# Which Consumers Are Most Responsive to Media-Induced Food Scares?

**Collin R. Payne, Kent D. Messer, and Harry M. Kaiser**

In understanding decreases in demand after exposure to media-induced food scares, aggregate data are almost exclusively presented without taking into consideration potential confounding variables. However, a better approach may be to use an experimental design coupled with targeting homogeneous willingness-to-pay (WTP) subgroups based on similarities in behavioral, psychological, and demographic characteristics of those who are most vulnerable to food scare information. This is accomplished through experimental economics and an analysis strategy called a classification and regression tree (CART). A stigma framework—which guides conceptual understanding of effects of media-induced food scares—suggests controlling contextual variables to better approximate ceteris paribus. To this end, we conducted an experiment that exposed people to information about mad cow disease and then asked them to bid their willingness-to-pay for an actual hamburger. The CART found distinct homogeneous WTP subgroups of individuals that could be used by government and industry professionals to create interventions to reduce potential consumer concern and producer losses.

***Key Words:*** food scare, media, classification and regression tree, mad cow disease, stigma

Past research has documented declines in consumer demand in response to media-induced food scares for virtually all commodities. Media-induced food scares are those in which significant decreases in demand occur in response to a sudden surge of negative media information about a product, even though the true risk of contracting the illness from the food was unchanged. This research considers the impact of food scares related to mad cow disease (bovine spongiform encephalopathy, or BSE) on beef demand. Mad cow disease in cattle has been linked, through consumption of beef, to new variant Creutzfeldt-Jakob disease (nvCJD) —a fatal and incurable neurological disorder in humans. Because of this connection with nvCJD, a surge of negative media information about a possible mad cow disease outbreak may stigmatize beef consumption such that consumer demand falls and thus prices decline. For example, a 40 percent decrease in beef prices occurred in Great Britain—where news of the first mad cow disease outbreaks occurred (English, Menard, and Jensen 2004)—and cattle prices in Canada decreased 65 percent when similar reports surfaced there (Collins 2005). Conclusions from these and other studies suggest that, for "the average person," exposure to mad cow disease information significantly reduces beef demand.

In almost all previous studies, food-scare-induced decreases in demand have been measured in the population aggregate without taking into consideration potential confounding variables such as context (e.g., Kerr 2003). A great deal of useful information, for example, has been gathered by surveying large populations of individuals assessing risk perceptions of real or scenario-based food scares. These studies have resulted in identifying general consumer demographic (Dosman, Adamowicz, and Hrudey 2001, Angulo and Gil 2007, McCarthy and Henson 2005, de Jonge et al. 2007); behavioral (McCarthy et al. 2007, van Kleef

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et al. 2006, Berg 2004); and psychological differences (Wansink 2004, Lobb, Mazzocchi, and Trail 2007, Kuttschruter 2006) that may predict different demand responses to food safety scares. In addition, these studies—placed within the context of retrospective and historical analyses of actual consumer responses to food scares (see Scholliers 2008, Atkins 2008, Terrangi 2006, Wales, Harvey, and Warde 2006, Verbeke 2001, Miles and Frewer 2001, Setbon et al. 2005, Cuite et al. 2007)—have provided tremendous guidance into likely processes of consumer demand following a food scare. Nevertheless, these studies are limited because they do not provide adequate controls to exclude alternative explanations, resulting in conclusions that may be confounded by variables that were allowed to vary instead of being held constant.

The purpose of the research is to examine whether there are homogeneous WTP subgroups based on behavioral, psychological, and demographic characteristics that respond differently to negative media information regarding mad cow disease. This study involves a nonstudent subject pool making willingness-to-pay (WTP) purchase decisions for a fresh hamburger at lunchtime, in one of two conditions: (1) a control treatment with no negative information; and (2) a negative information treatment related to the mad cow disease outbreak that occurred in the United States in December 2003. CART analysis is used to identify target homogeneous WTP subgroups based on the impact of mad cow information on consumers' WTP for a hamburger.

The rest of the paper is organized as follows. We begin with a discussion of a methodological framework for explaining consumer responses to food scares. We then describe the experimental methodology that was used to elicit WTP for beef after exposure to negative information about it, including the benefits of the CART analysis. Finally, we present a CART analysis, pinpointing subgroups of individuals who are most likely to reduce their demand for beef.

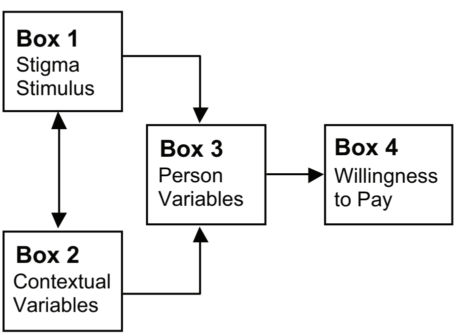


**Figure 1. Methodological Framework for Understanding Food Scares**

## A Methodological Framework for Explaining Consumer Reponse to Food Scares

Figure 1 illustrates a methodological framework for understanding how WTP for beef is impacted by the interaction of a stigma stimulus with the context in which it resides. Stigma, originally a psychological term, can be thought of as "a negative feature that typically pervades and dominates an otherwise acceptable entity" (Rozin 2004). In the context of beef, exposure to information that pairs mad cow disease with nvCJD may create a stigma effect on WTP. In this case, people exposed to a stigma stimulus (Box 1) (a hamburger) that has been paired with negative consequences (nvCJD)—what psychologists call classical conditioning—learn to avoid that stimulus. When studying stigma "in the field," however, it is difficult—if not impossible—to disentangle the stigma stimulus from multiple contexts in which people experience it.

This makes it challenging to determine whether results obtained are truly valid or skewed by unknown (or known) contextual variables (Box 2). Further complicating interpretation of aggregate data is the lack of information about which types of consumers are most vulnerable to food scares. This lack of information makes targeted interventions impossible. As a result, collection and analysis of data on individual characteristics is essential to mitigating potential economic misfortune generated by food scares—despite the lack of health threat—that lead to lower consumer demand for the product and to corresponding losses to producers (Box 3).

