Institut für Agrarpolitik und Marktforschung
der Justus-Liebig-Universität Giessen

Arbeitsbericht

Nr. 37

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Estimating the Demand for Risk Reduction from Foodborne Pathogens

Gießen 2004

Bestell-Nr. 04/1

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VORWORT

Die vorliegende Arbeit befasst sich im weitesten Sinne mit der Nachfrage nach sicheren Lebensmitteln. Es wird analysiert, wie Verbraucher neue Technologien zur Reduzierung pathogener Keime in Lebensmitteln bewerten. Im Mittelpunkt der Betrachtung steht dabei die Zahlungsbereitschaft für ein geringeres Risiko beim Rindfleischkonsum durch eine geringere Belastung mit *Escherichia coli* O157:H7 und *Salmonellen*. Dabei werden verschiedene Strategien zur Risikoreduzierung – Lebensmittelbestrahlung, Dampfpasteurisierung und die Möglichkeit der privaten Vorsorge – untersucht. Die empirische Analyse stützt sich auf eine Briefbefragung auf Basis der kontingenten Bewertung, die in acht Staaten der USA (CO, NE, KA, OK, IA, MO, AR und WY) durchgeführt wurde.

Die vorliegende Arbeit ist am Department of Agricultural Economics der Kansas State University, Manhattan, USA entstanden und wurde dort als Master Thesis eingereicht. An dieser Stelle möchte ich mich ganz herzlich bei Herrn Prof. Dr. J.A. Fox bedanken, der mich durch seine konstante Betreuung während der Arbeitsphase in besonderer Weise unterstützt hat.

Giessen, 20.02.2004

Jochen Hartl

ABSTRACT

Food manufacturers are currently allowed to use innovative technologies such as irradiation and steam-pasteurization to reduce the risk from foodborne pathogens in meat processing. Despite scientific evidence of the effectiveness and safety of irradiation, meat processors and retailers have been slow to market irradiated beef products due to uncertainty about consumer acceptance and willingness to pay. Factors influencing consumer demand for new food technologies provide useful information for beef processors and retailers. The objective of this study was therefore to examine the demand for risk reduction from foodborne pathogens using data from a contingent valuation survey with 3000 households in eight different states (CO, NE, KA, OK, IA, MO, AR and WY). The analysis focused on the value of reduced risk from Escherichia coli O157:H7 and Salmonella in ground beef consumption. In this context the study explored: (a) median willingness to pay (WTP) for risk reduction from alternative technologies (irradiation and steam-pasteurization); (b) whether private protective action (care in cooking and handling) influences WTP for irradiation or pasteurization; (c) whether "who" is at risk (adults or children) influences preferences; and (d) whether preferences for risk reduction vary with the severity of the risk. Respondents were on average willing to pay a price premium of 26 cents/lb for safer (irradiated or steam-pasteurized) ground beef. WTP amounts were influenced by private protective actions; the results indicate that trade-offs exist between public and private risk reduction. WTP was not significantly related to "who" is at risk; households with children did not place higher WTP amounts for safer (irradiated or steam-pasteurized) ground beef. The results regarding the sensitivity of WTP to the magnitude of the risk reduction were ambiguous. WTP was insensitive to scope between a 9 in 10,000 and a 7 in 10,000 risk reduction. However, WTP was significantly related to the magnitude of the risk reduction between a 3 in 10,000 and 2 in 10,000 risk reduction, although it varied less than proportionately to the risk increment.

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ACKNOWLEDGMENTS

I am very thankful to my advisor Dr. Sean Fox for his continuous guidance and to all people who made this thesis possible

1 Introduction

Foodborne disease caused by *Escherichia coli* (*E. coli*) O157:H7 and *Salmonella* in red meats has been acknowledged for many years to be a serious health problem. U.S. Department of Agriculture (USDA) scientists estimate there are at least 15,500 annual foodborne cases of *E. coli* O157:H7 infection and at least 656,000 cases of foodborne *Salmonella*. About 58 percent of *E. coli* O157:H7 cases and eight percent of *Salmonella* cases are due to consumption of ground beef (Lin, 1995).

To address this hazard, major changes related to food safety have been introduced in the meat industry in recent years. Meat packers and processors are required since 1996 to process in compliance with a *Hazard Analysis and Critical Control Point* (HACCP) plan. In addition, innovations such as irradiation and steam-pasteurization have been approved by the Food and Drug Administration (FDA) and the USDA to control or reduce foodborne pathogens in meat processing. Despite scientific evidence of the effectiveness and safety of irradiation, processors and retailers have been slow to offer irradiated products so far. Given the requirement to label irradiated foods, the implementation of this technology depends highly on consumer acceptance.

The goal of this research is to examine some aspects of the demand for food safety, in particular the value of reduced risk from *E. coli* O157:H7 and *Salmonella* in ground beef consumption. We will focus on: (a) median WTP for risk reduction from alternative technologies (irradiation and steam-pasteurization); (b) whether private protective actions (care in cooking and handling) influence WTP for irradiation or pasteurization; (c) whether "who" is at risk (adults or children) influences preferences; and (d) whether preferences for risk reduction vary with the severity of the risk.

To accomplish these objectives a contingent valuation (CV) study was conducted. A mail survey was sent to 3000 households in eight states (Colorado, Nebraska, Kansas, Oklahoma, Iowa, Missouri, Arkansas and Wyoming).

A number of previous studies have examined consumer acceptance and WTP for irradiation. This study attempts to address some shortcomings in this literature:

(1) *Previous studies use a rather restrictive range of risk reduction strategies - most have focused on a single risk reduction technology and no study has accounted for the possibility of private risk reduction by cooking meat to a high degree of doneness.* Our study compares WTP amounts for two risk reduction technologies - irradiation and steam-pasteurization (public risk reduction). In addition, we examine whether respondents' cooking and handling practices (private risk reduction) effectively substitute for "public" risk reduction achieved with irradiation or pasteurization.

(2) *Many CV studies fail tests of internal and external validity - WTP amounts are not sensitive to the scope or magnitude of the good or benefit being offered.* Our study included an external scope test by comparing WTP amounts of independent samples with different risk reduction levels (split-sample).

The study is structured as follows. Chapter 2 offers information about the pathogens of interest, *E. coli* O157:H7 and *Salmonella*. Chapter 3 describes new regulatory (HACCP) and technological (irradiation and steam-pasteurization) innovations in food safety. In chapter 4 the contingent valuation (CV) approach is discussed as a method to estimate consumers WTP for improvements in food safety. The research on consumers' acceptance of and WTP for irradiation is reviewed in chapter 5. Chapter 6 describes the design of the survey and outlines the resulting data. The statistical models are discussed in chapter 7. The estimation results are presented and discussed in chapter 8. In the final section, major conclusions are summarized and recommendations for future research are given.

2 Disease Causing Pathogens in Red Meat

2.1 Escherichia Coli O157:H7

Health risks associated with *E. coli* O157:H7 in ground beef and hamburgers have been a food safety concern in the U.S. for many years. In 2000, the Centers for Disease Control and Prevention (CDC) reported 69 confirmed outbreaks in 26 states caused by *E.* coli O157:H7, leading to 1,564 illnesses, 190 hospitalizations, 50 cases of hemolytic uremic syndrome (HUS) and four deaths. Most illnesses have been associated with eating undercooked ground beef and hamburgers (CDC, 2002).

It is important to note that *E.* coli O157:H7 infections are greatly underreported or are misdiagnosed by physicians (Marks and Roberts, 1993). USDA scientists estimate that the actual number of infections is much higher than the reported number, ranging between 15,500 and 225,000 foodborne *E. coli* O157:H7 infections annually in the U.S. (Lin, 1995). According to Lin (1995), about 70 percent of these cases are due to beef consumption, while 90 percent of those beef cases are attributable to the consumption of ground beef and hamburgers.

Infection with *E. coli* O157:H7 often leads to severe bloody diarrhea and abdominal cramps. Usually little or no fever is present, and the illness resolves in 5 to 10 days. In some persons, particularly children under 5 years of age and the elderly, the infection can also cause HUS, a severe disease characterized by kidney damage or failure and perhaps neurological impairment. HUS is the principal cause of acute kidney failure in children in the U.S., and is mostly caused by *E. coli* O157:H7 (Marks and Roberts, 1993; CDC, 2003).

Although the full extent of the social and economic impact of *E. coli* O157:H7 infections is hard to measure, studies indicate that the cost of illness, death, and business lost is high. For the U.S., Todd (1989) estimated the cost of illness and death due to *E. coli* O157:H7 infections as high as $223 million a year. Marks and Roberts (1993) estimated that medical costs and productivity losses due to *E. coli* O157:H7 ranged from $216 million to $580 million annually. Buzby *et al.* (1996) estimated a value of $659 million for medical costs, lost productivity and premature death due to foodborne *E. coli* O157:H7. Furthermore, results from a study by McKenzie and Thomson (2001) indicate that recalls for *E. coli* O157:H7 have a significant negative effect on beef prices at the wholesale level.

2.2 Salmonella

Salmonella in ground beef and hamburgers is also an important cause of foodborne illness.

About 40,000 cases of salmonellosis are reported in the U.S. every year. Because many milder cases are not diagnosed or reported, the actual number of infections is estimated to be twenty or more times greater (CDC, 2003). USDA scientists estimate that the annual number of foodborne cases of *Salmonella* infection ranges between 656,000 and 3,840,000 (Lin, 1995). Beef, along with poultry and egg consumption are the top three causes of *Salmonella* infection: About ten percent of cases are due to beef consumption, and of those 90 percent are attributable to consumption of ground beef (Lin, 1995).

Most people infected with *Salmonella* have symptoms including diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The disease usually lasts 4 to 7 days, and most people recover without treatment. However, in some cases the diarrhea may be so severe that the patient needs to be hospitalized. These patients often develop potentially infections of the bloodstream or other parts of the body and the infection can cause death unless treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

According to Todd (1989) *Salmonella* is the costliest bacterial foodborne disease with annual costs for the U.S. estimated at $4 billion per year. Lin *et al.* (1993) estimated the medical costs and lost productivity due to *Salmonella* at $1.2 billion to $1.6 billion annually.

3 Innovations to Improve Food Safety in the Meat Industry

In recent years, the meat industry has seen both regulatory initiatives aimed at enhancing food safety and technological innovations that can help achieve higher microbiological standards.

3.1 Regulations - HACCP

In 1996, USDA's Food Safety and Inspection Service (FSIS) implemented HACCP regulations for meat and poultry plants. Under these regulations each meat packer and processor is required to identify critical control points in the production process, and to indicate production steps where an intervention method can prevent or reduce food safety hazards[1] (Roberts *et al.*, 1996).

The movement towards the implementation of mandatory HACCP regulations has raised the discussion about the benefits of such regulations. Unnevehr and Jensen (1996) emphasize the preventive character as a main advantage of HACCP. According to them a combination of HACCP as a standard for a minimum level of safety with further incentives for firms to exceed that standard would provide the highest net benefit to society. Roberts *et al.* (1996) also argue that HACCP improves economic incentives for further pathogen control by shifting back the responsibility to the firm. Antle (1996) in contrast cautions the implementation of mandatory HACCP regulations: he examines the

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[1] HACCP plans are based on seven principles: (a) assess the hazards; (b) determine critical control points (CCPs); (c) establish critical limits for each CCP; (d) establish procedures to monitor each CCP; (e) establish corrective actions; (f) establish record keeping for the HACCP system; (g) conduct verification procedures (Roberts *et al.*, 1996).

efficiency of design standards (like HACCP regulations) in comparison to performance standards (like microbial testing or end-product testing). Since HACCP systems involve significant start-up costs independent from the size of operation, the efficiency of HACCP regulations likely varies with the scale of the firm. Mandatory HACCP systems might therefore threaten the economic survival of smaller firms.

3.2 Technologies

Our research is focused on two major risk reduction technologies: irradiation and steam-pasteurization.

3.2.1 Irradiation

The food irradiation process exposes products to ionizing radiation to reduce microbial pathogens and extend shelf life. In 1997, the U.S. Food and Drug Administration (FDA) approved irradiation for red meat, and in 1999, USDA followed allowing irradiation of raw meat and raw meat products (Buzby and Morrison, 1999).

The process of irradiation involves passing food through a field of ionizing energy from either electron beams or gamma rays from cobalt-60. The ionizing radiation passes through the food and generates large numbers of short-lived free radicals. These can destroy living cells like microorganisms, and inhibit many processes, such as those that cause sprouting and ripening. At no time during the irradiation process does food come into contact with the radiation source and, by using cobalt-60 or electron beams up to 10 MeV[2], it is not possible to induce radioactivity in the food.

[2] Mega Electron Volt

Several studies investigated the ability of irradiation to reduce the numbers of pathogens on meat (An-Hung-Fu, 1994; Ito, 1998). It has been shown that a relatively low irradiation dose of 0.46 kGy[3] is sufficient to inactivate 90 percent of the *E.* coli O157:H7 population in ground beef under frozen conditions. Ito (1998) concluded that a dose of 3 kGy is sufficient to eliminate *E.* coli O157:H7. This treatment would also give a significant reduction in the number of *Salmonella*.

Irradiation has, if any, little effect on the taste and appearance of ground beef and hamburgers. Wheeler *et al.* (1999) for example investigated the effects of gamma irradiation on vacuum-packaged frozen ground beef patties using both a trained sensory panel and a group of consumers. The results imply that irradiated hamburger patties would encounter only marginal acceptance problems.

Current USDA rules require that irradiated meat and meat products be labeled with the radura symbol (Figure 1). In addition, products have to bear a statement indicating that the product was treated by irradiation. In case of unpackaged meat products, the statement and radura symbol must be conspicuously displayed to the purchaser. Meat products which use irradiated meat as ingredient have to be listed as such on the packing (Buzby and Morrison, 1999).

The requirement to label irradiated foods has been viewed by many in the meat industry as an impediment to consumer acceptance. The 2002 U.S. Farm Bill provides for a re-examination of the requirement and raises the possibility that irradiated foods could

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[3] The amount of time the food is exposed to the source of irradiation establishes the amount of radiation received, which is measured in units called kiloGrays (kGy). USDA regulations have established an upper limit of 4.5 kGy for refrigerated and 7.0 kGy for frozen meats.

be labeled as "cold-pasteurized" or "electronically pasteurized" (USDA, 2003). It is argued that food irradiation as currently done often involves exposure to an electron beam rather than radioactive isotopes. The irradiation industry hopes to reduce consumer concerns about irradiation with a more euphemistic labeling. One of the goals of this study is therefore to examine the difference in acceptance for products labeled as "irradiated" or "pasteurized".

Figure 1: *Radura Symbol*

In the U.S., the marketing of irradiated beef began in May 2000. *Huisken Meat Company* was one of the first meat processors to distribute irradiated ground beef in the Minneapolis-St. Paul area. Since then several other large meat processors, as well as retailers and supermarkets have begun to offer irradiated ground beef. Table 1 provides a list of companies marketing irradiated ground beef as of February 2003[4]. The three major beef packers – *IBP*, *Excel*, and *Swift* – have either used irradiation for some ground beef products or have announced plans to use the technology. On the restaurant side, *Dairy Queen* was the first company introduced irradiated hamburger patties in February 2002.

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[4] For a list of restaurants and retailers marketing irradiated ground beef, see Minnesota Beef Council (2003).

Champps Americana Restaurants and *Embers Restaurants* followed in fall 2002. With accelerating pace in late 2002 and early 2003, several large retailer and supermarket chains such as *Hy-Vee Supermarkets*, *Pathmark Supermarkets*, *Giant Foods*, and *Publix* began to sell fresh irradiated ground beef (Minnesota Beef Council, 2003).

***Table 1**: Companies Marketing Irradiated Ground Beef (Feb 2003)*

	IMPLEMENTATION	QUANTITY
Meat Processors		
Huisken Meats	May-00	-
Colorado Boxed Beef	Jun-00	-
Excel	-	-
W.W. Johnson	May-01	-
Brawley Beef	Sep-02	-
IBP	Sep-02	-
Swift	Jan-03	-
Restaurants		
Dairy Queen	Feb-02	147 stores
Champps Americana Restaurants	Sep-02	2 stores
Embers Restaurants	Oct-02	65 stores
Home Delivery		
Schwans	Jul-00	-
Omaha Steaks	Jan-01	all ground beef irradiated
Winn-Dixie	-	>1000 stores
Retailers and Supermarkets		
Pick'n Save	Jul-01	80 stores
Kroger	Feb-02	market trial
Wegman's	May-02	64 stores
Lowes Foods	Sep-02	48 stores
D'Agostino Supermarkets	Sep-02	23 stores
Hy-Vee Supermarkets	Oct-02	188 stores
Pathmark Supermarkets	Oct-02	143 stores
Price Chopper	Oct-02	102 stores
Dominicks	Nov-02	113 stores
Giant Foods	Nov-02	189 stores
Jewel	Nov-02	191 stores
Hannafords	Nov-02	117 stores
Fresh Brands Inc.	Dec-02	101 stores
Schnucks	Jan-03	102 stores
Giant-Eagle	Jan-03	213 stores
Weis Markets	Jan-03	160 stores
Safeway Eastern Division	Jan-03	136 stores
Publix	Jan-03	711 stores

3.2.2 Steam-Pasteurization

Steam-pasteurization, developed by the Frigoscandia Equipment Group and Cargill, with the help of Kansas State University scientists, kills pathogens on the slaughtered carcass surface by using a brief exposure to high temperature steam. The process of steam-pasteurization became USDA approved for use on fresh beef in 1995 (Majchrowitz, 1999).

During the process beef carcasses enter a slightly pressurized, closed chamber and are sprayed for six to eight seconds with steam that blankets and condenses over the entire carcass. This raises the surface temperature to 195°F or 200°F and kills nearly all pathogens. Carcasses are then sprayed with chilled water, bringing the surface temperature down to 65°F. The speed of the process and subsequent cooling prevents carcass discoloration. To lower bacterial contamination of ground beef products, steam-pasteurization can also be applied on beef trimmings before they are used in ground beef (Marsden *et al.*, 1999). Scientists have also tested the application of steam-pasteurization on packaged meats (Thippareddi, 2002).

The effectiveness of steam-pasteurization in reducing bacterial populations on beef carcasses has been shown in several studies. Phebus *et al.* (1997) showed that steam-pasteurization provided a greater overall reduction of bacteria than standard commercial methods like water washing or spraying with lactic acid. The steam-pasteurization chamber eliminated at least 99.9 percent of *Salmonella* and *E. coli* O157:H7 deliberately introduced on the surface of meat. In commercial tests, the process killed the naturally occurring overall bacterial contamination by over 90 percent and reduced the population of *E. coli* O157:H7 to undetectable levels (Nutsch *et al.*, 1996).

The use of a steam-pasteurization label is only permitted for wholesale carcasses and parts of carcasses that are to be further processed. The labeling of further processed products, such as retail cuts and offal, with statements about reductions in microorganisms or the use of the term steam-pasteurization, is not permitted.

Steam-pasteurization was initially used at four major beef facilities in 1995. Currently it is estimated that close to 50 percent of U.S. beef is steam-pasteurized.

4 The Contingent Valuation Method

4.1 Contingent Valuation as a Technique to Value Non-Market Goods

The value of improvements in food safety resulting from irradiation and steam-pasteurization could be obtained from aggregate market demand data or alternatively by directly eliciting from consumers their willingness to pay (WTP) for the safety enhanced products. At this point however there are still some problems if we attempt to rely on indirect valuation via market demand data. Irradiated foods are, as yet, only sold in select markets and furthermore surveys suggest that most consumers remain uninformed about the irradiation process. For steam-pasteurization, as noted above, consumers are not informed that their meat products may come from carcasses treated with the process and so there is effectively no market data to value the process. In these circumstances, direct elicitation of WTP has the advantage that it allows all respondents to be informed about the process and the associated reductions in risk.

