    ;  j  =  0  S

   ORDERED PROBIT  ; Lhs = Z  ;  Rhs = W  ;  Par S

      CALC    ; Nolist ; JP = Max(Z)  +  1  ;  JP1 = JP + 1
              ; KP = Col(W) ; KP1 = KP+1 ; M = JP-2 ; L=KP-M S

      MATRIX  ; list  ; ALPHA=Part(B,1,KP)

              ; U1= [-10000 / 0 ]
              ; U2= Part(B,KP1,1)
              ; U3= [10000]
              ; MUA=[U1/U2/U3]
            ; Z11 = Part(VARB,1,KP,1,KP)
            ; Z21 = Init(2,KP,0)
            ; Z22 = [0,0/0,0]
            ; Z31 = Part(VARB,KP1,L,1,KP)
```

```
      ; Z32 = Init(M,2,0)
      ; Z33 = Part(VARB,KP1,L,KP1,L)
      ; Z41 = Init(1,KP,0)
      ; Z42 = [0,0]
      ; Z43 = Init(1,M,0)
      ; Z44 = [0]
      ; V=[Z11 / Z21,Z22 / Z31,Z32,Z33 / Z41,Z42,Z43,Z44]S

INCLUDE ; New ; Z = J S

CALC   ; J1 = J - 1
       ; J2 = J - 2 S

CREATE ; AJ1 = MUA(J1) - W'ALPHA
       ; AJ  = MUA(J2) - W'ALPHA
       ; DJ1 = N01(AJ1)
       ; DJ  = N01(AJ)
       ; FJ1 = Phi(AJ1)
       ; FJ  = Phi(AJ)
       ; LAMBDA = (DJ1-DJ)/(FJ-FJ1)
       ; DELTA = (AJ1*DJ1 - AJ*DJ)/(FJ-FJ1) - LAMBDA ^ 2 S

NAMES  ; XL       = X,LAMBDA S

REGRESS ; Lhs     = Y
        ; Rhs     = X, LAMBDA  S

CALC   ; P   = Col(XL)
       ; C   = B(P)
       ; S2  = SUMSQDEV/NREG - C^2 * Xbr(DELTA)
       ; RHOSQD =  c^2/s2  S

CREATE ; PJ1 = (J>1) * DJ1/(FJ-FJ1) * (LAMBDA-AJ1)
       ; PJ  = 0S

MATRIX  ;list; XP1 = XL'* PJ1
        ; XP  = XL'* PJ
        ; ZERO= Init(P,1,0)
        ; R   = Init(3,JP1,0)
        ; R(1,J1)=1
        ; R(2,J2)=1
        ; XPP = [XP1,XP,ZERO]
        ; XG1 = XL'[DELTA]W
        ; XG2 = XPP * R
        ; XG  = [XG1,XG2]  S
```

```
CREATE ; H  = 1 - RHOSQD * DELTA S

MATRIX ; list; VC = XL'[H]XL - RHOSQD * XG * V * XG'
       ; VC = S2 * <XL'XL> * VC * <XL'XL>
       ; Stat ( B , VARB)
       ; Stat ( B , VC ) S
```

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