### *The Stigma Context (Boxes 1 and 2)*

The context in which people are exposed to food scare information can have a dramatic effect on their responses. As previously mentioned, mad cow disease information can be retracted, positive information about beef and the security of the food supply can be disseminated, and consumers have varying degrees of access to media reports. Simply reporting aggregate data on decreases in beef demand may only compound industry concerns about beef consumption without identifying why the decreases occur or the types of consumers that drive them (Pennings, Wansink, and Meulenberg 2002).

Because different (and similar) contexts affect people's WTP for beef in different ways, which makes the interpretation of aggregate data tenuous, one way to limit the effect of multiple contexts is to simulate exposure to food scares in controlled experiments. This way, multiple potential confounding variables can be controlled, allowing more confidence in the results obtained. The assurance, however, that the context in which exposure to information about stigmatized food is known does not provide information about how the context affects demand for that food in different types of people. Identifying differences among homogeneous WTP groups does.

*Person Variables (Box 3)*

Different types of people likely respond differently to food scare information. Understanding the psychographic, demographic, and behavioral variables—in combination or individually—that affect beef demand would help government and industry professionals focus on groups of individuals that would benefit most from targeted messages (such as food safety information or generic advertising) so that economic damage can be averted for entire industries. Consider the behavioral variable of consumers who either frequently or infrequently consume beef. After exposure to food scare information, how will the demand of those who frequently consume beef change compared to those who rarely do? For example, frequent consumers may be willing to pay less for beef because they may feel they are more vulnerable, or they may not change their consumption behavior since consuming beef is habitual. Consumers may even increase their willingness to pay in response to a food scare to try to support the industry or to reduce their fear by asserting their invulnerability (Witte and Allen 2000, Corneille et al. 2001).

In addition, what about other psychographic and demographic variables such as risk perception, gender, and education? Almost all of these "person" variables have been proposed in various studies as key to understanding groups that would be most vulnerable to food scare information (Herrmann, Warland, and Sterngold 1998, Pennings, Wansink, and Meulenberg 2002). Furthermore, how do these variables affect WTP for beef given the multiple unknown (and known) contexts in which food scare information can operate?

*A Better Methodological Approach*

Multiple confounding variables may intercede between when consumers are exposed to information in the real world and when researchers are able to collect information about consumer characteristics—making conclusions about "types" of vulnerable consumers tenuous. It may be, for example, that consumers who do not frequently consume beef further reduce their demand once exposed to food scare information. However, negative information can be retracted, positive information about beef can be disseminated, and consumers have varying degrees of access to media reports. As a consequence, consumers' post-scare beef consumption may appear to remain constant due to a myriad of possible real-world interactions, making the assumption of ceteris paribus impossible. Fortunately, behavioral and experimental economics offer a solution that better controls for multiple variables impacting consumer decision-making. This makes it possible to identify relatively homogeneous WTP subgroups of consumers who are vulnerable (or immune) to food scare information. As an example of this approach, Brown, Cranfield, and Henson (2005) collected demographic information of participants and randomly assigned them to receive different risk information. In both treatments, participants would bid—determined by specific auctions—on how much they would be willing to pay for reductions in risk. By manipulating different risk scenarios, it could be understood how specific types of consumers respond to risk information—ceteris paribus. Others, such as Lusk et al. (2001), Shogren et al. (1999), Fox et al. (1995), and Messer et al. (Forthcoming) further describe this experimental approach to understanding how types of consumers respond to food scare information that minimizes—if not eradicates—the influence of potential confounding variables.

Even if a researcher could achieve ceteris paribus through experimental methodologies, traditional analyses of experimental data reveal only the "average person" who is vulnerable (or immune) to food scare information. When considering multiple psychographic, demographic, and behavioral variables, however, the "average person" does not actually exist; that is, because interventions may interact with multiple variables in different ways, the likelihood of finding a large group representing the "average person" in a study population is quite small. This could be the reason, for example, why many have lamented the inadequacy of traditional "individual-as-the-unit-of-analysis" methodologies in explaining sample variance (Assael 1970, Bass 1968).

In combination with experimental methodologies, a Classification and Regression Tree (CART) analysis can be used to identify relatively homogeneous WTP of subsets of consumers who are most likely to change their willingness to pay for a food. A CART analysis is unique: it not only finds optimal splits in continuous independent variables that allow for the greatest possible explanation in a dependent variable, but it also allows for simultaneous consideration of multiple interacting independent variables. Other segmentation methods—such as cluster analysis, factor analysis, discriminate analysis, and conjoint analysis—do not have this capability. In addition, traditional analysis methods such as multiple regression analysis can accommodate simultaneous consideration of independent variables and interaction terms, but interpretation can often be difficult when interactions are three-way or higher (Lemon et al. 2003).

Another benefit of a CART procedure is that it is nonparametric and therefore does not rely on assumptions of data being drawn from probability distributions. Furthermore, a CART leverages the advantage of using homogeneous WTP groups as the unit of analysis rather than individuals (Assael 1970, Fielding 2007). Information gleaned from a CART would be attractive to marketers and government agencies to help guide their responses to a food scare by segmenting and targeting relatively homogeneous WTP responses of groups of consumers based on behavioral, psychological, and demographic characteristics (Hoffman and Novak 1996, Aaker and Lee 2001). The experimental design in the next section incorporates a methodological approach that considers both context and person variables to predict consumer willingness to pay after a media-induced food scare.

## Experimental Design

This study involved 136 adult, nonstudent participants recruited through PawPrints, the print/e-mail publication for staff and faculty at Cornell University. The age of participants ranged from 18 to 63 years old with an average age of 25.5 years. Women comprised 61 percent of the participants and 17 percent of the participants had children living in their household. Participants ate an average of 0.8 hamburgers a week and had taken some college courses. We did not ask participants questions about their knowledge of BSE or nvCJD before the experiment. This was to not bias participants' natural responses to this information based on individual psychographic, demographic, and behavioral differences that possibly were collinear with BSE/nvCJD knowledge (i.e., education).