Non-market valuation techniques to measure WTP can be classified into two main types: (a) revealed preference methods, for example hedonic pricing, which derive values for non-market goods based on consumer choices between alternative market goods, and (b) stated preference methods, such as contingent valuation (CV), which question individuals directly about the value they place on non-market goods (Buzby *et al.*, 1995; Henson, 1996).

In this study we estimate the value of safer ground beef – achieved with either irradiation or steam-pasteurization - by using a CV approach. A CV instrument creates a hypothetical market scenario for respondents and asks them to either: a) state their maximum WTP for a product (or more commonly an environmental enhancement), or b) state whether they would be willing or unwilling to pay a certain amount for the product (or to help finance the environmental improvement). The former is referred to as open-ended (OE) valuation and is thought to be problematic for respondents, since the task is unfamiliar. The later, referred to as the dichotomous-choice (DC) format is favored because it more closely resembles the types of everyday choices that individuals make, i.e., whether to purchase a product or not at a posted price. The hypothetical market thus creates an opportunity for the respondent to reveal his or her WTP for a product or, in our situation, for an improvement in a product. The challenge of successful CV research is to communicate the market setting in a way that the respondent completely understands and accept the specified conditions. Factors of actual markets like the characteristics of the good, changes of the good, and characteristics of the payment need to be adequately described in the hypothetical setting (Mitchell and Carson, 1989; Krieger and Hoehn, 1995).

4.2 Advantages of the Contingent Valuation Approach

The major advantage of the CV methods is its great flexibility to construct a market where no market currently exists. Mitchell and Carson (1989) emphasize that the CV researcher can easily specify a variety of states of a product to be valued and the conditions of its provision. CV surveys are also less expensive than trial and error research like actual market experiments. In addition, CV surveys are relatively information rich in terms of data on the characteristics of respondents and they do not rely on secondary data sources originally developed for other needs. Mitchell and Carson (1989) also point out that CV studies are consistent with the consumer sovereignty assumption, since they allow the respondent to make his or her own tradeoffs in terms of money. Research has shown that the results from CV surveys are equivalent in terms of accuracy to the results obtained from market-based methods (Cummings *et al*., 1986; Mitchell and Carson, 1989).

4.3 Potential Biases of the Contingent Valuation Approach

With CV there are concerns that reported WTP amounts are biased and do not reflect real world conditions (Diamond and Hausmann, 1994; Neill *et al.*, 1994; Cummings *et al.*, 1995). Potential biases include hypothetical, strategic, starting point, non-response, and sampling frame biases[5] (Anderson and Bishop, 1986; Cummings *et al.*, 1986; Mitchell and Carson, 1989).

Thus, a major weakness of CV surveys is their reliance on *hypothetical* scenarios. The CV method implies that respondents will answer *hypothetical* questions in the same way they would answer an identical question asking for a real economic commitment. Braden *et al.* (1991) discuss the fact that respondents tend to inflate stated WTP amounts in hypothetical market settings. Since intentions in a *hypothetical* market are costless to express, respondents may not consider their WTP decision and budget constraint as carefully as they would in a real consumption choice. Diamond and Hausman (1994) point to respondents' lack of experience in trading or valuing abstract commodities like food safety as another potential source for *hypothetical bias*. It is likely difficult for respondents to place meaningful values on commodities with which they are not familiar. An often-discussed CV anomaly in this context is the *embedding effect* (Kahneman and

[5] For a more detailed discussion of potential biases in CV studies, see Mitchell and Carson (1989).

Knetsch, 1992; Diamond and Hausman, 1994). It describes the tendency of WTP responses to be highly similar across different surveys, even where theory suggests that the responses be very different. To test for the *embedding effect*, Arrow *et al.* (1993) recommend a split-sample. According to this technique, WTP amounts of independent samples with risk changes of different magnitudes are compared. A scope test is passed, when WTP differs with the scale of the risk reduction[6] (cp. chapter 5.2.3) (Fischhoff and Furby, 1988; Neill *et al.*, 1994).

Strategic bias occurs when respondents give WTP amounts that differ from their true WTP in order to influence the study's outcome in a way that serves their personal interests. In this case, respondents might believe that their expressed WTP amounts will influence the decision-makers, and hence their own welfare. In conclusion, they may report larger or smaller values than their true WTP (Anderson and Bishop, 1986; Mitchell and Carson, 1989).

Starting point bias is thought to arise when respondents WTP amounts are influenced by a value introduced in the payment vehicle. This is especially likely when a respondent is uncertain about a value of a non-market good like food safety. In that situation the initial bid is thought to provide a frame of reference, which can anchor the stated WTP amount on the proposed amount. *Starting point bias* is likely to come along with *yea-saying*, the tendency of some respondents to agree with a studies request regardless of their true views (Cummings *et al.*, 1986; Mitchell and Carson, 1989).

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[6] The scope test involves testing whether median WTP for a sample with higher risk reduction is significantly greater than the corresponding WTP for a sample with lower risk reduction. Therefore the null hypothesis is $WTP_{HighRisk} = WTP_{LowRisk}$. Theory suggests the alternative is $WTP_{HighRisk} > WTP_{LowRisk}$.

CV surveys are also prone to some level of *non-response* to the WTP questions, with the consequence that the number of those who give valid WTP amounts will be smaller than the number of originally chosen people. The population sampled is therefore not really random, since different categories of respondents tend to have different *non-response* rates (Mitchell and Carson, 1989; Bockstael, 1999).

A *sampling frame bias* can occur when the sampling frame does not reflect the population. In case of a mail survey, researchers face the problem of obtaining up-to-date addresses.

4.4 WTP Elicitation Method

As described above, elicitation formats for WTP can be classified into two main groups: (a) continuous methods, including open ended or alternatively a payment card format that provides a listing of several dollar amounts and asks respondents to select the one closest to their maximum WTP, and (b) discrete methods, like the dichotomous-choice (DC) approach, which ask respondents to indicate whether they accept or reject a single take-it-or-leave-it offer for the item being valued (Boyle and Bishop, 1988; Kealy and Turner, 1993).

Several studies have shown that contingent values are sensitive to the elicitation method (Bishop and Heberlein, 1979; Boyle and Bishop, 1988; Kealy and Turner, 1993). Differences due to the questioning method indicate a lack of validity of either one or both of the elicitation methods. Thus, the question remains, whether one of the elicitation formats is likely to contain less error.

In our survey we use a DC approach, which several studies argue is the more appropriate technique for eliciting WTP (Sellar *et al.*, 1985; Cameron, 1987; Boyle and

Bishop, 1988; Arrows *et al*., 1993; Buzby *et al*., 1994; Ready *et al*., 1995). One argument is that DC questions are less cognitively demanding and easier for respondents to answer than open-ended questions. Thus, DC questions more closely resemble an actual market transaction or an actual voting situation. *Hypothetical bias* is therefore supposed to be less likely with the DC format. In addition DC formats are believed not to suffer from *starting point bias* and circumvent much of the incentives for *strategic* behavior (Cameron, 1988). The primary disadvantage with DC format is that it collects less information from each respondent and is somewhat more complicated to analyze statistically.

An implicit assumption with the DC approach is that each respondent is able to determine which option is preferred. Since respondents may have not thought about the economic trade-offs they would make for a non-market good like food safety, it may be difficult for them to make a decision. Some respondents will be forced to make a choice about which they still feel ambivalence. There is an ongoing discussion about how CV estimates are influenced when respondents are ambivalent. Ready *et al.* (1994) argue that DC surveys tend to underestimate actual WTP, since ambivalent respondents follow the simple decision rule of conservatism. According to this, ambivalent respondents, when forced to a decision, are more likely to stick with the status quo and respond “no”, rather than risk an unfamiliar alternative. In contrast, Champ *et al.* (1994), assume that WTP is higher in situations where preferences are uncertain, since ambivalent respondents more likely register support (*yea-saying*). To reduce this potential source of bias, Loomis and Ekstrand (1997) recommend allowing for uncertainty in the elicitation method. Instead of asking the respondents whether they would vote “yes” or “no” at a specific dollar amount they recommend allowing respondents to choose between the answer categories ”definitely-yes”, “probably-yes”, “unsure”, “probably no”, and “definitely no”.

A further development on the DC approach is the double-bounded DC approach. This method asks the respondent to engage in two rounds of bidding, in which the second DC question depends on the response to the first question: if the response to the first question is “yes”, the second is some amount greater than the first bid; if the response is ”no”, the second bid is some amount smaller. Hanemann *et al.* (1991) showed that the statistically efficiency of the DC method can be improved substantially by asking respondents two rounds of DC questions.

5 Literature Review

5.1 Consumer Acceptance of Irradiation

5.1.1 Consumer Concerns and Acceptance Levels

A number of previous studies have used surveys, experimental settings, and market trials to examine consumer acceptance of irradiated products (Sapp *et al.*, 1995; Shogren *et al.*, 1999; Lusk *et al.*, 1999; Resurreccion and Galvez, 1999; Frenzen *et al.*, 2001; Hashim *et al.*, 2001).

Several studies indicate that *consumer concerns* about food irradiation have decreased since the mid 1980s, with evidence to suggest that consumers are less concerned about food irradiation than they are about other food related issues such as pesticide residues and microbiological contamination (Bruhn, 1995; Lusk *et al.*, 1999; Resurreccion and Galvez, 1999).

Lusk *et al.* (1999) pointed out, however, that low levels of concern about irradiation do not necessarily imply a high level of acceptance of irradiated food. Thus, several studies have found a high level of variability in the proportions of consumers indicating acceptance of the technology. For example, Malone (1990) found that only 36 percent of survey respondents were willing to purchase irradiated food, while Bruhn and Noell (1987) reported a consumer in-store acceptability rate of 92 percent for irradiated papayas. Regarding meat products, Frenzen *et al.* (2001) indicated that 50 percent of adults were willing to buy irradiated meat or poultry, while Schroeter *et al.* (2001) found that 70 percent of participants in a focus group expressed acceptance for irradiated meat.

Variations in acceptance rate are to be expected due to differences in sampling frames, methodology, and the particular food for which acceptability is examined (Lusk *et al.*, 1999). In addition the acceptance rate is strongly affected by the level of information given to the consumer. Several studies indicate that education about irradiation has a strong positive impact on consumers' acceptance (Pohlman *et al.*, 1994; Sapp *et al.*, 1995; Hashim *et al.*, 1995; Hashim *et al.*, 2001). Overall, the different study settings make it difficult to conclude whether there is a trend to higher acceptability of irradiated products or not.

5.1.2 Sensitivity of Acceptance Rates to Demographic Variables

The literature has shown that consumers' acceptance of irradiated food is sensitive to the characteristics of the study population. Several studies indicate that respondents' gender, education, income and level of beef consumption systematically influence their acceptance of irradiated products (Schutz *et al.*, 1989; Malone, 1990; Terry and Tabor, 1990; Bruhn, 1995; Resurreccion *et al.*, 1995; Sapp *et al.*, 1995; Lusk *et al.*, 1999; Resurreccion and Galvez, 1999; Frenzen *et al.*, 2001; Fox, 2002).

In general, there is evidence that *men* are more willing to accept irradiated products than women. Malone (1990) for example identified a significant positive relationship between males and acceptance of irradiated products. Sapp *et al.* (1995) reported that males have a significantly higher opinion about irradiation than females, although they were not significantly more likely to eat irradiated food. Frenzen *et al.* (2001) also found that males were more likely willing to buy irradiated products.

Several studies have also shown that *higher educated* people are more willing to accept irradiated products (Schutz *et al.*, 1989; Terry and Tabor, 1990; Resurreccion *et* *al.*, 1995; Frenzen *et al.*, 2001). Resurreccion *et al.* (1995) for example found that higher educated consumers have less concern about irradiation technology, while Frenzen *et al.* (2001) showed that more educated consumers are more likely to buy irradiated products. However, Fox's (2002) results suggest a different association between the education level and a favorable attitude towards irradiation. Accordingly, higher educated people are either clear supporters or clear opponents of irradiated foods, but less likely undecided about irradiation technology. A low education level would therefore not necessary imply a higher opposition towards irradiation.

In addition, most studies show that people with higher *income* more likely accept irradiated products. For example, Lusk *et al.* (1999) found lower concern about irradiation for people with higher income levels. Frenzen *et al.* (2001) also found that consumer acceptance is positively related to income.

Lusk *et al.* (1999) also examined how frequency of beef consumption influenced consumer concerns about irradiation. Their results indicate a negative relationship – consumers with higher consumption of ground beef tended to be less worried about irradiation.

5.2 Willingness to Pay for Irradiation

A number of studies have used the CV method to value a wide range of non-market goods including water quality (Willis and Foster, 1983), air quality and pollution (Loehman and De, 1982; Loehman, 1984), environmental resources (Boyle and Bishop, 1984; Bergstrom *et al.*, 1985; Flynn *et al.*, 1994), and reduced mortality risk (Weinstein *et al.*, 1980; Krupnick *et al.*, 2002).

There is also a growing interest in using CV and revealed preference studies to examine the value of food-related risk reduction. A number of studies have elicited consumers' WTP for organic and pesticide-free produce (Ott, 1990; van Ravenswaay and Hoehn, 1991; Eom, 1992; Weaver *et al.*, 1992; Buzby *et al.*, 1993; Fu *et al.*, 1999; Huang *et al.*, 2000; Govindasamy *et al.*, 2001). Other studies examined WTP for pork with lower levels of saturate fat (Halbrendt *et al.*, 1994), WTP for lower levels of toxins in shellfish (Lin and Milon, 1993), WTP for safer oyster (Zellner and Degner, 1989), and WTP for certified safer pork (Miller and Unnevehr, 1999). Other studies have elicited WTP for foods produced with the aid of biotechnology (Boccatelli and Moro, 2000; House *et al.*, 2001). Most studies indicate that consumers would pay modest amounts in excess of the products' purchase price to decrease low-level food risks.

Regarding food irradiation, it is important to know whether consumers who are willing to buy irradiated products, are also willing to *pay a premium* for them, since there is an additional cost associated with using irradiation. WTP for irradiation has been elicited using CV methods, market trials and experimental settings (Malone, 1990; Giamalva *et al.*, 1997; Fox *et al.*, 1998; Shogren *et al.*, 1999; Frenzen *et al.*, 2000; Fingerhut *et al.*, 2001; Schroeter *et al.*, 2001). As with acceptance, the different studies show a high level of variability in the results. Frenzen *et al.* (2000) found that only 23 percent of consumers were willing to pay more for irradiated ground beef, while a further 17.5 percent were not sure about their decision. Results from a laboratory experiment by Giamalva *et al.* (1997) showed that 68 percent of participants are willing to pay some positive amount for an irradiated meat sandwich. Participants were on average willing to pay 71 cents for the right to exchange a standard meat sandwich for an irradiated sandwich. A CV study by Fingerhut *et al.* (2001) confirmed a high rate of WTP. According to this study, 60 percent of the respondents would pay a positive price premium for irradiated beef, with an average WTP of 36 cents/lb.

Similar to acceptance rates, WTP rates and amounts depend on the sampling frame, the methodology and the information given to the consumers. Fox *et al.* (1998), e.g., found that WTP amounts are upwardly biased in hypothetical settings. The study was designed to calibrate CV surveys with experimental auction markets. The results showed that participants had a higher WTP in a hypothetical setting than in a laboratory experiment; the average WTP to upgrade from a non-irradiated to an irradiated pork sandwich was 58 cents in the survey in comparison to 39 cents in the experiment. In addition Fox *et al.* (2002) examined the effect of information about food irradiation on WTP for a pork sandwich. Their findings suggest that a favorable as well as an unfavorable description of irradiation significantly influenced WTP. Notably, when subjects were given both descriptions, the negative effect of the anti-irradiation description dominated the positive effect of the pro-irradiation description.

5.2.1 Sensitivity of WTP to Demographic Variables

A conclusion that emerges from the literature is that WTP estimates are sensitive to the characteristics of the study population. Thus, different populations faced with different risks will have a different WTP values. Several variables are discussed that might systematically influence WTP (Golan and Kuchler, 1999).

In this context it might be necessary to account for differences in demand associated with the vulnerability of some segments of the population to foodborne illness. In particular, benefits from technologies to reduce foodborne pathogens like *E. coli*

O157:H7 and *Salmonella* are greater for children, older persons, and persons in compromised health (CDC, 2003). Economic theory suggests that the population most at risk from food borne illness should have higher WTP values for risk reduction.

Thus, consumers with *children* in the household might allocate greater expenditures to reduce children's risk. Viscusi *et al.* (1987) indeed reported that valuations of reduced nonfatal risks from hazardous home insecticides are about 2.3 times greater for avoided risk to children compared to adults. There is no evidence, however, that consumers with children are willing to pay more for *irradiated* products. Shogren *et al.* (1999) found a significant negative relationship between the presence of a child under the age of 18 and WTP for irradiated chicken. Giamalva *et al.* (1997) also reported a negative effect on WTP for an irradiated meat product, although the parameter was not significant.

Another hypothesis suggests that *age* is positively correlated with respondents' WTP, but again, studies show no clear evidence for this assumption. Krupnick *et al.* (2002) could find only a small variation of WTP by age to reduce mortality risk; persons age 50 and older had only a slightly higher WTP than people in the age group from 40 to 49 years. In addition Giamalva *et al.* (1997) did not find evidence that older people are more likely to choose irradiated meat products. The age parameter had in their model a positive sign, but it was not significantly different from zero.

Several studies have incorporated respondents' *health status* in their WTP estimation. Krupnick's *et al.* (2002) results indicate that WTP to reduce mortality risk does not vary much with individuals physical health status. Only individuals with cancer had a higher WTP to reduce their risk. Shogren *et al.* (1999) reported that poor health status decreased WTP for irradiated chicken.

There is evidence that *gender* has an impact on WTP; several studies report lower WTP amounts for men. Flynn *et al.* (1994) for example showed that men were more likely to dismiss the importance of small environmental cancer risks than woman and thus men's WTP for such risk reduction is likely to be less than women's. Henson (1996) reported significantly higher WTP amounts for female respondents than for male respondents for reductions in the risk of food safety. Also Shogren's *et al.* (1999) results showed that men are less willing to pay for irradiated chicken.

Another source of variation in WTP is *income*. Theory suggests that individuals with less income may choose to give up more safety for a given amount of money relative to others, reflecting their higher marginal utility of money (Bockstael, 1999). Income is therefore expected to be positive correlated with WTP. Viscusi (1994) for example has shown that demand for health care increases with increases in income. Boccaletti and Moro (2000) found income to be the variable with the strongest impact on consumers' WTP for genetically modified foods. In addition, Giamalva *et al.* (1997) and Shogren *et al.* (1999) reported a positive relationship between income and WTP for irradiated meat, although the income parameter was not significant in both cases.

The effect of *education* on WTP is not clear. Some studies have shown that higher educated people are more willing to pay for safer foods. Fu *et al.* (1999) for example found that higher educated consumers express greater WTP for low-pesticide fresh produce. Most studies dealing with WTP for irradiation found a negative relationship between higher education and WTP (Malone, 1990; Giamalva, 1997). Malone (1990) found evidence that higher educated people have a higher acceptance of the technology (cp. chapter 5.1.2), but a lower WTP for irradiated products.

5.2.2 Sensitivity of WTP to the Risk Reduction Technology

Meat-processors can choose among a wide variety of risk reduction technologies such as irradiation and steam-pasteurization. The implementation of a certain technology increases overall welfare if consumers' WTP for enhanced food safety exceeds the cost of attaining it. From this viewpoint, it is important to know if consumers have preferences for risk reducing technologies.