All sessions of the experiment started at 11:00 a.m. and lasted one hour so that participants were making their decision about how much to pay for a fresh hamburger shortly before noon. Participants earned an average of $15 in cash and products.

Participants were seated at individual computer terminals equipped with privacy shields. All decisions were made confidentially using Excel spreadsheets programmed with Visual Basic for Applications. Participants read written instructions (see Appendix) and listened to an oral description of the experimental protocol during which questions regarding the protocols were welcome. No communication between participants was permitted.

In Part A of the experiment, participants first engaged in five rounds of bidding for a given cash value shown on their computer screens. This was done to help participants become familiar with the type of bidding that would later occur with hamburgers and the setting and technology used (see Messer, Kaiser, and Schulze 2008). Participants' WTP was elicited using the Becker-DeGroot-Marschak (BDM) mechanism (Becker, DeGroot, and Marschak 1964), which is theoretically an incentive-compatible mechanism in an expected utility framework and has been shown to be demand-revealing in previous experimental studies [see, for instance, Irwin et al. (1998) and Noussair, Robin, and Ruffleux (2004)].

In each round of Part A, participants were given an initial balance, $E$, of \$10 and told to submit a confidential bid, $B_i$, from \$0.00 to \$10.00, representing the most they were willing to pay for a specific, induced cash value, $V_i$ (\$2, \$5, or \$8). After all the bids were submitted, a random price, $P$, ranging from \$0.00 to \$9.99 was determined using a random-number table that provided payoff criteria. If a participant's bid was greater-than-or-equal-to the random price ($B_i \geq P$), the participant's payoff, $\pi_i$, was the sum of the initial balance and cash value minus the random price ($\pi_i = E + V_i - P$). If the participant's bid fell below the random price ($B_i < P$), s/he received only the initial balance ($\pi_i = E$). After participants completed all five rounds of Part A, they exchanged their obtained cash at a ratio of fifteen experimental dollars to one U.S. dollar.

In Part B, participants were given an initial balance of \$1 and told that they should submit a confidential bid on an object, $O$. This second training part was done so that participants could practice the BDM mechanism in a setting in which their valuation of the object was endogenously determined and followed the procedures of Kanter, Messer, and Kaiser (2009). In this case, the object was a *Pentel Wow* pen and participants were given an opportunity to view a sample of the pen. The participants were informed that enough pens were available for everyone to obtain one so that it was not a competitive auction.

Participants' bids could range from \$0.00 to \$1.00.[1] As before, a random price was determined, ranging from \$0.00 to \$0.99, with a random-number table. If a participant's bid was greater-than-or-equal-to the random price ($B_i \geq P$), s/he purchased the pen and received the initial balance minus the random price ($\pi_i = E + O - P$) in cash. If the participant's bid fell below the random price ($B_i < P$), s/he did not purchase the pen but retained the entire initial balance of \$1 ($\pi_i = E$). Participants were told that if they absolutely wanted the pen they should submit a bid of \$1.00—indicating that they were willing to pay up to the maximum possible cost of \$0.99 for the pen—and that if they absolutely did not want the pen they should submit a bid of \$0—indicating that they would not pay even one cent for the pen.

In the last part of the experimental design (Part C), participants were given \$10 and told to bid on a fresh hamburger. Before they submitted bids, all participants were able to view a sample of the hamburgers. They were told that the hamburgers had been produced locally and were assured that there were enough hamburgers for all to obtain one if desired.[2]

Participants' WTP for a hamburger was elicited using a between-subject design in which participants experienced one of two information conditions: (1) a control condition with no information, and (2) a negative information condition involving mad cow disease. In the control treatment, participants were not shown any information about beef. In the negative information treatment, participants were shown a five-minute video about mad cow disease. The video included clips from a Public Broadcasting System episode of NOVA that discussed the effects of nvCJD on humans and a December 2003 Fox News interview (shortly after the first cow in the United States was diagnosed with BSE) by Tony Snow of Michael Hansen, senior staff scientist for Consumer Union, the publisher of *Consumer Reports* magazine. The interview included discussion of the potential risk of bovine spongiform encephalopathy (BSE) in the food supply and current U.S. Department of Agriculture testing procedures.

As before, a random price was determined, this time ranging from \$0.00 to \$9.99. If participants' bids were greater than or equal to the random price, they purchased a hamburger and received their initial balance of \$10 minus the obtained random price in cash. Participants who bid less than the random price did not receive a hamburger, but retained all of the original balance of \$10. At the end of the experiment, participants completed a questionnaire and the pens and hamburgers were distributed to those who purchased them.

[1] In Parts B and C, the participants were not told the retail price of the objects used—the Pentel pen or fresh hamburger. Also, no exchange rate was used in either of these parts.

[2] While participants who purchased the fresh hamburgers were given them at noon, the experiment administrators did not require their immediate consumption prior to the payoff of other money earned in the experiment.

## Results

### *Classification and Regression Tree Analysis (CART)*

A CART analysis begins with a target variable (a "parent node" or dependent variable)—in this case, WTP for beef—and then "grows" by finding binary independent variables ("child nodes") that produce the greatest reduction in error variance in the dependent variable. In other words, a CART analysis finds an independent variable and makes a binary split in the case of a continuous variable or simply uses a binary split from an already discrete variable. In either case, a CART analysis finds the binary split in the independent variable that produces the greatest dependent-variable separation. The extent to which the error variance is reduced in the dependent variable on account of the binary independent variable is indexed by an "improvement score," which is simply a pooled, weighted estimate of variance between groups that is obtained by first determining the least-squared deviation or weighted variance for each node as follows:

$$\text{(1)} \quad Risk(t) = \frac{1}{N(t)} \sum_{i \in t} (y_i - \bar{y}(t))^2$$

where $N(t)$ is the number of people in a particular node; $y_i$ is the WTP amount of the $i^{th}$ person in the node; and $\bar{y}(t)$is the mean WTP amount for the node—the dollar amount predicted for a person in a particular node. This variance and the variance of its sibling node are subtracted from the variance of a parent node as follows:

$$\text{(2)} \quad Improvement = Rp(t) - p_t R(t_t) - p_b R(t_b)$$

where $Rp(t)$ is the risk (or variance) of a parent node ($t$) multiplied by the ratio of people ($p$) in the node to total people in the population; $p_t R(t_t)$ is the risk of a child node ($t$) multiplied by the ratio of people ($p_t$) in the top child node to total people in the population; and $p_b R(t_b)$ is the risk of a child node ($t$) multiplied by the ratio of people ($p_t$) in the bottom child node to total people in the population (SPSS 2001, Breiman et al. 1984).

The result is an improvement score or value that represents how many variance units the dependent variable has decreased because of categorization of it within a binary split of a continuous (or discrete) independent variable. A CART analysis maximizes "improvement" by searching for binary splits that minimize the variance (or error). Propagation of the tree continues until one or more stopping rules are met (tree depth, minimum number of cases in a node, or minimum change in error reduction).

While propagation of a CART tree is automated by the aforementioned search algorithms, one can force CART to first consider the effect of an independent variable of theoretical or practical interest on the dependent target variable. This approach allows for a better understanding of how the variable of interest interacts with other independent variables to produce different homogeneous WTP segments. In this case, we focused the CART analysis to first consider the possible effect of being exposed to mad cow disease information (treatment group) or not (control group) on WTP. Thereafter, the CART was allowed to search for binary splits of subsequent independent variables that either enhanced the possible effect of exposure to mad cow disease information on WTP or retracted it. This search was guided by finding the independent variable split that resulted in the greatest improvement score (or reduction in error variance)—unless the split resulted in a child node with less than five people. This process continued until either there were no more candidate variables or the criterion for reduction of error variance in the dependent variable—due to the splitting of a candidate independent variable—was met (Breiman et al. 1984).

In this CART analysis, we used WTP as the "parent node" from which a regression tree was propagated from twenty candidate variables (see Table 1). These candidate variables were also tested for differences between control and treatment groups. Expected differences were found between groups that pertained to risk perceptions of consuming beef—such that those exposed to mad cow disease information perceived the consumption of beef as more risky.[3] Six segments of people resulted from the CART analysis of WTP (see Table 2). Figure 2 illustrates these segments in tree form.

[3] An unexpected difference occurred between groups: the proportion of females to males was greater in the treatment condition. A CART analysis, however, did not find gender to be an important variable on which to create segments. Nevertheless, gender differences were found to be an important variable in profiling segments—this is discussed later in the paper.

**Table 1. Candidate Variables for CART Analysis**

| | Description | Measurement | Treatment | Control |
|---|---|---|---|---|
| 1 | How many times have you eaten a hamburger in the past month? | Integer | 2.63 (3.72) | 3.55 (5.01) |
| 2 | In the last seven days, how many times have you consumed beef? | Integer | 1.76 (1.81) | 2.37 (2.14) |
| 3 | Have you switched to other meats or fish because of BSE? | No/Yes (0/1) | 0.10 | 0.04 |
| 4 | For me, eating beef is… | Risky/Not Risky (1–9) | 6.15 (2.2) | 7.05 (2.12)* |
| 5 | For me, eating beef is worth the risk. | Disagree/Agree (1–9) | 5.15 (2.72) | 6.27 (2.48)* |
| 6 | I am … to accept the risk of eating beef. | Willing/Not Willing (1–9) | 4.36 (2.78) | 3.44 (2.55) |
| 7 | When eating beef, I am exposed to… | Not Much Risk/ Much Risk (1–9) | 3.90 (2.31) | 3.28 (2.17) |
| 8 | I am concerned with eating beef. | Strongly Disagree/ Strongly Agree (1–9) | 4.26 (2.5) | 3.35 (2.58) |
| 9 | I think eating beef is risky. | Strongly Disagree/ Strongly Agree (1–9) | 4.00 (2.42) | 3.29 (2.17) |
| 10 | I am willing to risk eating beef. | Strongly Disagree/ Strongly Agree (1–9) | 5.10 (2.60) | 6.10 (2.70)* |
| 11 | What do you think is the chance of getting Variant Creutzfeldt-Jakob Disease from eating beef? | Very Small/ Very Large (1–9) | 2.98 (2.05) | 2.14 (1.43)* |
| 12 | What do you think Variant Creutzfeldt-Jakob Disease will do to you? | 0- I would die; there is no treatment.<br>1- I might die, but there is treatment and a chance of surviving.<br>2- I would get very ill and the illness would stay with me for the rest of my life.<br>3- I would get ill and would recover after some time.<br>4- I would feel ill but would recover fast. | 2.17 (.95) | 2.83 (1.24)* |
| 13 | What is your gender? | Female/Male (0/1) | .20 | .48* |
| 14 | Do you have children? | No/Yes (0/1) | .17 | .17 |
| 15 | Are you a vegetarian? | No/Yes (0/1) | .07 | .08 |
| 16 | What is your education level? | Categorical (0–6) | 3.31 (1.14) | 3.31 (1.06) |
| 17 | Suppose that science has shown with absolute certainty that getting Variant Creutzfeldt-Jakob Disease by eating beef is **1 case per 100 million** people per year. Under these circumstances, I would be willing to take the risk to eat beef. / I would think eating beef would be risky. / Would you reduce your beef consumption? (yes/no) | Strongly Disagree/ Strongly Agree (1–9) | 6.32 (2.31)<br>3.24 (2.21)<br>0.30 | 6.73 (2.48)<br>2.81 (1.97)<br>0.20 |
| 18 | Suppose… **1 case per 1 million** people per year… Under these circumstances, I would be willing to take the risk to eat beef. / I would think eating beef would be risky. / Would you reduce your beef consumption? (yes/no) | Strongly Disagree/ Strongly Agree (1–9) | 5.41 (2.11)<br>4.56 (2.36)<br>0.56 | 6.01 (2.43)<br>3.99 (2.37)<br>0.41 |
| 19 | Suppose… **1 case per 10,000** people per year…. Under these circumstances, I would be willing to take the risk to eat beef. / I would think eating beef would be risky. / Would you reduce your beef consumption? (yes/no) | Strongly Disagree/ Strongly Agree (1–9) | 3.93 (2.40)<br>6.39 (2.20)<br>0.85 | 4.20 (2.51)<br>5.98 (2.50)<br>0.72 |
| 20 | Suppose… **1 case per 100** people per year…. Under these circumstances, I would be willing to take the risk to eat beef. /I would think eating beef would be risky. (yes/no) | Strongly Disagree/ Strongly Agree (1–9) | 1.63 (1.46)<br>8.20 (1.68)<br>0.93 | 2.65 (2.42)*<br>7.76 (2.17)<br>0.87 |

*Represents significant difference at $p<0.05$. Values in parentheses represent standard deviation.