So far not many studies have examined the effects of different risk reduction technologies. Fingerhut *et al.* (2001) investigated consumers' WTP for beef treated with steam and hot water pasteurization, in comparison with beef treated with irradiation, and beef that had not been treated with any technology at all. More than 87 percent of respondents reported that they preferred ground beef treated with some technology to ground beef not treated at all. Between the risk reduction technologies, consumers had a preference toward the more effective technologies. Thus, more than 60 percent indicated that they preferred beef treated with irradiation rather than beef treated with steam or hot water pasteurization. Fingerhut *et al.* (2001) concluded that the stronger consumer preference towards the more effective technology irradiation suggests that consumers value marginal reductions in already low risk levels.

5.2.3 Sensitivity of WTP to Different Risk Reduction Levels

Economic theory suggests that WTP to reduce low-level food risks should be increasing in the magnitude of the risk reduction. Theory also suggests that WTP should be approximately proportional to the magnitude of the risk change (Hammitt and Graham, 1999).

A literature review by Hammit and Graham (1999) showed that most studies are poorly designed to assess the sensitivity of stated valuations to changes in risk magnitude, since they do not provide information that is relevant to conduct a magnitude test. When results are reported, WTP is often, contrary to theoretical expectation, not sensitive to the magnitude of risk reduction.

Several reasons for insensitivity of stated WTP to variation in risk magnitude have been discussed. One possible explanation arises from the assumption that respondents do not understand probabilities or respondents do not or cannot tell one magnitude of risk reduction from another. Indeed, several studies have shown that peoples' perception for numerical differences in magnitude is low (Kahneman and Tversky, 1973; Baron, 1997).

Another reason could be that people make decisions based on their own beliefs and do not pay attention to risk information provided in the scenario (Viscusi, 1985; Viscusi, 1989). In this case, stated WTP should be proportional to their risk perception rather than to the risk reduction stated to respondents in the scenario. A study by Giamalva *et al.* (1997), for example, suggests that consumers' perception of the risks associated with foodborne disease may be more important in consumers' decision-making process than the actual risk. The authors report a significantly positive effect of the *perceived* chance of contracting a foodborne disease on the bid amount. Other studies suggest that consumers' level of concern and worry is an important determinant of WTP. Henson (1996) reported a significant influence of consumers' concern about food poisoning on WTP to reduce foodborne risk. Hammit (1990) found large differences between consumers in WTP for organically grown produce that are plausibly associated with consumers' risk perception.

It is also possible that respondents do not value risk changes in compliance with the predictions of utility theory. Respondents might focus more on general concerns about food safety than on differences in the level of risk; any improvements toward complete safety are acceptable and the level of improvement does not matter.

Several studies suggest that the baseline level of risk will influence WTP (Weinstein *et al.*, 1980; Pratt and Zeckhauser, 1996). Thus, respondents may hold a subjective threshold level of the baseline risk below which the different magnitudes of risk reduction are irrelevant. Moreover, respondents simply might not pay close attention to the evaluation task, particularly when the payment card method is used in a CV survey (Buzby et al., 1993; Eom, 1992; Lin and Milon, 1993).

To measure the success of a CV survey, Krupnick *et al.* (2002) recommend internal and external scope tests. An internal scope test is passed when a respondent's WTP increases with the size of the risk reduction *within* the sample. The internal test is less demanding, since it is possible for respondents to coordinate their responses. External (between sample) scope tests use a *split-sample*, where different groups of respondents are asked to value risk changes of different magnitudes. An external scope test shows whether median WTP for the sample with the higher risk reduction is significantly greater than the corresponding WTP for the sample with lower risk reduction. If respondents maximize expected utility or, more generally, if their utility function is linear in probabilities, WTP for small risk changes increase in proportion to the size of the risk change.

Hammitt and Graham (1999) tested different approaches to enhance sensitivity to scope. They suggest distinguishing between respondents who indicated high confidence in their responses and those who did not. Respondents reporting the highest confidence level were separated from other respondents and the authors examined whether the separate samples have a different sensitivity to the magnitude of risk reduction.

To improve the communication of small numerical risks, so that the respondent better understands the risk changes they are asked to value, Krupnick *et al.* (2002) recommended a graph containing 1,000 squares to communicate mortality risk. White squares represent chances of surviving; red squares the chances of dying.

Since respondents may not believe that risk changes (or baseline risks) apply to them, Krupnick *et al.* (2002) recommend further to use a 10-year risk reduction period. According to the authors, respondents are more willing to accept baseline risks over longer periods.

6 Survey Design and Data

6.1 Description of the Questionnaire

Appendix 1 shows a complete version of the questionnaire. Basically the questionnaire is divided into three parts.

The **first part** elicited information about respondents' ground beef and hamburger *consumption habits* as well as their *food safety perceptions*. The questionnaire asked respondents how often they consume and how they typically prepare hamburgers (degree of doneness). In addition, two questions were asked to elicit respondents' handling of raw meat. Another question was designed to determine whether respondents would prepare hamburgers to a lower degree of doneness, if the risk of contaminated hamburgers would be zero. A change in preparation to a lower degree of doneness would indicate that respondents were aware of and using higher degree of doneness to reduce risk.

The next questions were used to measure respondents' perception of the risk of food-borne illness. Respondents were asked if they ever had food poisoning. In the case of a "yes" response, respondents were asked in follow-up questions if the food poisoning was confirmed as a cause of illness and if the illness resulted in hospitalization. Another question asked how worried the respondent was about getting a food related illness. Respondents were also asked the likelihood of becoming seriously ill from food poisoning. A risk ladder, communicating the risk of serious illness or injury from various (e.g., accidental falls, lightning), was employed to give respondents a frame of reference.

The **second part** elicited the respondent's *WTP for reducing food safety risk* from ground beef. Respondents were faced with a hypothetical scenario in which they could choose between ground beef “A” (standard product) and ground beef “B” (irradiated or steam-pasteurized product) in their local supermarket. The survey provided information about the differences in the processing of ground beef “A” and “B” as well as differences regarding to the risk of illness from consuming ground beef “A” and “B” over a 10-year period. The probability of getting ill was communicated using grids containing 10,000 squares, where black squares represented the chance of getting ill (cp. chapter 5.2.3).

Respondents were then asked whether they would purchase ground beef “A” (standard) or ground beef “B” (irradiated or steam-pasteurized), if both cost the same. This question was followed by dichotomous-choice (DC) questions to obtain more information about respondents WTP. The initial DC question asked the respondent to choose between “A” and “B” with product “B” priced at a certain premium. The follow-up DC question repeated the choice at a lower/higher premium for ground beef “B”, depending on whether the respondent chose ground beef “A”/ground beef “B” at the initial premium. The wording in the initial as well as in the follow-up question was: “*If you could choose between the standard product (A) at $1.69 per pound, or the irradiated product (B) at $”PRICE” per pound every time you purchase ground beef, which one would you buy?”* Typically the answers to DC questions are simply “no” (*‘I would choose ground beef “A”’*) or “yes” (*‘I would choose ground beef “B”’*). In our survey however we attempted to allow for respondent uncertainty (cp. chapter 4.4), by allowing a more differentiated set of possible answers. In particular, the “no” response was split into three parts *(‘I would always choose ground beef “A”’, ‘I would usually choose ground beef “A”’* and *‘I’m not sure which one I would choose’*) and the “yes” response was split into two parts (*'I would usually choose ground beef "B"'* and *'I would always chose ground beef "B"'*).

The premium for the safer ground beef "B" varied between 5 cent/lb and 40 cent/lb based on earlier focus group findings (Schroeter *et al.* 2001). In addition, different versions of the questionnaire were used to explore, (a) whether the risk reduction technology mattered, (b) whether reminding respondents about the effectiveness of proper cooking to eliminate pathogens would have a significant effect on WTP, and (c) how WTP varied with the risk reduction level. Table 2 summarizes the 24 alternative versions of the survey instrument. We used four different risk reduction levels (from 10/10,000 to 1/10,000; from 10/10,000 to 3/10,000; from 3/10,000 to 0/10,000 and from 3/10,000 to 1/10,000). We focused our research basically on irradiation as the risk reduction technology. However, with risk reduction from 10/10,000 to 3/10,000 we had two versions – one in which risk was reduced using irradiation and the other in which the technology was steam-pasteurization. Similarly, at the 10/10,000 to 1/10,000 risk reduction level, we included an additional version that included a reminder about the effectiveness of proper cooking – what we will term a 'cheap-talk' sentence. For each of those six scenarios we had four sets of bid or price levels for the 'treated' product for a total of 24 distinct versions.

In the **third part** of the survey instrument we included questions to elicit information about household size, children, gender, age, education level, employment status, location and household income.

Table 2: *Versions of the Questionnaire*

GROUP OF RESPON-DENTS	TECHNOLOGY	CHEAP-TALK	RISK REDUCTION	INITIAL PAYMENT QUESTION	FOLLOW-UP QUESTION (IF "NO")	FOLLOW-UP QUESTION (IF "YES")	NUMBER OF SURVEYS MAILED
1.1	Irradiated	No	10/10,000-3/10,000	1.79	1.74	1.89	125
1.2	Irradiated	No	10/10,000-3/10,000	1.89	1.79	1.99	125
1.3	Irradiated	No	10/10,000-3/10,000	1.99	1.89	2.09	125
1.4	Irradiated	No	10/10,000-3/10,000	2.09	1.99	2.19	125
2.1	Steam-pasteurized	No	10/10,000-3/10,000	1.79	1.74	1.89	125
2.2	Steam-pasteurized	No	10/10,000-3/10,000	1.89	1.79	1.99	125
2.3	Steam-pasteurized	No	10/10,000-3/10,000	1.99	1.89	2.09	125
2.4	Steam-pasteurized	No	10/10,000-3/10,000	2.09	1.99	2.19	125
3.1	Irradiated	No	10/10,000-1/10,000	1.79	1.74	1.89	125
3.2	Irradiated	No	10/10,000-1/10,000	1.89	1.79	1.99	125
3.3	Irradiated	No	10/10,000-1/10,000	1.99	1.89	2.09	125
3.4	Irradiated	No	10/10,000-1/10,000	2.09	1.99	2.19	125
4.1	Irradiated	Yes	10/10,000-1/10,000	1.79	1.74	1.89	125
4.2	Irradiated	Yes	10/10,000-1/10,000	1.89	1.79	1.99	125
4.3	Irradiated	Yes	10/10,000-1/10,000	1.99	1.89	2.09	125
4.4	Irradiated	Yes	10/10,000-1/10,000	2.09	1.99	2.19	125
5.1	Irradiated	No	3/10,000-1/10,000	1.79	1.74	1.89	125
5.2	Irradiated	No	3/10,000-1/10,000	1.89	1.79	1.99	125
5.3	Irradiated	No	3/10,000-1/10,000	1.99	1.89	2.09	125
5.4	Irradiated	No	3/10,000-1/10,000	2.09	1.99	2.19	125
6.1	Irradiated	No	3/10,000-0/10,000	1.79	1.74	1.89	125
6.2	Irradiated	No	3/10,000-0/10,000	1.89	1.79	1.99	125
6.3	Irradiated	No	3/10,000-0/10,000	1.99	1.89	2.09	125
6.4	Irradiated	No	3/10,000-0/10,000	2.09	1.99	2.19	125

6.2 Survey Response Rates

In a *first mailing*, the survey was sent to 3000 households in eight different states – Colorado (464), Nebraska (220), Kansas (373), Oklahoma (402), Iowa (412), Missouri (746), Arkansas (323) and Wyoming (60). The first mailing was sent on August 12, 2002. The households were selected by purchasing a random sample list of households from a commercial survey-sampling company. After allowing for 71 undelivered surveys, the response rate of the first mailing was 21.44%, with 628 surveys returned.

A *follow-up mailing* was sent to 893 non-respondents on September 15, 2002. To examine the effect of different incentives on response rate we split this second mailing into three groups: (a) 306 surveys without any incentive (b) 288 surveys that included a refrigerator-magnet, and (c) 299 surveys that included a one-dollar bill. Table 3 shows the response rates according to the different incentives. The results suggest that the refrigerator magnet has no effect on response rate, while the one-dollar bill had a significant positive impact. The mean response rate of the second mailing was 20.38%, with 182 surveys returned. This raised the overall response rate up to 27.65%, with 819 returned questionnaires.

Table 3: *Response Rates According to Different Reply Incentives*

DIFFERENT INCENTIVES	HOUSEHOLDS	RESPONSES	RESPONSE RATE (PERCENT)
Without Incentive	306	44	14.38
Refrigerator Magnet	288	45	15.63
One-Dollar Bill	299	93	31.10

6.3 Sample Statistics

Table 5 (page 43) presents the coding and definition of independent variables as well as sample statistics.

6.3.1 Consumption Habits

On average respondents indicated that they consumed hamburgers or ground beef about 6 times per month at home and about 5 times away from home. These responses appear to match up well with national averages. Average U.S. beef consumption is approximately 64lbs/hd (USDA, 2003), of which about 43 percent (Cattle-Fax, 2003) is consumed as ground beef. If our respondents consume at each consumption ¼lb ground beef, their annual consumption would be about 33lbs (11 times per month * ¼lb * 12 month) or about 51 percent of average per capita beef consumption. This suggests that our sample is fairly representative of U.S. beef consumers.

The majority of respondents preferred well-done (53 percent) or medium-well done (28 percent) hamburgers (average degree of doneness was 3.27 on a scale from 0=rare to 4=well-done). For a 5-year old child, more respondents would prepare hamburgers well-done (74 percent), and about 20 percent choose medium-well (average degree of doneness for a 5-year-old child was 3.67). The fact that average cooking levels were higher for the child suggests awareness among respondents of the role of cooking temperatures in ensuring microbial safety.

When asked if they ever forgot to wash hands before or after handling raw meat, about 26 percent of the respondents indicated that they sometimes forget and about 2 percent indicated that they always forget to wash hands. Similarly, when asked whether they ever forgot to refrigerate left-overs immediately after a meal, about 36 percent stated that they sometimes, about 1 percent stated that they always do forget. We phrased these questions using the negative *'Do you ever forget …'* question format after finding in a pre-test that when the question was phrased in the affirmative *'Do you always wash …'* format that no respondent ever admitted to not following the recommended protocol. Since the two variables are highly correlated with each other and basically contain similar information, we combined them into one dummy variable (*CARELESS*). Whenever a respondent indicated that he/she sometimes/always forget to wash hands after handling raw meat *or* to refrigerate left-overs after a meal, *CARELESS* took the value of one. The statistics show that over half (53 percent) of the respondents behave sometimes/always in a careless way.

Respondents were then asked how they would prepare hamburgers that were '*guaranteed not to be contaminated with any disease causing bacteria*'. We asked this question in an effort to determine both the extent to which respondents cooked hamburgers above their level of taste preference for safety reasons and to identify respondents who did so. Given that guarantee, 17 percent of respondents indicated that they would prepare hamburgers to a lower degree of doneness than they now do. The share of respondents preferring well-done hamburgers would decline to approximately 47 percent; about 28 percent would prepare hamburgers medium-well (average degree of doneness was 3.12 on the 0-4 scale). When then asked the same question about how they would prepare the '*bacteria-free burger*' for a 5-year-old child, 11 percent of the respondents indicated that they would lower the degree of doneness. Again, fewer respondents would prepare hamburgers well done (67 percent); 23 percent would prepare them medium-well (average degree of doneness was 3.44 on the 0-4 scale). However, we have some concerns about these responses because a number of respondents (52) answered the question incorrectly – indicating that they would prepare meat guaranteed to be bacteria free to a *higher* degree of doneness. Therefore, while we use a dummy variable – *PREFRARE* – to indicate respondents choosing a lower degree of doneness, and while these 52 observations were excluded from the sample, we do have some concerns about this variable.

6.3.2 Risk Attitudes and Perceptions

When asked about their experience with food poisoning, about 37 percent of respondents stated that they (or any member of their close family) never had food poisoning. About 24 percent of respondents stated that they (or any member of their close family) had (ever) a non-confirmed case of food poisoning, while about 19 percent indicated that they did not know. A total of 16 percent reported that they (or a close family member) had had a *confirmed* case of food poisoning, while about 4 percent reported a food poisoning that resulted in *hospitalization*.

When asked how worried they were about getting a food-borne illness, most respondents stated that they were *'seldom worried'* (43 percent) or *'moderately worried'* (35 percent). The average response to this question on a scale where 0 represented *'not at all worried'* and 4 represented *'very worried'* was 1.54. We asked this question about worriedness because we believed that the respondent's attitude to the risk of illness, in addition to their perception of the level of that risk, would help explain their WTP for enhanced safety (cp. chapter 5.2.3).

We elicited risk perceptions by asking respondents their opinion about the *'risk of becoming seriously ill'* as a result of food poisoning. We presented the following risk ladder in the survey instrument to provide information about the risk of serious health consequences (hospital or emergency room treatment) from different events (Figure 2).

Figure 2: *Risk Ladder*

	Hospital/ER treatments per 100,000 people
Accidental falls	**2,700**
Auto accidents	**1,390**
Residential fire	**149**
Dog bites	**126**
Lyme disease	**6**
Lightning	**0.13**

We then asked respondents how many people per 100,000 they believed received hospital or emergency room treatment per year as a result of food poisoning. Table 4 reports the distribution of the responses. The actual risk is about 118 treatments per 100,000 people per year (Mead *et al.*, 1999). Overall about 10 percent of respondents underestimated (<10 per 100,000) the risk and about 36 percent overestimated (>1000 per 100,000) the risk.

Table 4: *Distribution of Responses*

HOSPITAL/EMERGENCY TREATMENTS PER 100,000 PEOPLE	PERCENT OF RESPONDENTS
>2000	26.2
1000-2000	10.1
140-1000	29.5
10-140	21.5
1-10	9.9
<1	2.8

6.3.3 Demographics

The average household size was about 3 persons. About 17 percent of respondents had at least one child less than 6 years old living in their household and 38 percent were from households containing children between 6 and 18 years.

About 61 percent of respondents were females and the average age was 50 years. U.S. Census Bureau (2003) reports average ages in the states we surveyed ranging from 32.0 in Wyoming to 34.0 in Iowa. Weighted by the state population this suggests an average age of 33.1 years in the states we surveyed. Average age in our sample is higher since we effectively ruled out children as respondents. About 97 percent of respondents had completed high school, and 49 percent had graduated from college. About 18 percent indicated post-graduate education. The majority of respondents were employed full-time (53 percent) or retired (19 percent). Twenty percent of respondents lived in a rural area, 43 percent in a medium-size city (1,000 to 60,000), and 36 percent in a city with more than 60,000 people. The median household income in the sample was between $40,000 and $50,000. U.S. Census Bureau (2003) reports median household incomes in the states we surveyed ranging from $25,814 in Arkansas to $40,706 in Colorado. Weighted by the number of households median income in the sample states was estimated at $32,250. Thus, average household income in our sample is somewhat higher than that of the general population.

Table 5: *Definitions of Variables and Sample Statistics*

VARIABLES	DESCRIPTION OF THE VARIABLES	MEAN	STANDARD DEVIATION
HOME	Number of times respondent eats hamburgers *at home* per month	6.21	5.05
AWAY	Number of times respondent eats hamburgers *away from home* per month	4.57	4.51
DONENESS	Typical preparation of hamburgers of the respondent (0=rare, 1=medium rare, 2=medium, 3=medium well and 4=well done)	3.27	0.92
DONE-CHILD	Typical preparation of hamburgers of the respondent *for a 5-year-old child* (0=rare, 1=medium rare, 2=medium, 3=medium well and 4=well done)	3.67	0.58
CARELESS	= 1 if respondent ever forgets to wash hands before and after handling raw meat or to refrigerate immediately left-overs after a meal, 0 otherwise	0.53	0.50
PREFRARE	= 1 if respondent prepares hamburgers to a lower degree of doneness, if the risk of contaminated hamburgers would be zero, 0 otherwise	0.17	0.38
FOODPOI-NO*	= 1 if respondent or any member of his close family never had food poisoning, 0 otherwise	0.37	0.48
FOODPOI-UNSURE	= 1 if respondent does not know if he or any member of his close family ever had food poisoning, 0 otherwise	0.19	0.39
FOODPOI-YES	= 1 if respondent or any member of his close family ever had food poisoning but the case was not confirmed, 0 otherwise	0.24	0.43
CONFIRMED	= 1 if respondent or any member of his close family ever had a confirmed case of food-poisoning but was not hospitalized, 0 otherwise	0.16	0.37
HOSPITAL	= 1 if respondent or any member of his close family had a confirmed case of food-poisoning that resulted in hospitalization, 0 otherwise	0.04	0.20
WORRIED	Worriedness of the respondent to get a food related illness (0=not at all worried, 1=seldom worried, 2=moderately worried, 3=quite a bit worried, 4=very worried)	1.54	0.90
UNDERESTIMATE	= 1 if respondent underestimates** the risk of becoming seriously ill as a result of food poisoning, 0 otherwise	0.10	0.30
OVERESTIMATE	= 1 if respondent overestimates** the risk of becoming seriously ill as a result of food poisoning, 0 otherwise	0.36	0.48
VERSION1*	=1 if the respondent received a questionnaire with a risk reduction level of 10 to 1 (irradiation, no cheap-talk), 0 otherwise	0.17	0.38
VERSION1-TALK	= 1 if the respondent received a questionnaire with a risk reduction level of 10 to 1 and a cheap-talk sentence (irradiation), 0 otherwise	0.16	0.37
VERSION2-STEAM***	= 1 if the respondent received a questionnaire with a risk reduction level of 10 to 3 with steam-pasteurization as the risk reduction technology (no cheap-talk), 0 otherwise	0.16	0.37
VERSION2	= 1 if the respondent received a questionnaire with a risk reduction level of 10 to 3 (irradiation, no cheap-talk), 0 otherwise	0.16	0.37
VERSION3	= 1 if the respondent received a questionnaire with a risk reduction level of 3 to 0 (irradiation, no cheap-talk), 0 otherwise	0.16	0.37
VERSION4****	= 1 if the respondent received a questionnaire with a risk reduction level of 3 to 1 (irradiation, no cheap-talk), 0 otherwise	0.19	0.39
HOUSESIZE	Number of people living in the household	2.84	1.30
KIDU6	= 1 if having children under 6 living in the household, 0 otherwise	0.17	0.38
KID618	= 1 if having children between 6 and 18 living in the household, 0 otherwise	0.38	0.48

__Table 5 (Cont'd):__ Definitions of the Independent Variables and Sample Statistics

VARIABLES	DESCRIPTION OF THE VARIABLES	MEAN	STANDARD DEVIATION
MALE	Respondent's gender (0=female, 1=male)	0.39	0.49
AGE	Respondent's age in years	49.85	13.68
EDU-SH*	= 1 if respondent attended some high school, 0 otherwise	0.03	0.17
EDU-HG	= 1 if respondent is a high school graduate, 0 otherwise	0.17	0.38
EDU-SC	= 1 if respondent attended some college, 0 otherwise	0.30	0.46
EDU-CG	= 1 if respondent is a college graduate, 0 otherwise	0.31	0.46
EDU-PG	= 1 if respondent is a post graduate, 0 otherwise	0.18	0.39
EMP-FT*	= 1 if respondent is full-time employed, 0 otherwise	0.53	0.50
EMP-PT	= 1 if respondent is part-time employed, 0 otherwise	0.09	0.28
EMP-UN	= 1 if respondent is unemployed, 0 otherwise	0.01	0.11
EMP-HOME	= 1 if respondent is a homemaker, 0 otherwise	0.08	0.28
EMP-SELF	= 1 if respondent is self-employed, 0 otherwise	0.08	0.27
STUDENT	= 1 if respondent is a full time student, 0 otherwise	0.01	0.09
RETIRED	= 1 if respondent is retired, 0 otherwise	0.19	0.39
RURAL*	= 1 if respondent lives in a city with less than 1,000, 0 otherwise	0.20	0.40
SMALLCITY	= 1 if respondent lives in a city from 1,000 to 60,000, 0 otherwise	0.43	0.50
LARGECITY	= 1 if respondent lives in a city with more than 60,000, 0 otherwise	0.36	0.48
INC	Annual household income before taxes of the respondent (1=<$20,000, 2=$20,000-$30,000, 3=$30,000-$40,000, 4=$40,000-$50,000, 5=$50,000-$70,000, 6=$70,000-$100,000 and 7=>$100,000)	4.43	1.88

* These variables are used as baseline categories in our models.

** The actual risk of becoming seriously ill as a result of food poisoning is about 118 yearly hospitalizations per 100,000 people; if a respondent stated a number smaller than 10, the answer was coded as an underestimation; if the respondent stated a number higher than 1,000, the answer was coded as an overestimation

*** The risk reduction technology is irradiation in all other versions.

**** Version 1 has risk reduction from 10 cases (for 10,000 individuals in 10 years) to 1 case; Version 2 has reduction from 10 cases to 3; Version 3 from 3 cases to 1; Version 4 from 3 cases to zero.

6.3.4 Willingness to Pay Responses

6.3.4.1 Acceptance Rate

Respondents were asked whether they would prefer ground beef "A" (standard product) or treated ground beef "B" (irradiated or steam-pasteurized product) if prices were the same. Our results showed that 79.8 percent of respondents would choose the safer treated product. When the treated product was steam-pasteurized, the acceptance rate was 93 percent, while for the irradiated product the overall acceptance rate (over all risk reduction scenarios) was 77 percent. This value is in the range of former focus group findings; Schroeter *et al.* (2001) found that about 70 percent of participants expressed acceptance for *irradiated* meat.

Acceptance rate varied somewhat with the level of risk reduction as indicated in Table 6. Thus, when risk reduction was from 3 cases to 1 (*VERSION4*), acceptance of the irradiated product was 72 percent; when reduction was from 10 to 1 (*VERSION1*), acceptance was 78 percent.

Table 6: *Acceptance Rate Regarding to Different Questionnaire Versions*

QUESTIONNAIRE VERSIONS	ACCEPTANCE RATE
VERSION1	78.4
VERSION1-TALK	82.6
VERSION2	77.8
VERSION2-STEAM	93.0
VERSION3	74.4
VERSION4	71.9

6.3.4.2 Distribution of Willingness to Pay Responses

Table 7 presents a summary of the responses to the double-bounded dichotomous-choice questions used to elicit WTP. As described above, respondents were faced with a hypothetical scenario in which they could choose between ground beef “A” (standard product) and ground beef “B” (the safer product).

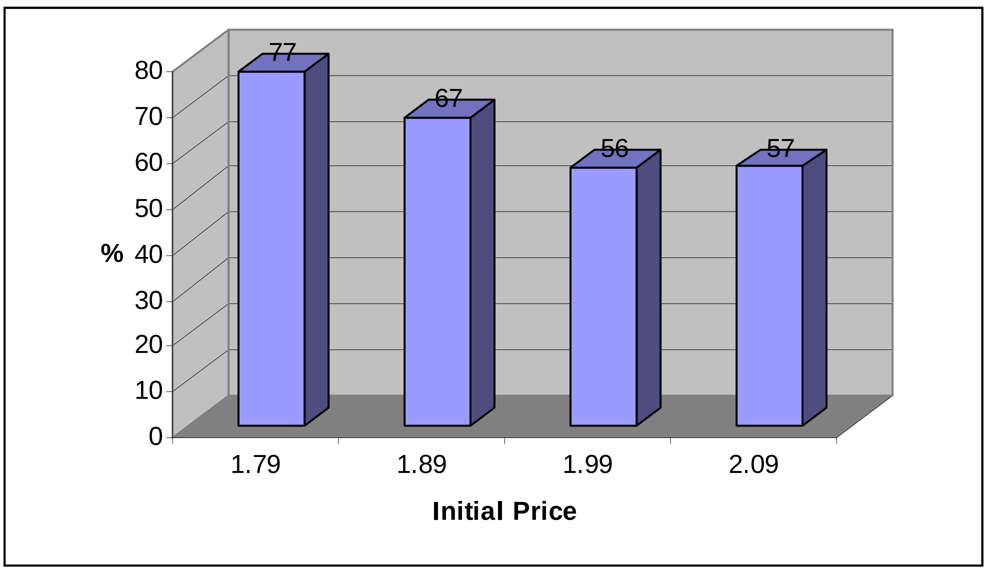
Table 7: *Distribution of Responses to Initial and Follow-up Questions*

BID STRUCTURE*	DISTRIBUTION OF RESPONSES (PERCENT)			
	"no-no" response	"no-yes" response	"yes-no" response	"yes-yes" response
VERSION1 (10 to 1)				
1.79, 1.74, 1.89	19.2	7.7	15.4	57.7
1.89, 1.79, 1.99	20.0	5.0	20.0	55.0
1.99, 1.89, 2.09	39.3	0.0	14.3	46.4
2.09, 1.99, 2.19	34.8	0.0	13.0	52.2
VERSION1-TALK (10 to 1)				
1.79, 1.74, 1.89	17.2	10.3	13.8	58.6
1.89, 1.79, 1.99	42.9	4.8	14.3	38.1
1.99, 1.89, 2.09	40.9	4.5	36.4	18.2
2.09, 1.99, 2.19	47.8	13.0	4.3	34.8
VERSION2 (10 to 3)				
1.79, 1.74, 1.89	0.0	0.0	18.2	81.8
1.89, 1.79, 1.99	14.3	19.0	28.6	38.1
1.99, 1.89, 2.09	44.0	8.0	16.0	32.0
2.09, 1.99, 2.19	17.4	17.4	8.7	56.5
VERSION2-STEAM (10 to 3)				
1.79, 1.74, 1.89	20.0	8.0	24.0	48.0
1.89, 1.79, 1.99	22.6	9.7	12.9	54.8
1.99, 1.89, 2.09	30.4	4.3	13.0	52.2
2.09, 1.99, 2.19	48.0	0.0	4.0	48.0
VERSION3 (3 to 0)				
1.79, 1.74, 1.89	27.6	3.4	24.1	44.8
1.89, 1.79, 1.99	20.8	12.5	16.7	50.0
1.99, 1.89, 2.09	47.6	0.0	14.3	38.1
2.09, 1.99, 2.19	36.0	12.0	16.0	36.0
VERSION4 (3 to 1)				
1.79, 1.74, 1.89	17.4	4.3	21.7	56.5
1.89, 1.79, 1.99	11.8	11.8	11.8	64.7
1.99, 1.89, 2.09	42.9	0.0	19.0	38.1
2.09, 1.99, 2.19	33.3	0.0	4.8	61.9

*Entries indicate the 1st price at which the treated product was offered (compared to untreated product at $1.69/lb), then the lower price if the respondent chose the untreated product, then the higher price if the respondent chose the treated product at the initial price.

It is supposed that the frequency of ”yes“ and “no“ responses[7] to this question is a function of the risk reduction level and the bid vector. Thus, economic theory suggests that the proportion of “yes” (“no”) responses is a decreasing (increasing) function of the bid amount and an increasing (decreasing) function of the risk reduction level. Table 7 and Figure 3 shows that the proportion of “yes” and “no” responses is sensitive to the bid amount, but not to the risk reduction level: (a) in most cases a higher bid amount lowers the proportion of “yes-yes” responses and increases the proportion of “no-no” responses, (b) no specific pattern can be recognized between the different risk levels.

Figure 3: *Proportion of Respondents who Preferred Treated Product at the Initial Price*

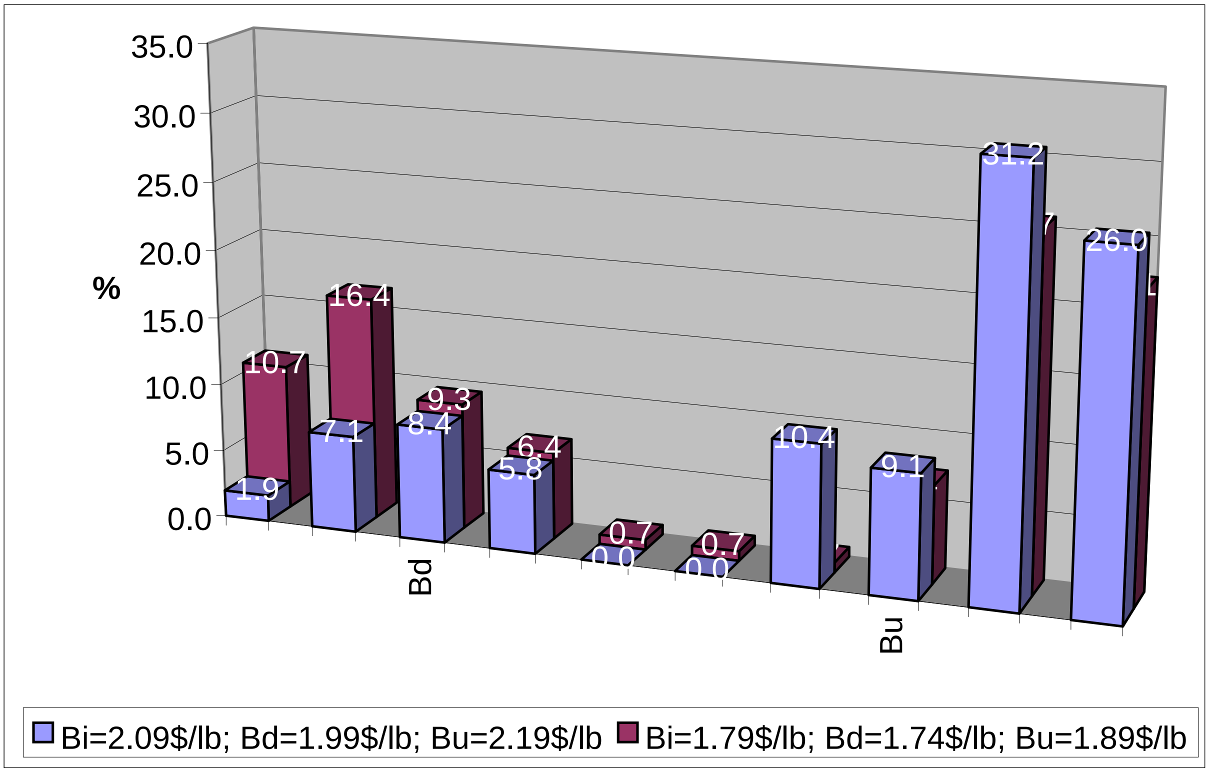


[7] Appendix 2 presents the distribution of responses using the five answer categories: *‘I would always choose ground beef “A”’, ‘I would usually choose ground beef “A”’, ‘I’m not sure which one I would choose’, ‘I would usually choose ground beef “B”’*, and *‘I would always choose ground beef “B”’*. For a better overview we simplified responses here into “yes” and “no” categories.

As we will see it Chapter 7, we assume in the analysis of the double-bounded dichotomous-choice data that the underlying distribution function is the logistic one. Figure 4 shows the distribution of WTP responses regarding to the highest (2.09$/lb) and the lowest (1.79$/lb) initial price over all different risk reduction scenarios. As we can see, the distribution does *not* have the expected shape of a logistic distribution function; in fact the distribution is U-shaped. It turns out that respondents stuck in the follow-up questions to the answer they have given to the initial WTP question: The majority of respondents, who indicated to buy the treated product in the initial question, also indicated WTP in the second follow-up question, vice versa.

A possible explanation can be seen in the WTP elicitation method. Since we included five different answer categories, respondents might find it hard to switch from a "yes" response to an "always-no" response, or similar, from a "no" response to a always "yes" response. Indeed, this categories account for a very low percentage - for observations with the highest initial price (2.09$/lb), even zero consumers responded in this way. Psychological barriers coming along with the elicitation method might therefore be the reason for the unexpected shape of the distribution.

Figure 4: *Distribution of WTP Responses*



7 Theoretical Framework of the Statistical Analyses

The analysis of our data will be focused on the following points:

- To identify determinants of *acceptance* of the treated product "B", we will estimate a *probit* model.
- To model *WTP* we will estimate a
  - *single-bounded* dichotomous-choice model, and a
  - *double-bounded* dichotomous choice model.

As we have seen in the last chapter, the distribution of our double-bounded (DB) dichotomous-choice (DC) data is unexpected, and results based on this data might be biased. Given this background, we will estimate a single-bounded (SB) DC model, which is independent from the unexpected distribution function, as well as a DB DC model.

The analysis of our SB, and DB DC data will follow the ideas of Hanemann *et al.* (1991). However, our WTP question differed from the traditional format by allowing for a degree of respondent uncertainty in their response. Instead of having the respondent reply with a simple "yes" or "no" we expanded the context of the scenario to include multiple repeated purchases by allowing five answer categories: *'I would <u>always</u> choose ground beef "A"', 'I would <u>usually</u> choose ground beef "A"', 'I'm <u>not sure</u> which one I would choose', 'I would <u>usually</u> choose ground beef "B"'*, and *'I would <u>always</u> choose ground beef "B"'*.

In our analysis we coded the first three answer categories (*'always "A"', 'usually "A"'*, and *'not sure'*) as a "no" response, and the final two answer categories *('usually "B"'*, and *'always B"'*) as a "yes" response. This is consistent both with former studies that treat "not sure" responses as "no's" (Loomis and Ekstrand, 1997) and with the instructions given to our respondents contingent on their response to the initial WTP question.

7.1 *The Single-Bounded Dichotomous Choice Model*

In the simplified, single-bounded model we use only the initial DC question. There are only two possible outcomes to this question: If treated ground beef is valued more highly than the given dollar amount (B_i^u), the person answers "yes", otherwise "no".

In case of a "yes" response, respondent's maximum WTP lies between B_i^u and infinity; in case of a "no" response, respondent's maximum WTP lies between zero and B_i^u. The probability of obtaining a "no" or a "yes" response can be represented by

(1) $\pi^n\left(B_i^d\right) = G\left(B_i^d;\theta\right)$, and

(2) $\pi^y\left(B_i^d\right) = 1 - G\left(B_i^d;\theta\right)$,

where $G\left(B_i^d;\theta\right)$ is some cumulative distribution function (typically the logistic) parameterized by θ.

For a given sample of N respondents the log-likelihood function is:

(3) $$\ln L(\theta) = \sum_{i=1}^{N} \left\{d_i^y \ln \pi^y\left(B_i^d\right)\right.$$

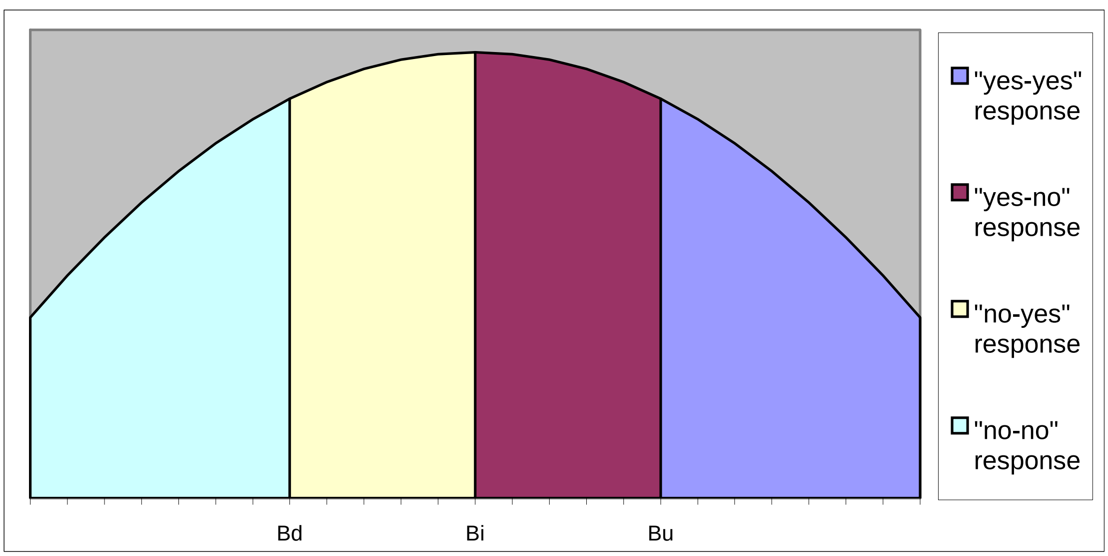
$$\left. + d_i^n \ln \pi^n\left(B_i^d\right)\right\}.$$

7.2 The Double-Bounded Dichotomous Choice Model

In the DB analysis there are four possible outcomes to the two-part WTP question: (a) a “yes-yes” response; (b) a “no-no” response; (c) a “yes” response followed by a “no” response; (d) a “no” response followed by a “yes” response. Figure 3 illustrates the WTP intervals for these different outcomes.