**Table 2. Segments of WTP by Experimental Manipulation**

| | Average WTP | Group Size | Z |
|---|---|---|---|
| **Control Population** | **$2.14** | 94 | |
| 1. Willing to take risk to eat beef if 1 per 10,000 ≤ 2 | $2.50 | 75 | 1.54 |
| 2. Willing to take risk to eat beef if 1 per 10,000 > 2 | $0.68 | 17 | –6.24*** |
| **Mad Cow Information Population** | **$0.88** | 44 | |
| 1. Number of hamburgers last month ≤ 5 | $0.44 | 33 | –1.73* |
| 2. I am concerned with eating beef > 4 | $0.12 | 21 | –2.99*** |
| 3. Number of hamburgers last month > 5 | $2.21 | 11 | 5.23*** |
| 4. I am concerned with eating beef ≤ 4 | $0.98 | 12 | 0.39 |
| 5. Chance of getting Variant Creutzfeldt-Jakob Disease from eating beef ≤ 2 | $0.42 | 6 | –1.81* |
| 6. Chance of getting Variant Creutzfeldt-Jakob Disease from eating beef > 2 | $0.01 | 15 | –3.42*** |

Note. Numbers indicate terminal nodes (segments). *$p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

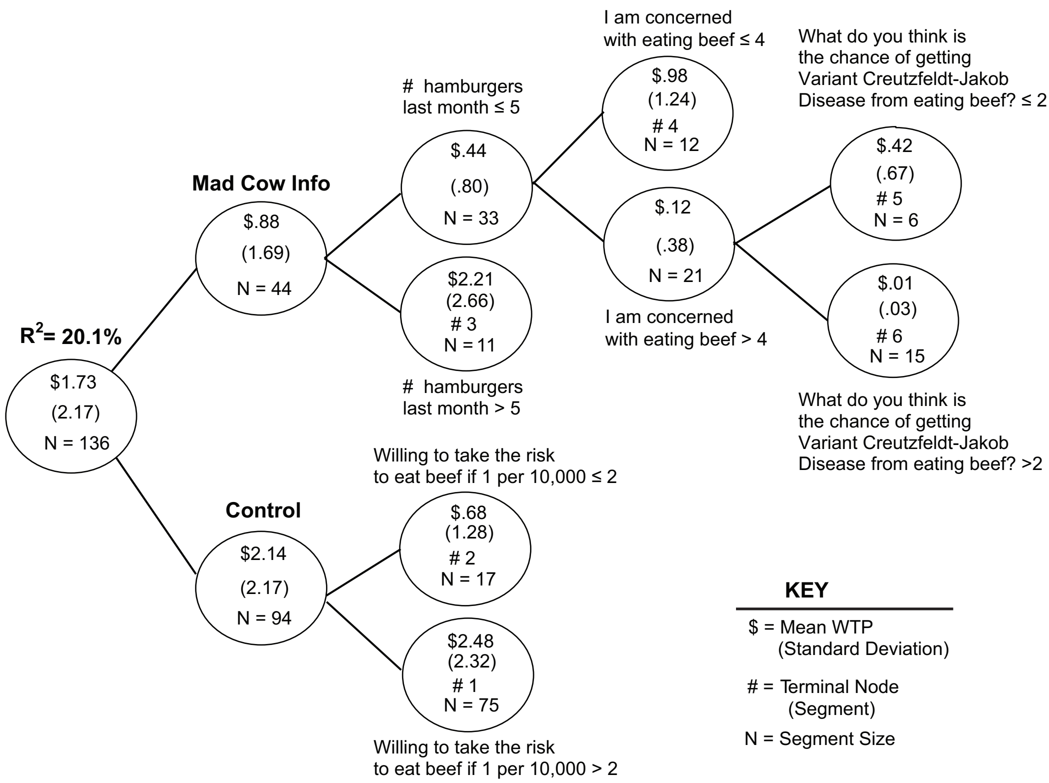


**Figure 2. CART Analysis of WTP**

The first two segments involved participants who were in the control condition (no mad cow information). The survey question (and scale split) that reduced the WTP error variance the most for the control group was "Suppose that science has shown with absolute certainty that getting Variant Creutzfeldt-Jakob Disease by eating beef is **1 case per 10,000** people per year… under these circumstances I think eating beef would be risky." The first segment consisted of individuals who strongly disagreed (≤ 2). WTP for these individuals was $2.50—116.8 percent of the average WTP for the control group (z = 1.54, $p = 0.12$) (see Table 2). The second segment comprised everyone else (> 2); WTP for these individuals was \$0.68–31.8 percent of the average WTP for the control group (z = –6.24, $p < 0.001$).

The next four segments contained participants in the treatment condition (mad cow disease information). The survey question (and number split) that reduced the WTP error variance the most for the treatment group was "How many times have you eaten a hamburger in the past month?" Segment three consisted of individuals who had consumed more than five hamburgers in the past month. WTP for these individuals was \$2.21–251 percent of the average WTP for the treatment group (z = 5.23, $p < 0.001$). The fourth segment involved individuals who had consumed five or less hamburgers in the past month and disagreed or strongly disagreed (≤ 4) with the statement "I am concerned with eating beef," the survey question (and scale split) that reduced the WTP error variance the most for this segment. WTP for these individuals was \$0.98–111.4 percent of the average WTP for the treatment group (z = 0.39, $p = 0.69$).