A “yes-yes” response indicates that respondent’s maximum WTP lies between B_i^u - the higher price offered in the 2nd part of the WTP question conditional on a positive response at the initial price (B_i) - and infinity. Similarly, a “no-no” response indicates a value between zero and B_i^d ; a “no-yes”/“yes-no” response indicates that the respondent’s maximum WTP lies between B_i^d and B_i/B_i and B_i^u .

Figure 5: *Intervals of Respondents’ WTP*



We use π^{yy} π^{nn} π^{yn}, and π^{ny} to represent the likelihood of these outcomes. First, consider a “yes-yes” response. In that case,

(4) $$\pi^{yy}\left(B_i, B_i^u\right) = \Pr\left\{B_i^u \leq \max WTP\right\} = 1 - G\left(B_i^u;\theta\right),$$

where $G\left(B_i^u;\theta\right)$ is again some cumulative distribution function (typically a logistic) parameterized by θ.

When we have a "no-no" response,

(5) $$\pi^{nn}\left(B_i, B_i^d\right) = G\left(B_i^d;\theta\right).$$

In case of a "yes-no" response,

(6) $$\pi^{yn}\left(B_i, B_i^u\right) = G\left(B_i^u;\theta\right) - G\left(B_i;\theta\right),$$

and in case of a "no-yes' response,

(7) $$\pi^{ny}\left(B_i, B_i^d\right) = G\left(B_i;\theta\right) - G\left(B_i^d;\theta\right).$$

For a given sample of N respondents, the log-likelihood function takes the form

(8) $$\ln L(\theta) = \sum_{i=1}^{N} \Big\{ d_i^{yy} \ln \pi^{yy}\left(B_i, B_i^u\right)$$

$$+ d_i^{nn} \ln \pi^{nn}\left(B_i, B_i^d\right)$$
$$+ d_i^{yn} \ln \pi^{yn}\left(B_i, B_i^u\right)$$
$$+ d_i^{ny} \ln \pi^{ny}\left(B_i, B_i^d\right)\Big\},$$

where d_i^{yy}, d_i^{nn}, d_i^{yn}, d_i^{ny} are indicator variables such that for example $d_i^{yy}=1$ if the respondent answers "yes" to both questions, and 0 otherwise. The formulas for the corresponding response probabilities are given by (1)-(4).

Using a logistic specification for the cumulative distribution, each $G(B;\theta)$ takes the form

(9) $$G(B) = \left[1 + e^{\alpha+\gamma Z-\beta(B)}\right]^{-1}.$$

Here Z is a vector of independent variables expected to influence WTP, B is the offer price, and $\alpha, \gamma,$ and β are the parameters to be estimated.

Median WTP is given by the intercept parameter (α), divided by the slope parameter (β), in a model where all slope parameters except that on price (B) are set to zero (Hanemann *et al.*, 1991).

7.3 Expected Signs of Explanatory Variables

In equation (9), Z is a vector of independent variables elicited in the questionnaire and expected to influence WTP. Table 8 shows the expected coefficient signs of the independent variables.

Table 8: *Expected Coefficient Signs of Explanatory Variables*

VARIABLES	DESCRIPTION OF THE VARIABLES	SIGN
HOME	Number of times respondent eats hamburgers *at home* per month	not clear
AWAY	Number of times respondent eats hamburgers *away from home* per month	not clear
DONENESS	Typical preparation of hamburgers of the respondent (0=rare, 1=medium rare, 2=medium, 3=medium well and 4=well done)	not clear
PREFRARE	= 1 respondent prepares hamburgers to a lower degree of doneness, if the risk of contaminated hamburgers would be zero, 0 otherwise	+
CARELESS	= 1 if respondent ever forgets to wash hands before and after handling raw meat or to refrigerate immediately left-overs after a meal, 0 otherwise	+
FOODPOI-UNSURE	= 1 if respondent does not know if he or any member of his close family ever had food poisoning, 0 otherwise	+
FOODPOI-YES	= 1 if respondent or any member of his close family ever had food poisoning but the case was not confirmed, 0 otherwise	+
CONFIRMED	= 1 if respondent or any member of his close family ever had a confirmed case of food-poisoning but was not hospitalized, 0 otherwise	+
HOSPITAL	= 1 if respondent or any member of his close family had a confirmed case of food-poisoning that resulted in hospitalization, 0 otherwise	+
WORRIED	Worriedness of the respondent to get a food related illness (0=not at all worried, 1=seldom worried, 2=moderately worried, 3=quite a bit worried, 4=very worried)	+
UNDERESTIMATE	= 1 if respondent underestimates the risk of becoming seriously ill as a result of food poisoning, 0 otherwise	-
OVERESTIMATE	= 1 if respondent overestimates the risk of becoming seriously ill as a result of food poisoning, 0 otherwise	+
VERSION1-TALK	= 1 if the respondent received a questionnaire with a risk reduction level of 10 to 1 and a cheap-talk sentence (irradiation), 0 otherwise	-
VERSION2-STEAM	= 1 if the respondent received a questionnaire with a risk reduction level of 10 to 3 and with steam-pasteurization as the regarding technology (no cheap-talk), 0 otherwise	not clear
VERSION2	= 1 if the respondent received a questionnaire with a risk reduction level of 10 to 3 (Irradiation, no cheap-talk), 0 otherwise	-
VERSION3	= 1 if the respondent received a questionnaire with a risk reduction level of 3 to 0 (Irradiation, no cheap-talk), 0 otherwise	not clear
VERSION4	= 1 if the respondent received a questionnaire with a risk reduction level of 3 to 1 (Irradiation, no cheap-talk), 0 otherwise	-
HOUSESIZE	Number of people living in the household	-
KIDU6	= 1 if having children under 6 living in the household, 0 otherwise	+
KID618	= 1 if having children between 6 and 18 living in the household, 0 otherwise	+

Table 8 (Cont'd): Expected Coefficient Signs of Explanatory Variables

VARIABLES	DESCRIPTION OF THE VARIABLES	SIGN
MALE	Respondent's gender (0=female, 1=male)	-
AGE	Respondent's age in years	+
EDU	Education level of the respondent (1=some high school, 2=high school graduate, 3=some college, 4=college graduate, 5=post graduate)	not clear
EMP	Employment status of the respondent (1=employment full time, 2=employment part-time, 3=unemployed, 4=homemaker, 5=self-employed, 6=a full time student, 7=retired, 8=other)	not clear
LOC	1=rural, 2=city from 1,000 to 60,000 and 3=city with more than 60,000)	not clear
INC	Annual household income before taxes of the respondent	+

Economic theory or former research does not provide strong predictions for the effects on WTP of the variables *HOME* and *AWAY*. Lusk *et al.* (1999) reported that consumers with a high frequency of beef consumption tend to have a high acceptance rate of irradiated beef. However, there is no evidence that these consumers also have a higher WTP. One could argue that people with higher consumption are more often exposed to the risk of getting ill and thus have a higher WTP. On the other hand, a higher consumption has a negative effect on the budget constraint, which might lead to a lower WTP. In addition it is not clear if the frequency of *at home* consumption has a different effect on WTP than the frequency of *away* from home consumption.

It is also not possible to predict the coefficient sign of the variable *DONENESS*. Basically, the level of private risk reduction (degree of doneness) depends on respondents' taste preferences and on respondents' awareness that cooking hamburgers to a high degree of doneness has a major food safety effect. Table 9 illustrates that different groups of respondents influence the coefficient sign of the variable *DONENESS* in opposite ways.

It is expected that the variable *DONENESS* would have no influence on WTP for respondents who are *not* aware of private risk reduction possibilities (group 1 and group

3). However, we expect a negative effect of *DONENESS* on WTP for group 2 respondents. Since respondents in this group are aware of their high private risk reduction, they are likely less willing to pay for improvements in public safety. Respondents belonging to groups 4 and 5 are expected to be willing to pay more for public risk reduction. Group 4 respondents can be identified by the variable *PREFRARE*. It is assumed that group 4 respondents would trade private against public risk reduction, so they can enjoy hamburgers at a lower degree of doneness. The variable *PREFRARE* is therefore expected to have a positive sign.

Table 9: *Expected Effect of the Variable DONENESS on WTP*

GROUP OF RESPONDENTS				EFFECT OF VARIABLE *DONENESS* ON WTP
Group	Taste	Awareness of Private Risk Reduction	Typical Preparation (Degree of Doneness)	
Group 1	Well Done	Not Aware	Well Done	No Effect
Group 2	Well Done	Aware	Well Done	Negative Effect
Group 3	Medium	Not Aware	Medium	No Effect
Group 4	Medium	Aware	Well Done	Positive Effect
Group 5	Medium	Aware	Medium	Positive Effect
OVERALL				Not Clear

People who do not handle meat carefully (*CARELESS* = 1) are hypothesized to have a higher WTP. With more public food safety they can compensate for their lack of private risk reduction.

Further, it is expected that people who have experienced food poisoning may be more concerned and aware of the risk and therefore have a higher WTP. Thus, the variable *FOODPOI-UNSURE*, *FOODPOI-YES*, *CONFIRMED* and *HOSPITAL* (dummy variables representing respondents with confirmed cases of food poisoning, and food poisoning resulting in hospitalization, respectively) are expected to have a positive effect (with the variable *FOODPOI-NO* - never had food poisoning - as the baseline category).

Prior research suggests that respondent's concern or worry about contracting a foodborne illness has a significantly positive effect on WTP. Thus, the coefficient on *WORRIED* is hypothesized to be positive.

If a respondent underestimates the risk of getting seriously ill, his *perceived* risk is lower than the *actual* risk. Under the assumption that consumers base their WTP choices on perceived rather than actual risks, these respondents would be assumed to have a lower WTP. The coefficient for the variable *UNDERESTIMATE* is therefore expected to be negative. On the other hand, when a respondent overestimates the risk of getting seriously ill he is expected to have a higher WTP, resulting in a positive coefficient for the variable *OVERESTIMATE*.

The variable *VERSION1-TALK* identifies respondents for whom the risk scenario described a risk reduction from 10 to 1 case per 100,000 consumptions, risk reduction achieved with irradiation and respondents being informed of their private risk reduction possibilities. This scenario differs from the baseline category only in the provision of the information about private risk reduction (what we have labeled the 'cheap-talk' treatment). We assume that only those respondents who are *not* aware of private risk reduction possibilities would be influenced by the cheap-talk sentence. Returning to Table 8, group 2 respondents might reduce their WTP amounts after reading the cheap-talk sentence, since they are made aware of their high protection level. Group 4 respondents, however, are likely willing to pay more for public risk reduction, since they realize that their private protection is low.

The variable *VERSION2* identifies the subset of respondents for whom the scenario described a risk reduction from 10 to 3 cases per 100,000 consumptions (versus from 10 to 1 in the baseline). Similarly, the variable *VERSION2-STEAM* identifies individuals responding to a similar risk reduction scenario but one in which the reduction is achieved with steam-pasteurization rather than with irradiation. Difference in the magnitudes of these coefficients will show differences in consumer WTP for the two risk reduction technologies - irradiation and steam-pasteurization.

Regarding the different levels of risk presented to respondents (*VERSION1*, *VERSION2*, *VERSION3*, *VERSION4* describing reductions from 10 to 1, 10 to 3, 3 to 0, and 3 to 1 cases per 10,000 individuals respectively) we can test whether our estimated WTP values pass an external scope test. The scope test is passed if median WTP for the 10/10,000 to 3/10,000 (*VERSION2*) risk reduction is significantly lower than for the 10/10,000 to 1/10,000 (*VERSION1*) risk reduction. In particular, given that the baseline category is represented by *VERSION1* (risk reduction from 10 to 1) we would expect the coefficient of the variable *VERSION2* (risk reduction from 10 to 3) to be negative. An insignificant coefficient would suggest failure to pass the scope test. Similarly, we would expect a negative sign for *VERSION4* (risk reduction from 3 to 1). Regarding *VERSION3* (reduction from 3 to 0) we focus not on a comparison with the baseline category but rather on a comparison with *VERSION4* (from 3 to 1). We would expect respondents to value the *elimination* of risk more highly than its reduction.

Other variables hypothesized to influence respondents' WTP include demographic characteristics such as household size, number of children in the household, gender, age, education level, employment status, location, and household income. It is expected that larger households would have a lower WTP, because of an income effect; additional persons in the household decrease the income per person in the household.

Further it is assumed that consumers with children would allocate greater expenditures to reduce children's risk. The coefficient for the variables *KIDU6* and *KID618* are therefore expected to be positive.

Based on former studies, men are expected to have a lower WTP than women and thus we expect the coefficient for the variable *MALE* (male = 1) to be negative. Since older people are more at risk to receive foodborne illness, they might place higher WTP values for risk reduction. Thus, *AGE* is assumed to have a positive effect. The variable *INCOME* should also have a positive effect on WTP since we would expect risk reduction to be considered as a normal good. Economic theory or prior research does not provide strong predictions for the effects of respondents' education, employment and location. The expected parameter signs of the education, employment, and location dummy variables are therefore not clear.

8 Empirical Results

8.1 Determinants of Zero WTP

In the first WTP question respondents are asked whether they would prefer ground beef "A" (standard product) or ground beef "B" (irradiated or steam-pasteurized product), *if the prices were equal* (cp. chapter 6.1). In this context a preference for ground beef "A" indicates rejection of the 'safer' treated (irradiated or steam-pasteurized) product.

A *probit model*[8] was estimated[9] to identify consumer or product characteristics associated with rejection of the treated product. In this model the dependent variable takes the value of 1 if the respondent indicated a preference for the treated product (ground beef "B"), 0 otherwise. Thus, positive (negative) coefficient signs mean that higher values of an explanatory variable are associated with increasing (decreasing) acceptance of the treated product.

Table 10 shows the empirical results from the probit analysis. The sample size was reduced from the original 819 by incomplete responses and data cleaning[10] to 531. The analysis finds an association between acceptance-rejection of the treated product and

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[8] For a discussion of the *probit model* see Appendix 3

[9] The statistical estimation of the model was conducted with LIMDEP version 7.0

[10] Responses from those who would prepare hamburgers - that were guaranteed not to be contaminated with any disease causing bacteria - to a higher degree of doneness than standard hamburgers, were dropped.

the variables *AWAY*, *VERSION2-STEAM* (significant at $\alpha < 0.01$), and the variables *KIDU6*, and *LARGECITY* (significant at $\alpha < 0.1$).

Table 10: *Regression Results of the Probit Model, Marginal Effects, All Variables Included, Cleaned Data (N=531)*[11]

	VARIABLE	MARGINAL EFFECT	T-STATISTIC	P-VALUE
	Intercept	-0.002	-0.009	0.993
Consump-tion Habits	HOME	-0.002	-0.410	0.682
	AWAY	0.016	3.130	0.002
	DONENESS	0.024	1.373	0.170
	CARELESS	0.027	0.836	0.403
	PREFRARE	0.009	0.201	0.841
Risk Perception	FOODPOI-UNSURE	0.008	0.178	0.859
	FOODPOI-YES	0.005	0.109	0.914
	CONFIRMED	0.048	0.849	0.396
	HOSPITAL	0.118	1.082	0.279
	WORRIED	0.023	1.223	0.221
	UNDERESTIMATE	0.041	0.759	0.448
	OVERESTIMATE	0.023	0.649	0.517
Risk Reduction	VERSION1-TALK	0.019	0.346	0.729
	VERSION2-STEAM	0.198	2.965	0.003
	VERSION2	-0.030	-0.562	0.574
	VERSION3	-0.044	-0.850	0.395
	VERSION4	-0.045	-0.873	0.383
Demographics	HOUSESIZE	-0.033	-1.517	0.129
	KIDU6	0.102	1.762	0.078
	KID618	0.048	0.895	0.371
	MALE	-0.001	-0.024	0.981
	AGE	0.001	0.554	0.580
	EDU1	0.016	0.171	0.865
	EDU2	-0.012	-0.132	0.895
	EDU3	0.005	0.053	0.958
	EDU4	0.045	0.461	0.645
	EMP-PT	-0.084	-1.505	0.132
	EMP-HOME	-0.102	-1.542	0.123
	EMP-SELF	-0.067	-1.151	0.250
	RETIRED	-0.064	-1.117	0.264
	SMALLCITY	0.018	0.440	0.660
	LARGECITY	0.079	1.761	0.078
	INC	0.002	0.171	0.864

Pseudo R^2 (Zavoina and McKelvey): 0.422

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[11] For the Maximum Likelihood Estimates see Appendix 4.

A reduced model, omitting many of the insignificant variables, was also estimated but the results were essentially identical suggesting that the model is robust to different specifications.

The positive sign associated with the *AWAY* variable suggests that higher away from home consumption of ground beef is associated with a higher probability of choosing the treated product. The coefficient indicates that the consumption of an additional hamburger (ground beef) away from home increases the probability of choosing the treated product by 1.6 percent. Lusk et al. (1999) found that consumers with higher ground beef consumption tend to be less concerned about irradiation. However, thus far the literature has not distinguished between *at home* and *away from home* consumption as separate explanatory variables. Our results suggest that only the away from home consumption has an effect on the acceptance rate of irradiated or steam-pasteurized ground beef. One possible explanation for this finding is that consumers have limited possibilities for private risk reduction with away from home consumption. This may result in higher acceptance of a collective risk reduction strategy like irradiation or steam-pasteurization.

The estimated coefficient for *VERSION2-STEAM* has a positive sign. The probability of choosing the treated product is significantly 20 percent higher if steam-pasteurization rather than irradiation is used as the risk reduction technology. The results likely reflect the fact that some consumers have reservations about the process of food irradiation. This result would appear to confirm the opinion of many in the irradiation industry that a product labeled as “pasteurized” would enjoy higher consumer acceptance than one labeled as “irradiated”.

The positive sign of the *KIDU6* variable suggests that respondents are aware that bacterial infections are particularly dangerous for young children and they thus favor the safer treated product. The corresponding coefficient indicates an 11 percent increase of probability, when children under 6 are present in the household. Interestingly the variable *KID618* is not significant. Again, this might reflect that consumers are aware that younger children are more at risk than older children.

The positive sign of the *LARGECITY* variable suggests that respondents from larger cities are more likely to choose treated products. The probability is about 8 percent higher that a respondent from a larger city chooses the treated product.

Our findings could not confirm earlier results suggesting that consumer acceptance of irradiated products is influenced by gender, education and income. The coefficient of the variable *MALE* is not significant, although the sign suggests, as expected, that males are more willing to accept treated (irradiated) ground beef. Similar, the parameter of *EDU* is, as expected, positive implying a higher acceptance rate for more educated respondents, but again not significantly different from zero. The coefficient of the variable *INCOME* is unexpectedly negative but insignificant.

The ability of the model to yield correct predictions of acceptance-rejection was fair. The model predicted 447 of 559 responses (80.0 percent) in a correct way. The calculation of a pseudo R^2 based on the formula given by Zavoina and McKelvey (1975)[12] provided a result of 0.422.