The fifth and sixth segments consisted of participants who consumed five or less hamburgers in the past month and agreed or strongly agreed (> 4) that they were concerned about eating beef (\$0.12; z = –2.99, $p < 0.01$). Segment five was comprised of a subset of these individuals who also believed that "The chance of getting Variant Creutzfeldt-Jakob Disease from eating beef" was relatively small (≤ 2). Their WTP was \$0.42–47.7 percent of the average WTP for the treatment group (z = –1.81, $p < 0.10$). The sixth segment was a subset of participants who also believed that "The chance of getting Variant Creutzfeldt-Jakob Disease from eating beef" was relatively large (> 2). Their WTP was \$0.01–1.1 percent of the average WTP for the treatment group (z = –3.42, $p < 0.001$).

Lastly, demographic candidate variables that were not picked as significant predictors of WTP in the CART analysis can nevertheless be used to profile individual segments in the CART analysis. Table 3 provides this profile. Segments 1, 5, and 6 had gender distributions different than what was expected from the population total gender distribution (all *ps* < 0.05-one tailed). Segment 1 had significantly more men and significantly less women than expected, whereas Segment 6 had just the opposite. Segment 5 had significantly less men than expected. The only other demographic distribution that was different from what was expected was the distribution of vegetarian and non-vegetarians in Segment 2. Specifically, Segment 2 had significantly more vegetarians than what was expected ($p < 0.05$-one tailed).

*Efficacy of the CART Analysis*

The efficacy of individual nodes in the CART analysis can be assessed by one-sample z-tests—an assessment of the departure of a child node from its respective parent population's mean. The efficacy of terminal child nodes (i.e., segments)—nodes that can no longer be subclassified—can be assessed through Welch's independent t for unequal variances.

In this analysis fifteen comparisons of WTP were computed for each possible pair of segments. Ten of these comparisons were significantly differ-

**Table 3. Demographic Characteristics of Segments**

| | Female/ Male | No Children/ Children | Education | Age | Not Vegetarian/ Vegetarian |
|---|---|---|---|---|---|
| Segment 1 | .51*/.49* | .83/.17 | 3.27 (1.07) | 25.76 (11.40) | .96/.04 |
| Segment 2 | .59/.41 | .82/.18 | 3.44 (1.03) | 25.29 (11.92) | .77*/.23* |
| Segment 3 | .64/.36 | .91/.09 | 3.00 (.71) | 24.91 (9.35) | 1.0/.00 |
| Segment 4 | .83/.17 | .75/.25 | 3.10 (1.20) | 28.17 (11.98) | 1.0/.00 |
| Segment 5 | .83/.17* | 1.0/.00 | 3.50 (1.38) | 23.33 (6.68) | 1.0/.00 |
| Segment 6 | .87*/.13* | .75/.25 | 3.64 (1.29) | 24.13 (7.61) | .80/.20 |
| Total Population | .61/.39 | .83/.17 | 3.31 (1.08) | 25.56 (10.73) | .93/.07 |

*Represents significant binomial differences ($p < 0.05$-one tailed) between segment proportion and total population proportion. For example, the sample included 61% female and 39% male. Segment 1 gender proportions significantly differ from what was expected in the total population.

ent (see Table 4).[4] Specifically, the first segment was significantly different from the second ($t = 4.39$, $p < 0.001$); fourth ($t = 3.36$, $p < 0.01$); fifth ($t = 5.38$, $p < 0.001$); and sixth ($t = 9.22$, $p < 0.001$). The second segment was significantly different from the third ($t = 1.78$, $p < 0.10$) and the sixth ($t = 2.16$, $p < 0.05$). The third segment was significantly different from the fourth ($t = 1.40$, $p < 0.05$); fifth ($t = 2.11$, $p < 0.10$); and sixth ($t = 2.74$, $p < 0.05$) segments. The fourth segment was significantly different from the sixth ($t = 2.71$, $p < 0.05$).

*Performance of the CART Analysis*

The overall performance of a tree can be assessed by two criteria: the amount of unexplained variance for which it accounts and a receiver operating-characteristic (ROC) curve that depicts the predictive validity of the CART analysis on those who would be willing to pay a nonzero amount for the hamburger (1 = positive WTP) versus those who would not (0 = zero bid).

The CART tree in this study accounted for 20.2 percent of the unexplained variance in WTP—falling at the high end of the moderate effect range (see Cohen 1988). Thus, the model did quite well in explaining WTP variance.

As seen in Figure 3, the performance of a CART analysis is assessed by the size of the area under the curve (AUC), which represents the "probability that the [model] will rank a randomly chosen positive instance higher than a randomly chosen negative instance" (Fawcett, 2006). In this analysis, the area under the curve for the CART was statistically significant at 77.2 percent (CI = 68.5 percent to 85.8 percent, $p < 0.001$). That is, the probability that the CART would rank a randomly chosen positive WTP (depicted by the 45-degree line) higher than a randomly chosen zero WTP is 77.2 percent. Figure 3 also shows how well the CART analysis discriminates between zero and positive WTP at different levels of surety. For example, if one wanted to find at least 80 percent of the people who had positive WTP using the CART algorithm, 30 percent would be misclassified (i.e., zero WTP classified as positive WTP).