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[12] E[y*|y] = yf =x + lambda; R [var (yf) / (1+var (yf)]; lambda is the inverse Mill's ratio

8.2 *Determinants of WTP for Treated Ground Beef*

To model WTP, a single-bounded dichotomous-choice (SB-DC) model and a double-bounded dichotomous-choice (DB-DC) model were estimated[13] (cp. chapter 7.1 and 7.2). We included in the WTP models only those individuals who preferred the treated product – sample size was 425.

[13] Estimation of this and the following models were conducted with TSP version 4.4.

Table 11: *Regression Results of the SB-DC and DB-DC Model, All Variables Included, Cleaned Data, Without Zero WTP Observations (N=425)*

		SB-DC MODEL			DB-DC MODEL		
		Estimate	T-Statistic	P-Value	Estimate	T-Statistic	P-Value
	Intercept	6.693	2.884	0.004	9.736	7.161	0.000
	B	3.869	3.852	0.000	5.378	11.925	0.000
Consump-tion Habits	HOME	-0.065	-2.366	0.018	-0.068	-2.803	0.005
	AWAY	0.013	0.423	0.672	0.021	0.839	0.401
	DONENESS	0.387	3.196	0.001	0.332	3.140	0.002
	CARELESS	-0.167	-0.731	0.465	-0.298	-1.552	0.121
	PREFRARE	-0.209	-0.690	0.490	-0.479	-1.845	0.065
Risk Perception	FOODPOI-UNSURE	0.059	0.171	0.864	-0.044	-0.151	0.880
	FOODPOISYES	-0.698	-2.344	0.019	-0.485	-1.849	0.065
	CONFIRMED	0.175	0.507	0.612	0.112	0.391	0.696
	HOSPITAL	-0.612	-1.037	0.300	-0.283	-0.594	0.553
	WORRIED	0.532	3.559	0.000	0.568	4.460	0.000
	UNDERESTIMATE	-0.008	-0.022	0.983	0.055	0.163	0.870
	OVERESTIMATE	0.059	0.230	0.818	0.227	1.075	0.282
Risk Reduction	VERSION1-TALK	-0.143	-0.373	0.709	-0.125	-0.380	0.704
	VERSION2-STEAM	0.073	0.197	0.844	-0.346	-1.065	0.287
	VERSION2	0.700	1.695	0.090	0.482	1.458	0.145
	VERSION3	0.775	1.788	0.074	0.677	1.892	0.058
	VERSION4	-0.033	-0.086	0.931	-0.106	-0.336	0.737
Demographics	HOUSESIZE	-0.040	-0.279	0.780	-0.124	-0.972	0.331
	KIDU6	0.118	0.317	0.751	0.175	0.527	0.599
	KID618	0.116	0.332	0.740	0.333	1.081	0.280
	MALE	-0.368	-1.507	0.132	-0.182	-0.871	0.384
	AGE	-0.004	-0.340	0.734	-0.010	-0.926	0.354
	EDU-HG	-0.627	-0.754	0.451	-0.168	-0.273	0.785
	EDU-SC	-0.022	-0.026	0.979	0.031	0.050	0.960
	EDU-CG	-0.503	-0.598	0.550	-0.009	-0.014	0.989
	EDU-PG	0.483	0.566	0.572	0.529	0.820	0.412
	EMP-PT	-0.550	-1.306	0.192	-0.217	-0.571	0.568
	EMP-UN	-0.079	-0.103	0.918	-0.278	-0.348	0.728
	EMP-HOME	0.623	1.067	0.286	0.643	1.486	0.137
	EMP-SELF	-0.262	-0.643	0.520	0.017	0.046	0.963
	STUDENT	-1.926	-1.983	0.047	-1.942	-2.171	0.030
	RETIRED	0.140	0.315	0.752	0.482	1.350	0.177
	SMALLCITY	-0.022	-0.069	0.945	-0.023	-0.086	0.931
	LARGECITY	0.068	0.212	0.832	-0.031	-0.112	0.911
	INC	0.089	1.214	0.225	0.059	0.930	0.353

Log likelihood: -267.230 *Log likelihood: -536.815*

Table 11 reports the regression estimates of both models. The results show similarities, but also some differences between the two models. Thus, in both models the variables *DONENESS*, and *WORRIED* are significant at $\alpha < 0.01$, the variable *STUDENT* at $\alpha < 0.05$, the variable *VERSION3* at $\alpha < 0.1$, the variable *HOME* at $\alpha < 0.05$ (SB-DC model) and $\alpha < 0.01$ (DB-DC model), and the variable *FOODPOI-YES* at $\alpha < 0.05$ (SB-DC model) and $\alpha < 0.1$ (DB-DC model). The variable *PREFRARE* on the other side is only significant (at $\alpha < 0.1$) in the DB-DC model, the variable *VERSION2* only in the SB-DC model (at $\alpha < 0.1$).

In a second estimation, we excluded the variables *UNDERESTIMATE*, *OVERESTIMATE*, *EMP-SELF*, *EMP-UN*, *SMALLCITY*, and *LARGECITY* from the estimation, since they were not significant different from zero. In addition we omitted the variable *FOODPOI-UNSURE* and added respective observations to the baseline category *FOODPOIS-NO*. We also deleted the variables *CONFIRMED* and *HOSPITAL* and counted these observations to the variable *FOODPOI-YES*. We also excluded variable *STUDENT*, since this variable is based on a very low percentage (<1 percent) of observations, and its significance level was highly sensitive to model specifications. Also, the education dummy variables were combined to one continuous variable *EDU*. We also combined the variables *KIDU6* and *KID618* to a new variable *KIDS*[14]. In addition we omitted the variable *PREFRARE,* because of data validity concerns (cp. chapter 6.3.1).

Table 12 reports the results from the second estimation. Significant in both models are the variables *HOME* (at $\alpha < 0.01$), *DONENESS* (at $\alpha < 0.01$), *FOODPOI-YES*

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[14] *KIDS* = 1 if having children under 18 living in the household, 0 otherwise

(at $\alpha < 0.05$), and *WORRIED* (at $\alpha < 0.01$). The SB-DC model also reports the variable *MALE* as significant. To measure the goodness of fit, we calculated a pseudo R^2 (McFadden R^2). The Pseudo R^2 is slightly higher for the SB-DC (0.175) than for the DB-DC model (0.144).

Table 12: *Regression Results of the SB-DC and DB-DC Model, Reduced Variables, Cleaned Data, Without Zero WTP Observations (N=443)*

		SB-DC MODEL			DB-DC MODEL		
		Estimate	T-Statistic	P-Value	Estimate	T-Statistic	P-Value
	Intercept	5.089	2.620	0.009	8.560	7.759	0.000
	B	3.556	3.862	0.000	5.087	12.304	0.000
Consump-tion Habits	HOME	-0.052	-2.055	0.040	-0.058	-2.503	0.012
	AWAY	0.015	0.551	0.582	0.023	1.000	0.317
	DONENESS	0.357	3.230	0.001	0.311	3.164	0.002
	CARELESS	-0.160	-0.784	0.433	-0.284	-1.592	0.111
Risk	FOODPOISYES	-0.429	-1.970	0.049	-0.280	-1.484	0.138
	WORRIED	0.441	3.599	0.000	0.467	4.407	0.000
Risk Reduction	VERSION1-TALK	-0.501	-1.435	0.151	-0.348	-1.124	0.261
	VERSION2-STEAM	-0.161	-0.479	0.632	-0.452	-1.505	0.132
	VERSION2	0.446	1.222	0.222	0.428	1.387	0.166
	VERSION3	0.562	1.475	0.140	0.522	1.628	0.103
	VERSION4	-0.247	-0.710	0.478	-0.176	-0.590	0.555
Demographics	HOUSESIZE	-0.076	-0.595	0.552	-0.132	-1.148	0.251
	KIDS	0.235	0.893	0.372	0.369	1.518	0.129
	MALE	-0.434	-1.937	0.053	-0.269	-1.370	0.171
	AGE	0.007	0.693	0.488	-0.001	-0.083	0.934
	EDU	0.162	1.456	0.145	0.100	1.030	0.303
	EMP-PT	-0.455	-1.116	0.264	-0.166	-0.451	0.652
	EMP-HOME	0.627	1.212	0.226	0.579	1.399	0.162
	RETIRED	0.251	0.673	0.501	0.505	1.617	0.106
	INC	0.086	1.366	0.172	0.068	1.231	0.218

Log likelihood: -297.253
McFadden R^2: 0.175

Log likelihood: -582.846
McFadden R^2: 0.144

The following sections provide a more detailed discussion of the effects of certain variables on WTP.

8.2.1 Sensitivity of WTP to Demographic Variables

One goal of our research was to investigate associations between WTP and demographic characteristics of the respondents. Especially we were interested in whether "who" is at risk (adults or children) influences WTP.

Table 12 shows that households with children under 18 years tend to have, as expected, a higher WTP as indicated by the positive parameter sign of the variable *KIDS*. However, this effect is *not* statistically significant. The p-value equals 0.372 in the SB-DC model, and 0.129 in the DB-DC model.

In Table 13, we calculated median WTP for households with and without children under the age of 18 years. For this purpose, we split the data into the corresponding groups, and fit to each sub-sample a model that included only the intercept and the price parameter (cp. chapter 7.2). The median WTP is about 2.141$/lb for households with children, and 2.111$/lb for households without children according to the SB-DC model. The DB-DC model indicates even smaller differences (2.037$/lb and 2.027$/lb). A Wald test shows that the WTP values do not statistically differ from each other (Wald statistic = 0.031; p-value = 0.861)[15]. Thus, there is no evidence that respondents with children under the age of 18 years hold higher WTP amounts for safer ground beef "B".

[15] For the DB-DC model the Wald statistic was equal to 0.003 (p-value = 0.891).

Table 13: *Median WTP Regarding the Presence of Children under the Age of 18 Years in the Household, Cleaned Data, Without Zero WTP Observations*

DATA	SB-DC MODEL	DB-DC MODEL
With Children (N=215)	2.141	2.037
Without Children (N=356)	2.111	2.027

We were also interested in the influence of respondents' age on WTP. Table 12 shows that the variable *AGE* is positively associated with WTP according to the SB-DC model and negatively according to the DB-DC model. In both cases, the corresponding coefficient is close to zero, and also not statistically significant. The p-value equals 0.488 (SB-DC model), respectively 0.934 (DB-DC model).

The estimated coefficient of the variable *INCOME* is positive, in accord with the theoretical expectation that higher-income respondents can afford higher quality products. However, the coefficient it is not significantly different from zero, with p-value ranging from 0.172 (SB-DC model) to 0.218 (DB-DC model).

Our results can confirm former findings that gender has an impact on WTP. The variable *MALE* has the expected negative sign, indicating that men are less willing to pay for safer ground beef "B". The estimated parameter is significant in the SB-DC model (p-value = 0.053), however not significant in the DB-DC model (p-value = 0.171). Table 14 shows that females are holding higher median WTP values for safer ground beef "B". Thus, median WTP is estimated as 2.034$/lb (1.978$/lb) for males, and 2.199$/lb (2.068$/lb) for females regarding the SB-DC (DB-DC) model. A significant difference could be confirmed by a Wald test (SB-DC model: Wald statistic = 5.632, p-value = 0.018; DB-DC model: Wald statistic = 6.677, p-value 0.010).

Table 14: *Median WTP Regarding the Gender, Cleaned Data, Without Zero WTP Observations*

DATA	SB-DC MODEL	DB-DC MODEL
Male (N=234)	2.034	1.978
Female (N=336)	2.199	2.068

There is no evidence that WTP varies with the employment status of the respondent. The coefficients of the dummy variables *EMP-PT*, *EMP-HOME*, and *RETIRED* are insignificant. The signs suggest that retired respondents and homemakers would place higher WTP values for safer ground beef, while part-time employed respondents are less willing to pay. In addition, the parameter of the variable *HOUSESIZE* is not significant, although the negative sign is consistent with our expectation, that larger households have a lower WTP. Education, finally, has also no statistically significant influence on WTP. If any, the positive sign suggest that higher educated people are placing higher WTP values for safer ground beef “B”.

8.2.2 Sensitivity of WTP to the Risk Reduction Technology

Another objective of this study is to evaluate whether WTP amounts differ between the risk reduction technologies irradiation and steam-pasteurization. To measure the effect of technology, WTP was regressed on the dummy variable *VERSION2-STEAM*, while controlling for factors regarding consumption habits, food safety perceptions, and individual characteristics of the respondents. The analysis was conducted using only observations with the risk reduction from 10/10,000 to 3/10,000, since only questionnaire versions with this risk reduction were constructed with the irradiation as well as the steam-pasteurization technology.

Table 15 presents the results of the SB-DC model and the DB-DC model. The coefficient of the variable *VERSION2-STEAM* has a value of –0.611, and -0.546 respectively. The negative signs indicate that median WTP is higher for irradiated ground beef. Since both models show a significance level of $\alpha < 0.1$ there is some evidence that respondents place higher value on the more efficient risk reduction technology irradiation.

Table 15: *Regression Results on VERSION2-STEAM, Cleaned Data, Without Zero WTP Observations, Observations with 10/10,000 to 3/10,000 Risk Change (N=155)*

		SB-DC MODEL			DB-DC MODEL		
		Estimate	T-Statistic	P-Value	Estimate	T-Statistic	P-Value
	Intercept	7.502	1.945	0.052	10.653	5.043	0.000
	B	4.335	2.366	0.018	5.349	7.180	0.000
Consump-tion Habits	HOME	-0.029	-0.589	0.556	-0.067	-1.424	0.155
	AWAY	-0.250	-0.057	0.954	0.005	0.121	0.903
	DONENESS	0.234	1.175	0.240	0.218	1.277	0.202
	CARELESS	-0.251	-0.660	0.509	-0.226	-0.689	0.491
Risk	FOODPOISYES	-0.101	-0.263	0.793	0.003	0.873	0.993
	WORRIED	0.260	1.027	0.304	0.236	1.106	0.269
Technology	VERSION2-STEAM	-0.611	-1.649	0.099	-0.546	-1.693	0.090
Demographics	HOUSESIZE	0.079	0.323	0.746	0.126	0.578	0.563
	KIDS	0.170	0.362	0.718	-0.062	-0.143	0.886
	MALE	-0.151	-0.355	0.723	-0.013	-0.037	0.970
	AGE	0.010	0.506	0.613	-0.431	-0.263	0.793
	EDU	0.241	1.045	0.296	0.214	1.077	0.281
	EMP-PT	-0.102	-0.145	0.885	0.249	0.389	0.697
	EMP-HOME	2.122	1.409	0.159	1.144	1.540	0.124
	RETIRED	0.209	0.317	0.751	0.404	0.740	0.459
	INC	-0.122	-0.989	0.323	-0.228	-2.155	0.031

Log likelihood: -100.24 — *McFadden R^2: 0.179* (SB-DC); *Log likelihood: -198.936* — *McFadden R^2: 0.151* (DB-DC)

To test this hypothesis, we also calculated the *median WTP* for each risk reduction technology by separating the data by irradiation or steam-pasteurization, and fitting to each sub-sample a model that included only the intercept and the price parameter.

Table 16 shows that according to the SB-DC model median WTP is about 2.087$/lb for irradiated, and 2.154$/lb for steam-pasteurized ground beef. These median WTP values are in contrast to previous regression results and reject our hypothesis that respondents place higher values for the irradiated product. The results of the DB-DC model are as expected, since median WTP is estimated higher for the irradiated product (2.062$/lb for irradiated and 2.040$/lb for steam-pasteurized ground beef). In both cases, Wald tests could not confirm any statistically significant association. For the SB-DC model the Wald statistic is equal to 0.128 (p-value = 0.721), for the DB-DC model the Wald statistic is equal to 0.360 (p-value = 0.549).

Table 16: *Median WTP Regarding the Risk Reduction Technology, Cleaned Data, Without Zero WTP Observations, Observations with 10/10,000 to 3/10,000 Risk Change*

DATA	SB-DC MODEL	DB-DC MODEL
Irradiation (N=91)	2.087	2.062
Steam-Pasteurization (N=106)	2.154	2.040

The earlier probit analysis suggested that rejection of the treated product was significantly higher when the treatment was irradiation. To illustrate the effect of this higher rejection rate, median WTP was also estimated for a sample including observations *with* zero WTP. The results, presented in Table 17, indicate a median WTP of $1.992/lb (1.958/lb) for irradiated and $2.055/lb (2.000) for steam-pasteurized ground beef calculated with the SB-DC (DB-DC) model. A Wald statistic could not confirm that median WTP is higher for steam-pasteurized ground beef; for the DB-DC model the p-value was 0.292 (Wald statistic was equal to 1.112)[16].

[16] For the SB-DC model the Wald statistic is equal to 0.839 (p-value = 0.360).

Table 17: *Median WTP Regarding the Risk Reduction Technology, Cleaned Data, Observations with 10/10,000 to 3/10,000 Risk Change*

DATA	SB-DC MODEL	DB-DC MODEL
Irradiation (N=117)	1.992	1.958
Steam-Pasteurization (N=114)	2.055	2.000

These results show that differences in consumer valuation between the different technologies are driven by the higher rejection rate for irradiation versus steam-pasteurization. For consumers accepting irradiation, WTP for its risk reduction benefits tend to be higher to that provided by steam-pasteurization. We caution, however, that this effect could *not* be fully confirmed by the analysis of median WTP. Taking into account consumers, who reject the treated product, WTP tends to be higher for steam-pasteurization than irradiation.

8.2.3 Sensitivity of WTP to Private Risk Reduction

Do respondents' WTP amounts for a collective risk reduction strategy depend on their private risk reduction strategy? To answer this question, one group of respondents received a reminder about private risk reduction possibilities – somewhat analogous to a reminder about their budget constraint, i.e., 'cheap-talk'.

To measure the effect of this cheap-talk sentence, a regression of WTP on the variable *VERSION1-TALK* was conducted. The associated sample included only observations with a risk reduction level from 10/10,000 to 1/10,000, since only this risk reduction level was paired with and without a cheap-talk sentence. Data cleaning and the reduction of zero WTP observations led to a final sample size of 153.

Table 18 shows that the variable *VERSION1-TALK* has, as expected, a negative sign and amounts for –0.600 regarding to the SB-DC model and –0.406 regarding to the DB-DC model. The coefficient is not significant in both models, however, for the SB-DC model the p-value is 0.118 and therefore close to a significance level of $\alpha < 0.1$. Thus, the reminder about private risk reduction – i.e., the availability of a substitute - appears to have a negative influence on WTP.

Table 18: *Regression Results on VERION1-TALK, Cleaned Data, Without Zero WTP Observations, Observations with 10/10,000 to 1/10,000 Risk Change (N=153)*

		SB-DC MODEL			DB-DC MODEL		
		Estimate	T-Statistic	P-Value	Estimate	T-Statistic	P-Value
	Intercept	4.985	1.343	0.179	8.555	4.224	0.000
	B	4.144	2.448	0.014	5.459	7.309	0.000
Consump-tion Habits	HOME	-0.062	-1.403	0.161	-0.074	-1.747	0.081
	AWAY	0.051	1.046	0.296	0.058	1.458	0.145
	DONENESS	0.643	2.704	0.007	0.546	2.654	0.008
	CARELESS	-0.300	-0.786	0.432	-0.386	-1.148	0.251
Risk	FOODPOISYES	-0.328	-0.802	0.422	-0.232	-0.669	0.503
	WORRIED	0.431	2.021	0.043	0.423	2.325	0.020
Technology	VERSION1-TALK	-0.600	-1.562	0.118	-0.406	-1.233	0.218
Demographics	HOUSESIZE	-0.139	-0.558	0.577	-0.258	-1.167	0.243
	KIDS	-0.157	-0.315	0.753	0.318	0.750	0.453
	MALE	-0.764	-1.801	0.072	-0.520	-1.422	0.155
	AGE	0.008	0.400	0.689	-0.002	-0.118	0.906
	EDU	0.379	1.667	0.096	0.242	1.231	0.218
	EMP-PT	-0.634	-0.750	0.453	-0.734	-1.033	0.301
	EMP-HOME	0.224	0.299	0.765	0.310	0.455	0.649
	RETIRED	-0.346	-0.492	0.622	0.063	0.103	0.918
	INC	0.135	1.141	0.254	0.120	1.107	0.268
		Log likelihood: - 97.574			*Log likelihood: -193.687*		
		McFadden R^2: 0.217			*McFadden R^2: 0.164*		

Table 19 shows that the median WTP is higher without a cheap-talk sentence. Thus, respondents' median WTP is about 2.188 (2.074) without cheap-talk and only about 2.011 (1.953) with cheap-talk regarding to the SB-DC (DB-DC) model. A Wald test - conducted with the DB-DC model - indicates significant differences in median WTP between the two sub-samples (Wald statistic =11.087; p-value = 0.001).[17].