**Table 4. Between-Segment Comparisons**

| Terminal Nodes (Segments) | WTP | Effect Size |
|---|---|---|
| **1 vs. 2** | 4.39*** | 0.56 |
| **1 vs. 3** | 0.32 | 0.09 |
| **1 vs. 4** | 3.36*** | 0.56 |
| **1 vs. 5** | 5.38*** | 0.79 |
| **1 vs. 6** | 9.22*** | 0.73 |
| **2 vs. 3** | 1.78* | 0.44 |
| **2 vs. 4** | 0.63 | 0.13 |
| **2 vs. 5** | 0.63 | 0.15 |
| **2 vs. 6** | 2.16** | 0.48 |
| **3 vs. 4** | 1.40** | 0.36 |
| **3 vs. 5** | 2.11* | 0.52 |
| **3 vs. 6** | 2.74** | 0.65 |
| **4 vs. 5** | 1.24 | 0.30 |
| **4 vs. 6** | 2.71** | 0.63 |
| **5 vs. 6** | 1.50 | 0.56 |

Note: All values are Welch's independent t (for unequal group variances).
*$p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

*Discussion*

The CART analysis suggests that homogeneous WTP groups should be profiled first on previous consumption behavior (hamburgers/month); then on fear (concern about eating beef); and then on risk (chance of getting nvCJD) (see Figure 2). The advantage of using a CART analysis here is that one obtains information not only on multiple interacting explanatory variables that affect WTP, but also regarding the specific levels of continuous explanatory variables that affect WTP the most. If the beef industry or government agencies, for example, only had information on consumer consumption, then a CART analysis would allow them to target effectively the consumers who are most vulnerable to exposure to information. For example, new media efforts could be made to convey information about the risk of contracting nvCJD, the safety of the food supply, or generic advertising to those who consume less than five hamburgers per month (i.e., Martin 2009).

[4] Effect sizes are expressed as point-biserial correlations:

$$r = \sqrt{\frac{t^2}{t^2 + df}}$$

Effect sizes of 0.2, 0.5, and 0.8 are considered small, medium, and large respectively (Cohen 1988).

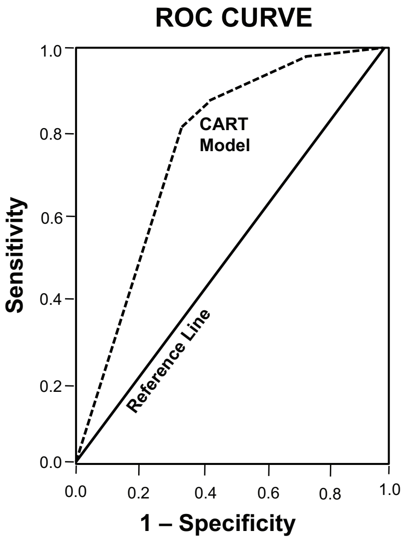


**Figure 3. Efficacy of the CART Depicted by a ROC Curve**

The CART analysis suggests segmenting infrequent (segment three) and frequent (segments four, five, and six) consumers of beef to best understand subsequent demand for beef after exposure to mad cow information. An interesting result is that the WTP of those who consume frequently (more than five hamburgers per month or 25 percent of the sample) does not seem to be affected by exposure to mad cow disease information and is not significantly different from the WTP of segment one, the control group that was not exposed to any mad cow disease information (see Table 2). On the other hand, another result is that the WTP of 75 percent of the participants was affected (segments four through six). Even though these segments include infrequent consumers of beef (≤ five hamburgers per month), they account for 75 percent of the sample—a tremendous amount of purchasing power. Focusing on these segments may improve efforts to staunch dramatic declines in beef demand in response to a scare.

If infrequent beef consumers could be reassured that the food scare does not actually endanger their health or that of their family, through additional information regarding the actual risks of contracting the disease or the safety of the food supply or perhaps through additional generic advertising, these consumers might purchase more beef. The CART analysis estimates that the WTP for these consumers would actually be 111.4 percent of that for the entire treatment group (segment four). Furthermore, if consumers who are concerned about eating beef could be convinced that the chance of getting nvCJD is minimal, stigma effects on WTP might not be as dramatic (–50 percent for segment five versus –98 percent for segment six).

Interestingly, segments one and two also provide revealing information about WTP for beef when individuals are not exposed to mad cow information but are given risk information. For example, the risk question in the survey that clearly distinguished between those with a relatively large WTP versus a small one was the following: "Suppose that science has shown with absolute certainty that getting Variant Creutzfeldt-Jakob Disease by eating beef is **1 case per 10,000** people per year; I would be willing to take the risk to eat beef." Other similar questions were asked, but the incidence rate was changed to "1 case per 100," "1 case per 1 million," and "1 case per 100 million." The WTP of those who strongly disagreed with the aforementioned statement (≤ 2) was similar to the WTP of those who were exposed to mad cow disease information (segment two). Framing incident rates in certain ways, it seems, can lead to increases or decreases in demand.

## Conclusion

This work attempted to first simulate, via experimental methods, the effect of exposure to food scare information on willingness to pay—ceteris paribus—and then to identify homogeneous WTP groups of consumers who would be most impacted by such exposure. This extends research in behavioral economics that attempts to understand consumer demand, given exposure to food scare information in line with Lusk et al. (2001), Shogren et al. (1999), Fox et al. (1995), and Messer et al. (Forthcoming). Unlike previous research, however, this study both incorporated a true control group and used a CART analysis that provided information regarding non-hypothesized (generated by a computer search) *linear* and *nonlinear* combinations of *all possible* explanatory psychographic, demographic, and behavioral variables that predict the vulnerability of *multiple* subgroups' WTP to stigma effects. To our knowledge, this work is the first to include the aforementioned elements in understanding consumer demand given a food scare.

Exposing people to mad cow disease information in a controlled setting demonstrated the effect of that information on WTP. However, by using a CART analysis, government and industry professionals could identify homogeneous WTP subgroups of individuals who are likely to change their beef consumption and develop interventions designed to reduce consumer concern. Results from this study suggest that by focusing on subgroups of consumers based on frequency of consumption and perceptions of fear and risk, the interventions can have the greatest impact—thereby reducing the likelihood that exposure to mad cow disease information will dramatically impact beef demand.

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# Appendix

## Instructions – (Part A)

Welcome to an experiment in the economics of decision-making. In the course of the experiment, you will have opportunities to earn money. Any money earned during this experiment is yours to keep, thus please read these instructions carefully. Please do not communicate with other participants during the experiment. As stated in the **Consent Form**, your participation in this experiment is voluntary.

In today's experiment, you will be asked to indicate the *highest* amount of money you would pay for different purchase decisions. We will refer to this amount as your **bid**. Sometimes a **purchase decision** will refer to a cash value and sometimes it will refer to a food item.