Table 19: *Median WTP Regarding a Cheap-Talk Sentence, Cleaned Data, Without Zero WTP Observations, Observations with 10/10,000 to 1/10,000 Risk Change*

DATA	SB-DC MODEL[18]	DB-DC MODEL
Cheap-Talk (N=95)	2.011	1.953
No Cheap-Talk (N=98)	2.188	2.074

Overall, the results imply that respondents' WTP is significantly lower when they are aware of their possibilities of conducting a private risk reduction strategy. This association may indicate that trade-offs exist between the reduction of public risk and private risk in a sense that respondents are willing to pay less for a higher public safety, when they can reduce their risk at home and feel safe about the ground beef served in their own kitchen.

In this context we would also like to discuss the estimation results of the consumption habits variables (*HOME*, *AWAY*, *DONENESS*, and *CARELESS*). Table 12 shows that respondents' *at home* consumption of hamburgers is negatively related to WTP, while the *away* from home consumption is positively related. The coefficients of

[17] For the SB-DC model the Wald statistic was equal to 2.172 (p-value = 0.141).

[18] Median WTP was calculated by fitting to the sample (observations with 10/10,000 to 1/10,000 risk change) a model that included the intercept, the price parameter, and the variable *VERSION1-TALK*. This approach was chosen, since the price parameter between the sub-samples (with and without cheap-talk) was not significant different.

the variable *HOME* are significant at $\alpha < 0.1$ and equal –0.052 (SB-DC model), and –0.058 (DB-DC model) respectively; the coefficients of the variable *AWAY* are insignificant and lower in value (the *Probit model*, however, has shown that a higher away from home consumption decreases the probability of rejection of the treated product). The results suggest that respondents might differentiate between home and away from home consumption: at home respondents have the possibility of private risk reduction and they are therefore less likely willing to pay for public safety. Away from home consumers rely on a collective risk reduction strategy, and they are more likely willing to accept such. Again, this result might indicate that trade-offs exist between private and collective risk reduction.

Another variable that is directly connected to private risk reduction is *DONENESS (preferred level of doneness)*. Our results show that respondents who prepare hamburger to a high degree of doneness tend to pay more for safer ground beef "B". The coefficient of the corresponding variable *DONENESS* has a positive sign and is significant at $\alpha < 0.01$. The variable *DONENESS* is difficult to interpret, because manifold influences determine the coefficient sign. Some possible factors (taste, awareness of private risk reduction) influencing the variable *DONENESS* are discussed in chapter 7.3. According to our model, the positive sign of *DONENESS* implies that group 4 respondents (respondents which prepare hamburgers well-done - because of food safety reasons -, but actually prefer the taste of more medium hamburgers) have a strong positive impact on WTP. This group of respondents can be represented by the variable *PREFRARE*. Unfortunately, we could not test this variable because of data validity concerns. Preferred level of doneness might also depend on respondents' concerns about food safety. A correlation of 0.175 between the variables *DONENESS* and *WORRIED* (cp. Appendix 5) indicates that respondents, who prepare hamburgers to a high degree of doneness, are also more worried about food safety. According to this, the variable DONENESS would reflect the strong positive impact of the variable *WORRIED* on WTP. Overall, the possibilities to draw conclusion from variable *DONENESS* are limited due to the complexity of this variable.

The variable *CARELESS* is also related to private risk reduction, since it identifies respondents with careless raw-meat-handling behavior. Table 12 shows that the coefficient of *CARELESS* is close to a significance level of $\alpha < 0.1$ in the DB-DC model. The negative sign indicates that respondents with careless behavior are less willing to pay for safer ground beef "B". This finding is contrary to our previous assumption that trade-offs exist between private and public safety. One possible explanation is that the variable *CARELESS* identifies respondents who are less concerned about food safety.

8.2.4 Sensitivity of WTP to the Severity of the Risk

8.2.4.1 Sensitivity of WTP to Actual Differences in the Risk Reduction Level

Another goal of this study is to investigate whether WTP amounts are sensitive to the risk reduction level. Four different risk reduction levels were used in the survey (cp. chapter 6.1). Economic theory suggests that WTP increases with the size of the risk change. Thus, the 10/10,000 to 1/10,000 (*VERSION1*) risk change should yield a higher median WTP than the 10/10,000 to 3/10,000 (*VERSION2*) risk change and the 3/10,000 to 1/10,000 (*VERSION4*) risk change. Similarly median WTP for the 3/10,000 to 0/10,000 (*VERSION3*) should be higher than for the 3/10,000 to 1/10,000 (*VERSION4*).

To test for sensitivity, we first conducted a regression of WTP on the risk reduction variable *VERSION2*, whereby we hold *VERSION1* as the baseline risk (Table 20). The estimation results suggest that stated WTP amounts do *not* vary between the risk reduction of *VERSION1* and *VERSION2*. The estimated coefficient of *VERSION2* is relatively low in value and insignificant (p-value = 0.315, respectively 0.223). Furthermore, the sign is actually positive when theory suggests it should be negative.

Table 20: *Regression Results on VERSION2, Cleaned Data, Without Zero WTP Observations, Observations with 10/10,000 to 1/10,000, and 10,000 to 3/10,000 Risk Change, Irradiation Technology, and Without Cheap-Talk Sentence (N=146)*

		SB-DC MODEL			DB-DC MODEL		
		Estimate	T-Statistic	P-Value	Estimate	T-Statistic	P-Value
	Intercept	5.615	1.336	0.182	9.722	4.693	0.000
	B	3.636	1.835	0.066	5.152	6.233	0.000
Consump-tion Habits	HOME	-0.090	-1.718	0.086	-0.101	-2.314	0.021
	AWAY	0.088	1.395	0.163	0.078	1.544	0.123
	DONENESS	0.112	0.518	0.604	0.014	0.075	0.941
	CARELESS	-0.753	-1.878	0.060	-0.477	-1.429	0.153
Risk	FOODPOISYES	-0.249	-0.603	0.546	-0.095	-0.276	0.782
	WORRIED	0.502	1.741	0.082	0.478	2.119	0.034
Technology	VERSION2	0.411	1.006	0.315	0.397	1.219	0.223
Demographics	HOUSESIZE	-0.056	-0.191	0.849	-0.061	-0.260	0.795
	KIDS	-0.106	-0.195	0.846	0.057	0.133	0.894
	MALE	-0.757	-1.512	0.130	-0.349	-0.877	0.381
	AGE	0.012	0.542	0.588	-0.002	-0.088	0.930
	EDU	0.307	1.280	0.200	0.190	1.018	0.309
	EMP-PT	-0.561	-0.821	0.411	-0.135	-0.230	0.818
	EMP-HOME	1.197	1.206	0.228	0.325	0.480	0.631
	RETIRED	-0.101	-0.138	0.890	0.338	0.563	0.573
	INC	0.118	0.881	0.378	0.018	0.170	0.865

Log likelihood: -89.099 *McFadden R^2: 0.224*

Log likelihood: -187.221 *McFadden R^2: 0.159*

We also regressed WTP on the risk reduction variable *VERSION4 (*3/10,000 to 1/10,000) with *VERSION3 (*3/10,000 to 0/10,000) as the baseline risk (Table 21). Here we expect respondents to value the reduction from 3 cases to 1 case lower than an elimination of the risk and thus expect a negative coefficient on *VERSION4*. In fact, the estimated parameter has the expected negative sign and is also statistically significant (p-value = 0.043, respectively 0.052).

Table 21: *Regression Results on VERSION4, Cleaned Data, Without Zero WTP Observation, Observations with 3/10,000 to 0/10,000, and 3/10,000 to 1/10,000 Risk Change, Irradiation Technology, and without Cheap-Talk Sentence (N=140)*

		SB-DC MODEL			DB-DC MODEL		
		Estimate	T-Statistic	P-Value	Estimate	T-Statistic	P-Value
	Intercept	7.461	2.030	0.042	9.381	4.463	0.000
	B	4.254	2.308	0.021	5.545	6.360	0.000
Consumption Habits	HOME	-0.065	-1.201	0.230	-0.024	-0.571	0.568
	AWAY	-0.025	-0.431	0.667	-0.034	-0.706	0.480
	DONENESS	0.254	1.218	0.223	0.241	1.335	0.182
	CARELESS	-0.088	-0.225	0.822	-0.423	-1.276	0.202
Risk	FOODPOISYES	-1.109	-2.405	0.016	-0.805	-2.108	0.035
	WORRIED	0.774	2.903	0.004	0.840	3.884	0.000
Technology	VERSION4	-0.879	-2.028	0.043	-0.687	-1.941	0.052
Demographics	HOUSESIZE	-0.195	-0.880	0.379	-0.332	-1.672	0.095
	KIDS	0.975	2.350	0.019	1.063	2.818	0.005
	MALE	-0.621	-1.343	0.179	-0.374	-1.017	0.309
	AGE	0.008	0.448	0.654	0.005	0.328	0.743
	EDU	0.017	0.086	0.932	-0.021	-0.133	0.895
	EMP-PT	-0.713	-0.990	0.322	-0.376	-0.577	0.564
	EMP-HOME	-0.248	-0.234	0.815	-0.209	-0.264	0.791
	RETIRED	1.152	1.540	0.124	0.957	1.743	0.081
	INC	0.171	1.325	0.185	0.285	2.585	0.010

Log likelihood: -88.524 *McFadden R^2: 0.236*

Log likelihood: -174.897 *McFadden R^2: 0.194*

Table 22 presents the median WTP for the different risk levels. According to this, median WTP for *VERSION1* was 2.143$lb (2.074$/lb), for *VERSION2* 2.172$/lb

(2.062$/lb), for *VERSION3* 2.257$/lb (2.099$/lb) and for *VERSION4* 2.099$lb (1.987$lb) according to the SB-DC model (DB-DC model).

Respondents, who received the *VERSION1* risk reduction scenario, had therefore a lower/higher median WTP than those who received the *VERSION2* scenario regarding the SB-DC/DB-DC model. Anyway, Wald tests could not confirm that median WTP is statistically different between the two risk reduction levels (SB-DC model: test statistic = 0.114, p-value = 0.735; DB-DC model: test-statistic = 0.391, p-value= 0.532).

Median WTP amounts of respondents faced with *VERSION3* are in both models higher than of respondents faced with *VERSION4*. The Wald statistic for the null hypothesis of no difference between these two median WTP values is 8.380 for the DB-DC model (p-value = 0.004)[19]. Our results are therefore sensitive to scope regarding these two risk reduction levels. We are also interested if WTP amounts are *proportional* to the size of the risk reduction (cp. chapter 5.2.3). *VERSION3* has a 3 in 10,000 (from 3/10,000 to 0/10,000) risk reduction, *VERSION4* a 2 in 10,000 (from 3/10,000 to 1/10,000). The *VERSION3* risk reduction is therefore 1.5 times greater than the *VERSION4*. Our results indicate, however, that the price premium for the *VERSION3* risk reduction is less than 1.5 times the price premium for the *VERSION4* risk reduction (a Wald statistic of 33.830 rejects the null hypothesis of proportionality; p-value = 0.000). WTP is therefore *not* proportional to the size of the risk reduction.

Overall, there is evidence that the estimation results are sensitive to the size of the risk reduction between *VERSION3* and *VERSION4*, but not significant different between *VERSION1* and *VERSION2*. The question is why respondents *only* recognize risk change

[19] For the DB-DC model the Wald statistic was equal to 4.779 (p-value = 0.029).

differences between *VERSION3* and *VERSION4* as significant. It could be the case that respondents add a special value for the cancellation of the last unit of risk, and therefore for the *VERSION3* risk reduction. Zeckhauser (1986) already pointed out that consumers value the elimination of the last unit of risk more than the penultimate unit.

Table 22: *Median WTP Regarding the Risk Reduction Level, Cleaned Data, Without Zero WTP Observations*

DATA	SB-DC MODEL[20]	DB-DC MODEL
VERSION1 (10/10,000 to 1/10,000) (N=98)	2.143	2.074
VERSION2 (10/10,000 to 3/10,000) (N=91)	2.172	2.062
VERSION3 (3/10,000 to 0/10,000) (N=82)	2.257	2.099
VERSION4 (3/10,000 to 1/10,000) (N=99)	2.099	1.987

8.2.4.2 Sensitivity of WTP to the Perceived Risk of Food Poisoning

Sensitivity of WTP to variation in the magnitude of risk magnitude might be reduced if respondents base their WTP amounts on their own beliefs rather than on the actual risk information provided in the scenario (cp. chapter 5.2.3). One of the goals of the study was therefore to test whether WTP is sensitive to the *perceived risk* of food poisoning.

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[20] Median WTP was calculated by combining observations of *VERSION1* and *VERSION2* (*VERSION3* and *VERSION4*) and fitting to each sample a model that included the intercept, the price parameter, and the variable *VERSION2* (*VERSION4* respectively). This approach was chosen, since the price parameter between the sub-samples (*VERION1 – VERSION4*) was not significant different.

We hypothesized different variables to be associated with respondents' risk perception: (a) former experience of food poisoning (*FOODPOI-NO*, *FOODPOISYES*, *CONFIRMED*, *HOSPITAL*), (b) respondents' worriedness to receive a food related illness (*WORRIED*), and (c) the stated likelihood to become seriously ill from food poisoning (*UNDERESTIMATE*, *OVERESTIMATE*).

Returning to Table 12, the experience of food poisoning (either personal experience or those of a close family member), tends to lower respondents' WTP as indicated by the negative parameter sign of the variable *FOODPOISYES*. We point out, however, that respondents' WTP is not affected if the respondent experienced a more severe case of food poisoning: either a confirmed case of food poisoning or a severe food poisoning that resulted in hospitalization. Thus, the variables *CONFIRMED* and *HOSPITAL* were both *not* significant (cp. Table 11) and excluded from the estimation.

The effect of former experience of food poisoning on WTP is contrary to our expectations. The results suggest that personal experience of a *mild case* of food poisoning is negatively related to WTP. Henson (1996) reported similar results and discussed two factors that might explain this phenomenon. First, consumers might have a rather distorted concept of probability; they might believe that having suffered from food poisoning in the relatively recent past reduces the chance that they will suffer food poisoning in the future. Second, those respondents who had recently experienced a *mild* food poisoning might have given less weight to the probability of suffering *moderate*, or *severe* food poisoning and consequently were willing to pay less.

The variable *WORRIED* also provides information about respondents' attitude or perception of food related risks. Table 12 shows that *WORRIED* has a significant effect on WTP ($\alpha < 0.01$). The positive sign of the coefficient implies that, as expected, a higher worriedness about getting a food related illness increases WTP.

However, there is no significant association between the variable *UNDERESTIMATE* as well as *OVERESTIMATE* and respondents' WTP. Both models report the coefficients of both variables as highly insignificant (Table 11).

Our results cannot therefore fully confirm Giamalva's *et al.* (1997) finding that the perceived chance of contracting a foodborne disease has an effect on WTP. Our results suggest that respondents' subjective or general worriedness to receive a food related has a strong impact on WTP. However, respondents' stated numerical values of the chance to get seriously ill did not have any effect on WTP.

8.3 Estimation of Median WTP

Median WTP was computed by fitting to the sample a model that included only the intercept and the price parameter (cp. chapter 7.1). Two estimation methods were used: The SB-DC model and the DB-DC model. The calculated median WTP is based on a sample size of 718 (reduced from 819 by incomplete responses and data cleaning). We also computed median WTP for a sub-sample of 571 that did not take into account observations with zero WTP.

Table 23 shows that the overall median WTP was 1.95$/lb according to the SB-DC model, and 1.91$/lb according to the DB-DC model. Since the price of the standard product was given as 1.69$/lb, respondents are on average willing to pay a premium of 26 cent/lb, respectively of 22 cent/lb for relatively safer ground beef "B".

Without zero WTP observations, the median WTP amounts to 2.13$/lb according to the SB-DC model, and 2.03$/lb according to the DB-DC model. This is equal to a price premium of 44 cent/lb, respectively 34 cent/lb. The price premium estimates are fairly with in the range of Fingerhut's *et al.* (2001) findings; they reported an average WTP for irradiated beef of 36 cents/lb.

Table 23: *Median WTP for Treated Ground Beef*

DATA	SB-DC MODEL	DB-DC MODEL
Cleaned Data (N=718)	1.95	1.91
Cleaned Data, without zero WTP observations (N=571)	2.13	2.03

9 Conclusions

We conducted a CV study by sending a consumer survey to 3,000 households in eight different states (CO, NE, KA, OK, IA, MO, AR and WY). The overall response rate on the survey was 28 % (819 returned, 71 undeliverable).

Our goal was to examine the demand for the risk reduction from foodborne pathogens. In particular we focused our analysis on the value respondents would place for a reduced risk from *E. Coli* and *Salmonella* in ground beef. In this context, the study explored (a) median WTP for risk reduction from alternative technologies (irradiation and steam-pasteurization); (b) whether private protective actions (care in cooking and handling) influence WTP for irradiation or pasteurization; (c) whether "who" is at risk (adults or children) influences preferences; and (d) whether preferences for risk reduction vary with the severity of the risk.

Several interesting findings emerged from our CV study. First we identified reasons for the acceptance/rejection of irradiated or steam-pasteurized ground beef. Our results show a significant association between the acceptance rate and the risk reduction technology, the number of times the respondent eats ground beef away from home as well as the existence of children under 6 years in the household: (a) probability of zero WTP is significantly higher, if irradiation is used as the risk reduction technology, indicating that consumers are more suspicious of irradiated than steam-pasteurized ground beef; (b) a higher away from home consumption of ground beef increases the acceptance of irradiated or steam-pasteurized ground beef. The results might indicate that the limited possibility of conducting a private risk reduction strategy away from home, results in a higher acceptance of a collective risk reduction strategy; (c) households with children under 6 years tend to have a higher level of acceptance.

The WTP analysis showed that respondents were on average willing to pay a price premium ranging from 22 cent/lb to 26 cent/lb (depending on the estimation method) for safer (irradiated or steam-pasteurized) ground beef.

There is no evidence that WTP is related to "who" is at risk. Although our results - as previous mentioned - indicate that households with children under the age of 6 have a higher acceptance of irradiated or steam-pasteurized ground beef, they do not support the hypothesis that respondents are also willing to pay more.

We also can conclude that the risk reduction technology might have an effect on WTP. As mentioned before, steam-pasteurization has a higher acceptance rate, but consumers, who accept irradiation, tend to value the more effective irradiation technology higher.

We found that the results regarding to the sensitivity of WTP to the magnitude of the risk reduction were ambiguous. WTP was insensitive to scope between a 9 in 10,000 (from 10/10,000 to 1/10,000) and a 7 in 10,000 (from 10/10,000 to 3/10,000) risk reduction. However, WTP was significantly related to the scope or magnitude of the risk reduction between a 3 in 10,000 (from 3/10,000 to 0/10,000) and 2 in 10,000 (from 3/10,000 to 1/10,000) risk reduction, although it varied less than proportionately to the risk increment. The magnitudes of the risk reduction of both sub-samples were similar, but with the difference that the 3 in 10,000 risk reduction resulted in the elimination of the risk. This might explain the different outcome: respondents might add a special value to cancel the last unit of risk.

Our results indicate that WTP amounts were influenced by private protective actions. Thus WTP was significantly lower for respondents, which were aware of their possibilities of conducting a private risk reduction strategy. The results indicate that trade-offs exist between public and private risk reduction. However, our study has at this point several limitations. One variable, designed to elicit directly trade-offs between private and public risk reduction, could not be used, because of data-validity concerns. In addition trade-offs seem not to take place for all respondents groups. Respondents, which are careless in the handling of raw meat, for example have different than expected a lower WTP. Thus, careless respondents (which have a low private risk reduction) seem to treat public risk reduction as a complement.

For further research it would be worthwhile to confirm our results in actual experimental-auction settings or grocery store trials. A direct comparison of values elicited in hypothetical to non-hypothetical settings would strengthen the results.

10 References

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11 Appendix

Appendix 1: *Complete Version of a Questionnaire used in the Mail Survey*

CONSUMER FOOD SAFETY SURVEY

Version**1.1**

KANSAS STATE UNIVERSITY – DEPARTMENT OF AGRICULTURAL ECONOMICS

(To be completed by the person who is most responsible for purchasing food in your household.)

We are interested in your perceptions and opinions about the safety of foods we eat - particularly hamburgers. This survey is in multiple-choice and fill-in-the-blank format and will take only 7-8 minutes to complete. Please return it in the enclosed postage paid envelope.

GROUND BEEF AND HAMBURGERS

1. How often do you or your family consume ground beef or hamburgers *(Please fill in the blank)*

a) at home?	______ *times per week*	**or**	______ *times per month*
b) away from home?	______ *times per week*	**or**	______ *times per month*

2. How do you typically prepare hamburgers *(Please circle)*

a) for yourself?	*Rare*	*Medium rare*	*Medium*	*Medium well*	*Well done*
b) for a 5-year-old child?	*Rare*	*Medium rare*	*Medium*	*Medium well*	*` Well done*

3. Do you ever forget to wash your hands before and after handling raw meat? *(Please circle)*

Never forget *Sometimes forget* *Usually forget*

4. Do you ever forget to refrigerate left-overs immediately after a meal? *(Please circle)*

Never forget *Sometimes forget* *Usually forget*

Ground beef can be contaminated with bacteria such as E. coli and Salmonella. These bacteria can cause food poisoning and in some cases death.

5. **How would you prepare hamburgers that were <u>guaranteed not to be contaminated</u> with any disease causing bacteria** *(Please circle)*

a) for yourself?	*Rare*	*Medium rare*	*Medium*	*Medium well*	*Well done*
b) for a 5-year-old child?	*Rare*	*Medium rare*	*Medium*	*Medium well*	*Well ` done*

Typical symptoms of food-poisoning include abdominal pain, nausea, vomiting and diarrhea. Severe cases can result in death.

6. **Have you, or any member of your close family, ever had food poisoning?** *(Please circle)*

Yes *No* *Don't know*

7. **If your response to 6) was '*Yes*', was food-poisoning <u>confirmed</u> as the cause of illness?** *(Please circle)*

Yes *No*

8. **If your response to 6) was '*Yes*', did the illness result in <u>hospitalization</u>?** *(Please circle)*

Yes *No*

9. **How worried are you about getting a food related illness?** *(Please circle)*

Not at all worried *Seldom worried* *Moderately worried* *Quite a bit worried* *Very worried*

Next we would like your opinion about the <u>risk of becoming seriously ill</u> as a result of food poisoning. The following table presents information about the risk of serious illness or injury from different events.

	Hospital/ER treatments per 100,000 people
Accidental falls	**2,700**
Auto accidents	**1,390**
Residential fire	**149**
Dog bites	**126**
Lyme disease	**6**
Lightning	**0.13**

The table shows that 2,700 individuals out of every 100,000 receive hospital or emergency room (ER) treatment for accidental falls in an average year. At the other end of the scale, lightning results in hospital treatment for fewer than 1 individual per 100,000 each year.

10. How many people per 100,000 do you believe receive hospital or emergency room treatment each year <u>as a result of food poisoning</u>? ***(Please fill in the blank)***

______ yearly hospital/emergency room treatments per 100,000 people.

FOOD SAFETY CHOICES

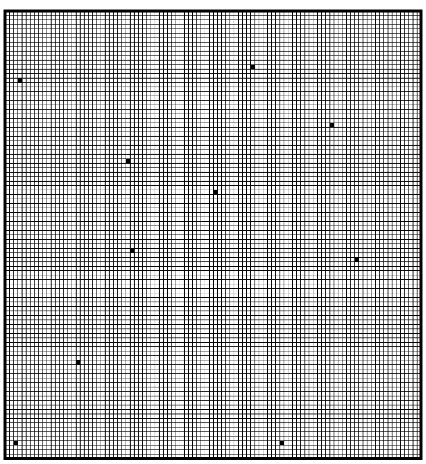
Please read the following information and answer the question below.

Imagine that your local supermarket sells two types of ground beef: “A” and “B”. Both have the same appearance and have the same nutritional value. They differ only in how they are produced.

Ground beef “A” (Standard product)

❖ Ground beef “A” is manufactured using a standard, government-mandated procedure to prevent contamination with bacteria. This procedure monitors and controls each step of the production process.

❖ Scientists estimate that for 10,000 average consumers, ground beef “A” would cause 10 serious illnesses in a period of 10 years.

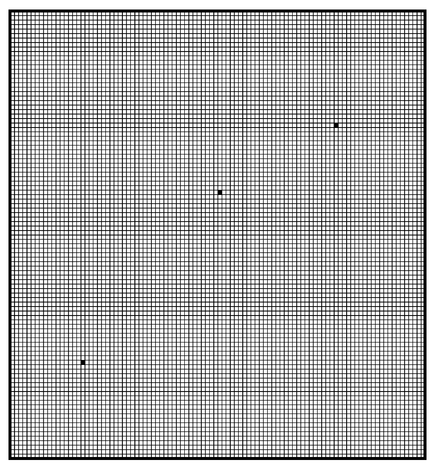


Risk of illness from ground beef “A”
The grid contains 10,000 squares, with 10 squares shaded to represent the number of illnesses in a 10-year period.

Ground beef “B” (Irradiated)

❖ Ground beef “B” is manufactured in exactly the same way as ground beef “A”, but it has also been irradiated to kill bacteria. Irradiation is a process that can be used to kill Salmonella, E. coli, and other harmful bacteria on meats and other foods.

❖ Scientists estimate that for 10,000 average consumers, ground beef “B” would cause 3 serious illnesses in a period of 10 years.



Risk of illness from ground beef “B”
The grid contains 10,000 squares, with 3 squares shaded to represent the number of illnesses in a 10-year period.

11. If the price of the standard product (A) and the irradiated product (B) were the same, which one would you choose? *(Mark only one response and follow the instructions by your response)*

_____ *I would choose Standard ground beef “A” (Please go to #15)*
_____ *I would choose Irradiated ground beef “B” (Please go to the next page)*

Please answer #12 and, depending on your response, either #13 or #14.

Ground beef "A" (Standard product)

Risk: 10 illnesses per 10,000 consumers in 10 years.

Ground beef "B" (Irradiated)

Risk: 3 illnesses per 10,000 consumers in 10 years.

12. If you could choose between the standard product (A) at $1.69 per pound, or the irradiated product (B) at $1.79 per pound every time you purchased ground beef, which one would you buy? *(Mark only one response and follow the instructions by your response)*

_____ *I would always choose Standard ground beef "A" at $ 1.69 per pound* _____ *I think I would usually choose Standard ground beef "A" at $ 1.69 per pound* _____ *I'm not sure which one I would choose*	Go to #13, do not answer #14
_____ *I think I would usually choose Irradiated ground beef "B" at $1.79 per pound* _____ *I would always choose Irradiated ground beef "B" at $1.79 per pound*	Go to #14, do not answer

13. If you could choose between the standard product (A) at $1.69 per pound, or the irradiated product (B) at $1.74 per pound every time you purchased ground beef, which one would you buy? *(Mark only one response and follow the instructions by your response)*

_____ *I would always choose Standard ground beef "A" at $ 1.69 per pound* _____ *I think I would usually choose Standard ground beef "A" at $ 1.69 per pound* _____ *I'm not sure which one I would choose* _____ *I think I would usually choose Irradiated ground beef "B" at $1.74 per pound* _____ *I would always choose Irradiated ground beef "B" at $1.74 per pound*	Please go to the next page

14. If you could choose between the standard product (A) at $1.69 per pound, or the irradiated product (B) at $1.89 per pound every time you purchased ground beef, which one would you buy? *(Mark only one response and follow the instructions by your response)*

_____ *I would always choose Standard ground beef "A" at $ 1.69 per pound* _____ *I think I would usually choose Standard ground beef "A" at $ 1.69 per pound* _____ *I'm not sure which one I would choose* _____ *I think I would usually choose Irradiated ground beef "B" at $1.89 per pound* _____ *I would always choose Irradiated ground beef "B" at $1.89 per pound*	Please go to the next page

DEMOGRAPHIC DATA FOR STATISTICAL PURPOSES

15. How many people including yourself live in your household? *(Please fill in the blank)*

______ *People*

16. Are there any children in your household *(Please circle)*

a) under age 6?	*Yes*	*No*
b) between 6 and 18?	*Yes*	*No*

17. What is your gender? *(Please circle)*

Male *Female*

18. What year were you born? *(Please fill in the blank)*

Year _______

19. What is the highest level of education you have completed? *(Please circle)*

Some high school	*High school graduate*	*Some college*
College graduate	*Post graduate*	

20. What is your current employment status? *(Please circle)*

Employed full time	*Employed part-time*	*Unemployed*
Homemaker	*Self-employed*	*A full time student*
Retired	*Other (Please indicate)* _______	

21. In which area do you live? *(Please circle)*

Rural	*City from 1,000 to 60,000*	*City with more than 60,000*

22. What is your annual household income before taxes? *(Please circle)*

Less than $ 20,000	*$ 20,000 - $ 30,000*	*$ 30,000 - $ 40,000*
$ 40,000 - $ 50,000	*$ 50,000 - $ 70,000*	*$ 70,000 - $ 100,000*
more than $ 100,000		

Your response to this survey is greatly appreciated. Please check the survey to ensure that you have answered all of the questions. We have provided a postage paid envelope for you to return the completed survey. If you would like a copy of the results of this survey, please enclose a business card or a separate sheet of paper with your name and complete mailing address.

Appendix 2: *Distribution of Responses to Initial and Follow-up Questions*

BID STRUCTURE	DISTRIBUTION OF RESPONSES (%)									
	no-1	no-2	no-3	no-4	no-5	yes-1	yes-2	yes-3	yes-4	yes-5
RISK1IR (10 to 1)										
1.79, 1.74, 1.89	3.8	0.0	15.4	7.7	0.0	0.0	7.7	7.7	15.4	42.3
1.89, 1.79, 1.99	5.0	10.0	5.0	5.0	0.0	0.0	5.0	15.0	25.0	30.0
1.99, 1.89, 2.09	10.7	10.7	17.9	0.0	0.0	0.0	7.1	7.1	32.1	14.3
2.09, 1.99, 2.19	13.0	13.0	8.7	0.0	0.0	4.3	0.0	8.7	34.8	17.4
VERSION1-TALK (10 to 1)										
1.79, 1.74, 1.89	3.4	10.3	3.4	10.3	0.0	0.0	6.9	6.9	34.5	24.1
1.89, 1.79, 1.99	4.8	33.3	4.8	4.8	0.0	4.8	4.8	4.8	23.8	14.3
1.99, 1.89, 2.09	4.5	18.2	18.2	4.5	0.0	0.0	13.6	22.7	13.6	4.5
2.09, 1.99, 2.19	26.1	13.0	8.7	8.7	4.3	0.0	4.3	0.0	17.4	17.4
VERSION2 (10 to 3)										
1.79, 1.74, 1.89	0.0	0.0	0.0	0.0	0.0	0.0	9.1	9.1	50.0	31.8
1.89, 1.79, 1.99	0.0	14.3	0.0	19.0	0.0	4.8	14.3	9.5	19.0	19.0
1.99, 1.89, 2.09	0.0	20.0	24.0	8.0	0.0	0.0	4.0	12.0	28.0	4.0
2.09, 1.99, 2.19	0.0	13.0	4.3	17.4	0.0	0.0	0.0	8.7	30.4	26.1
VERSION2-STEAM (10 to 3)										
1.79, 1.74, 1.89	0.0	12.0	8.0	8.0	0.0	0.0	12.0	12.0	28.0	20.0
1.89, 1.79, 1.99	9.7	3.2	9.7	6.5	3.2	0.0	3.2	9.7	25.8	29.0
1.99, 1.89, 2.09	0.0	13.0	17.4	4.3	0.0	0.0	4.3	8.7	21.7	30.4
2.09, 1.99, 2.19	8.0	24.0	16.0	0.0	0.0	0.0	0.0	4.0	28.0	20.0
VERSION3 (3 to 0)										
1.79, 1.74, 1.89	0.0	10.3	17.2	3.4	0.0	0.0	13.8	10.3	27.6	17.2
1.89, 1.79, 1.99	0.0	8.3	12.5	12.5	0.0	0.0	8.3	8.3	29.2	20.8
1.99, 1.89, 2.09	23.8	14.3	9.5	0.0	0.0	0.0	0.0	14.3	14.3	23.8
2.09, 1.99, 2.19	16.0	8.0	12.0	12.0	0.0	0.0	0.0	16.0	8.0	28.0
VERSION4 (3 to 1)										
1.79, 1.74, 1.89	4.3	8.7	4.3	4.3	0.0	0.0	13.0	8.7	34.8	21.7
1.89, 1.79, 1.99	0.0	5.9	5.9	11.8	0.0	0.0	11.8	0.0	23.5	41.2
1.99, 1.89, 2.09	4.8	28.6	9.5	0.0	0.0	0.0	4.8	14.3	14.3	23.8
2.09, 1.99, 2.19	0.0	28.6	4.8	0.0	0.0	0.0	0.0	4.8	38.1	23.8

Appendix 3: *Discussion of the Probit Model*

The Probit model can defined as:

$$Y_i^* = \beta' X_i + \varepsilon_i$$

Y_i^* is an unobservable variable. The observed dichotomous choice variable is related to Y_i^* in the following manner:

$$Y_i = 0 \text{ if } Y_i^* \leq 0$$

$$Y_i = 1 \text{ if } Y_i^* > 0$$

$Y_i = 1$, if the respondent reported a preference for ground beef "B"; $Y_i = 0$, if the respondent has a zero WTP. β is a coefficient vector, X_i is a vector of explanatory variables, and ε_i is a random error with $\varepsilon_i \approx N[0,1]$.

Appendix 4: *Probit Model: Maximum Likelihood Estimates*

	VARIABLE	ESTIMATE	T-STATISTIC	P-VALUE
	Intercept	-0.006	-0.009	0.993
Consump-tion Habits	HOME	-0.006	-0.410	0.682
	AWAY	0.064	3.057	0.002
	DONENESS	0.094	1.373	0.170
	CARELESS	0.107	0.836	0.403
	PREFRARE	0.034	0.201	0.841
Risk Perception	FOODPOI-UNSURE	0.032	0.178	0.859
	FOODPOI-YES	0.022	0.109	0.914
	CONFIRMED	0.191	0.848	0.397
	HOSPITAL	0.469	1.077	0.281
	WORRIED	0.093	1.221	0.222
	UNDERESTIMATE	0.164	0.759	0.448
	OVERESTIMATE	0.089	0.649	0.516
Risk Reduction	VERSION1-TALK	0.075	0.346	0.729
	VERSION2-STEAM	0.786	2.897	0.004
	VERSION2	-0.119	-0.562	0.574
	VERSION3-	-0.176	-0.850	0.395
	VERSION4	-0.178	-0.872	0.383
Demographics	HOUSESIZE	-0.129	-1.518	0.129
	KIDU6	0.407	1.759	0.079
	KID618	0.189	0.896	0.371
	MALE	-0.003	-0.024	0.981
	AGE	0.004	0.554	0.580
	EDU1	0.062	0.171	0.865
	EDU2	-0.049	-0.132	0.895
	EDU3	0.020	0.053	0.958
	EDU4	0.180	0.461	0.645
	EMP-PT	-0.335	-1.505	0.132
	EMP-HOME	-0.404	-1.538	0.124
	EMP-SELF	-0.266	-1.152	0.249
	RETIRED	-0.254	-1.117	0.264
	SMALLCITY	0.072	0.440	0.660
	LARGECITY	0.312	1.760	0.079
	INC	0.007	0.171	0.864

Log-Likelihood: -270.382

Appendix 5: *Correlation Matrix*

	HOME	AWAY	DONENESS	CARELESS	FOODPOI-YES	WORRIED	VERSION1-TALK	VERSION2-STEAM	VERSION2	VERSION3
HOME	1.000									
AWAY	0.289	1.000								
DONENESS	0.026	-0.037	1.000							
CARELESS	0.079	-0.019	-0.113	1.000						
FOODPOI YES	-0.009	0.066	-0.042	-0.047	1.000					
WORRIED	0.009	0.067	0.172	-0.114	0.103	1.000				
VERSION1-TALK	0.014	-0.034	0.041	0.014	-0.045	0.010	1.000			
VERSION2-STEAM	0.002	0.033	-0.010	-0.023	-0.019	-0.019	-0.212	1.000		
VERSION2	-0.022	0.042	0.022	-0.001	-0.001	-0.021	-0.190	-0.205	1.000	
VERSION3	-0.014	-0.062	-0.037	-0.082	0.068	-0.023	-0.186	-0.200	-0.179	1.000
VERSION4	0.042	0.023	-0.064	0.101	-0.005	0.035	-0.201	-0.217	-0.194	-0.190
HOUSESIZE	0.178	0.140	-0.057	0.004	0.060	-0.018	-0.051	0.005	-0.038	0.013
KIDS	0.164	0.180	-0.045	-0.010	0.013	-0.053	-0.094	-0.052	0.024	0.016
MALE	0.005	0.155	-0.194	0.095	0.055	-0.027	0.004	0.018	-0.027	-0.003
AGE	-0.080	-0.267	0.116	-0.052	-0.151	0.061	0.091	-0.034	0.021	-0.012
EDU	-0.072	0.063	-0.157	0.018	0.247	-0.114	-0.039	0.024	-0.060	0.005
EMP-PT	-0.038	0.001	0.032	-0.112	0.057	-0.018	-0.065	-0.039	0.023	0.049
EMP-HOME	0.076	0.028	0.024	-0.030	0.017	0.048	0.026	0.049	0.012	-0.070
RETIRED	-0.042	-0.205	0.088	-0.029	-0.151	0.094	0.038	-0.029	0.028	0.024
INC	-0.078	0.056	-0.193	0.041	0.180	-0.145	-0.064	0.026	-0.036	0.059

	VERSION4	HOUSESIZE	KIDS	MALE	AGE	EDU	EMP-PT	EMP-HOME	RETIRED	INC
VERSION4	1.000									
HOUSESIZE	-0.034	1.000								
KIDS	-0.021	0.764	1.000							
MALE	0.033	0.046	0.010	1.000						
AGE	-0.030	-0.401	-0.462	0.024	1.000					
EDU	0.012	0.203	0.164	0.143	-0.216	1.000				
EMP-PT	0.010	0.105	0.105	-0.149	-0.090	0.113	1.000			
EMP-HOME	-0.020	0.121	0.096	-0.213	-0.051	-0.134	-0.076	1.000		
RETIRED	-0.069	-0.378	-0.359	0.065	0.688	-0.184	-0.151	-0.144	1.000	
INC	0.001	0.321	0.221	0.202	-0.258	0.457	0.024	-0.012	-0.320	1.000

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