For the first several purchase decisions, the experiment proceeds as follows:

First, you will receive an **initial balance** of $10. You will then be informed of your **cash value** that you would receive if you purchase the decision. Your cash values will vary during the course of the experiment. The possible amounts are $2, $5, and $8.

You will then be asked to indicate the *highest* amount that you would pay for this purchase decision. For each decision, you can bid any amount between $0 and your initial balance of $10. Once you have decided your bid, you will type it into the computer spreadsheet, hit ENTER on the keyboard, and then click the "Submit" button. After everyone has submitted his or her bids, the price for the purchase decision will be determined.

The **price** will be determined by having a volunteer subject drop a pen onto a random number table. Since these numbers have been generated by a random number table, each price between $0.00 and $9.99 is equally likely. Whether the decision is purchased depends on your bid and the randomly determined price. There are two possible outcomes:

**The decision is PURCHASED:**

**The decision is purchased if your bid is *equal to or greater than* the price**. In this case, you will receive the cash value in addition to your initial balance of $10. However, you will also have to pay the randomly determined price. Therefore, your earnings would be your initial balance, plus your cash value, minus the price.

**The decision is NOT PURCHASED:**

**The decision is not purchased if your bid is *less than* the price.** In this case, you will not receive the cash value, but you will not have to pay the price. Therefore, your earnings would simply be your initial balance of $10.

In this setting, it is in your best interest (i.e., you will make the most possible earnings) if you submit bids equal to your cash value for the decision. Note that while your bid helps determine whether the decision is purchased, your earnings are calculated based on your initial balance, the cash value, and the determined price (not your bid). For example, if a decision was *not purchased* and the cash value was $5 and the determined price was $9, your earnings would still be $10. However, if the decision was *purchased* with the same cash value and price, your earnings would be $6 ($10 + $5 - $9).

*Example 1.*

| Outcome | Initial Balance | Cash Value | Price | Earnings |
|---|---|---|---|---|
| Purchased | $10 | $5 | -$9 | $6 |
| Not Purchased | $10 | $5 | -$9 | $10 |

Consider another example where the cash value was $5 and the determined price was $2. In this example if the decision was *not purchased* your earnings would again be $10, while if the decision was *purchased*, your earnings would be $13 ($10 + $5 - $2).

*Example 2.*

| Outcome | Initial Balance | Cash Value | Price | Earnings |
|---|---|---|---|---|
| Purchased | $10 | $5 | -$2 | $13 |
| Not Purchased | $10 | $5 | -$2 | $10 |

### Calculation of Earnings

After everyone has submitted their bids for the decision and the price has been determined, the administrator will display all of the bids on the screen in the front of the room. These bids will be displayed anonymously from lowest to highest and no subject numbers will be associated with these bids. The administrator will then ask all the participants the following questions:

1) Which Participants purchased the decision?
2) How much will these Participants have to pay and how much will they earn in this round?
3) How much will the Participants who did not purchase the decision earn in this round?

Then you will be asked to click the RECEIVE button and the computer will display whether you purchased the decision and calculate your earnings. The computer will add your experimental earnings for all of the rounds, and convert this amount to U.S. dollars by applying an exchange rate of 15 experimental dollars to $1 USD. For example, if you earn $300 experimental dollars, your monetary payoff from this part of the experiment would be $20.

## Instructions - Part B

### Pen as a Decision

You will be asked to indicate the *highest* amount of money you would pay for a pen using the same procedures as discussed previously. In this case, your starting balance will be $1 and you can submit any bid between $0 and $1. The random price will again be determined using a random numbers table, however, now the price will range from $0.00 to $0.99. In this part, there will not be an exchange rate as one experimental dollar will equal $1 USD.

Note that in the case, you will need to determine the "highest amount" that you would pay to purchase this pen. Again, it is in your best interest to submit a bid equal to this highest amount, since, if you purchase the pen, you will pay the randomly determined price not your bid. The two possible outcomes are as follows:

**The pen is PURCHASED:**

**The pen is purchased if your bid is *equal to or greater than* the price**. In this case, you will receive the pen in addition to your initial balance of $1. However, you will also have to pay the randomly determined price.

**The pen is NOT PURCHASED:**

**The pen is not purchased if your bid is *less than* the price.** In this case, you will not receive the pen, but you will not have to pay the price. Your cash earnings would simply be $1.

Again, after everyone has submitted their bids and the price is determined, the administrator will display the submitted bids and lead a group discussion that identifies who purchased the decision and how much each type of subject will have earned. You can then receive the results of the round. The administrators will distribute the pens to the Participants who purchased them.

**Instructions – (Part C)**

The procedures are similar to the ones used in Part A of the experiment, except for two important differences.

1) The purchase decision is a hamburger. The hamburger will be freshly grilled and a wide variety of fixings are available so that you can customize it to your liking.
2) For the decision that is selected, the exchange rate will be one U.S. dollar for one experimental dollar. For example, if you earn $8 experimental dollars in the second part of the experiment, your monetary payoff would be $8.

For each decision, the experiment proceeds as follows:

You will receive an initial balance of $10. For each decision, you will be asked to type in your bid. You can bid any amount between $0 and your initial balance of $10. The price for the decision will be determined in the same manner as in Part A using a new random number table. As with the pen, you should submit a bid equal to the highest amount that you would pay for the hamburger. There are two possible outcomes:

**The hamburger is PURCHASED:**

**The hamburger is purchased if your bid is *equal to or greater than* the price**. In this case, you will receive the hamburger in addition to your initial balance of $10. However, you will also have to pay the randomly determined price.

**The hamburger is NOT PURCHASED:**

**The hamburger is not purchased if your bid is *less than* the price.** In this case, you will not receive the hamburger, but you will not have to pay the price. Therefore, your cash earnings would simply be $10.

Please do not submit your bid until instructed by the administrator.

*It is important that you clearly understand these instructions.*
*Please raise your hand if you have any questions.*
*Please do not talk with other participants in the experiment.*