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Offsetting Behavior and the Benefits of Food Safety Policies in Vegetable Preparation and Consumption

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ABSTRACT

Foodborne disease outbreaks have a tremendous impact on society, including foodborne illnesses, hospitalizations, lost work time, and deaths. These food-safety events have a significant influence in shaping consumer's perception of risk. In food consumption, outbreaks of foodborne illnesses also have an effect on the development of public health policy. Due to these safety-related uncertainties in the food supply chain, various regulatory safety and health policies are implemented to decrease potential harm to likely victims. The expected effect of these food-safety policies forecasted in terms of reduction in foodborne illnesses, mortality, and food-related diseases may be overstated if consumer's offsetting behavior is overlooked. Reduction and in some cases reversal of direct policy effect may occur. This research tests the presence of dominant or partial offsetting behavior in the preparation and consumption of vegetables if a food-safety policy such as the Pathogen Reduction/Hazard Analysis and Critical Control Point (PR/HACCP) is mandated in the vegetable sector.

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INTRODUCTION

Food-safety related worries occur at all levels of the food supply chain: on-farm, in transportation systems, and in the course of handling. These food-safety related uncertainties are responsible for numerous food recalls (USDA, FSIS, 2001). For this reason, many regulatory, safety, and health policies are adopted to reduce harm to likely victims from accidents and other harmful events. Some regulatory economic studies (e.g., Peltzman, 1975; Hause, 2006; Blomquist, 1988) have observed that reductions, and in some cases, even reversal of direct policy effects on expected harm may occur in the face of articulated policy because of decreased care by potential victims. This increase in expected harm attributed to decreased care by victims in response to the implemented policies is what has been termed offsetting behavior (OB). If the effect of OB is overlooked, the expected outcome of food-safety policy implementation will be misleading.

Extensive studies have been carried out to show the existence of OB and its preponderance in the automobile sector (e.g., Lave and Weber, 1970; Peltzman, 1975); workplace and consumer product accidents (Viscusi, 1985); effect of health on the way of life-dependent disorders and death (Wilde, 1994); and the effect of medical innovations (Peltzman, 2001). OB has been found to exist in food consumption as well. Nganje *et al*. (2007) and Miljkovic *et al*. (2008) found out that OB exists in food-safety. In their findings, they discovered that despite the mandatory and widespread implementation of the Pathogen Reduction/Hazard Analysis and Critical Control Point (PR/HACCP) in the meat sector, the numbers of outbreaks in the meat sector are on the increase.

The specific objectives of this study are threefold. First we examine the relationship between food-safety associated risk tolerance and consumer's perception of risk. Second, we model and evaluate the impact of both positive and negative information on consumer's perception of risk. This involves measuring how consumers react to new information on the safety of the vegetables they consume. This will then be employed to assess the presence or absence of OB in the preparation and consumption of vegetables. Third, we provide guidelines and scope for policy makers to take into account OB where it is significant, such that predicted food-safety policy effects can be more accurately stated.

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To carry out these objectives, risk tolerance indexes were developed using factor analysis, and then these indexes were used to model the impact of information on consumer's perception of risk, handling, and preparation of vegetables if a food-safety policy such as PR/HACCP is implemented in the sector. The emphasis is on how positive and negative information affect consumer's perception of risk, handling, and preparation practices. The tested hypothesis is that imposing a food-safety measure (PR/HACCP) does not change consumer's perception in such a manner that they become less cautious about how they prepare and consume their vegetables. Apart from the health benefits associated with regular consumption of vegetables, for at least two additional reasons, vegetables present certain qualities that make it suitable for this type of evaluation. Vegetables are consumed in a minimally processed (raw) form and are responsible for an increasing number of outbreaks.

Food-Safety Policy, Recalls, and Outbreaks in the Vegetable Sector

Though the Federal Government has a long record of regulation of food quality and safety, there has been a movement towards increased regulation possibly due to sporadic outbreaks (Caswell, 1988). Food-safety policy is based on a combination of voluntary measures undertaken by producers and regulatory measures imposed by government (Segerson, 1999).

Food recalls play a significant role in ensuring food-safety. Recalls involve the removal of a food substance from circulation by a firm involved when it is believed the product presents a threat to consumers (Title 21 CFR 7.3 (g). Outbreaks of foodborne disease have an important influence on the development of public health policy (Palmer *et al*., 2000). Outbreaks of foodborne illnesses have increased fears about the effectiveness of protective measures designed for food-safety assurance (Antle, 1995). In 1998, due to an increase in the reported number of outbreaks of foodborne illnesses associated with both domestic and imported fresh fruits and vegetables, the U.S. Food and Drug Administration (FDA) and the Center for Food safety and Applied Nutrition (CFSAN) of the Food Safety Inspection Service (FSIS) published a document entitled "Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables" (FDA, CFSAN, 1998). This guide was meant to support a continuing effort to develop national guidelines for the safety of fruits and vegetables by emphasizing the need to address safety hazards and good agricultural practices. The non-mandatory nature of food safety policy has been blamed for the increasing outbreaks witnessed in the fruit and vegetable sector (Krauter, 2007).

Similarly, following repeated discoveries of *E. coli* O157:H7 and Salmonella in the U.S food supply chain (Antle, 2000), the U.S Food and Drug Administration (FDA) and the Food Safety Inspection Service introduced new mandatory food-safety regulations (FDA, FSIS, 1996). This new regulation, PR/HACCP, was to ensure the safety of meat and poultry products by mandating the set up of critical control points (CCPs) in food production and processing operations. This would ensure regular testing for potentially dangerous products.

Despite the reduction in the level of most pathogens, the number of outbreaks in retail facilities increased (CDC, 2006). In the vegetable sector there has been a significant increase in the number of nationwide outbreaks leading to recalls of varying magnitude. The 2003 green onion hepatitis A outbreak that originated in Mexico, and the 2006 spinach and lettuce *E. coli* O157: H7 and *Salmonella* nationwide outbreaks (Onyango *et al*., 2007) are recent examples. This general increase in outbreaks with lower pathogen prevalence suggests a possibility of the presence of OB. The studies carried out by Nganje *et al*. (2007) and Miljkovic *et al*. (2008) where OB was found to exist in food-safety, this study aims to carry out similar evaluations, given certain observations in the vegetable sector assess if OB is present in the preparation and consumption of vegetables. This evaluation will be carried out under the assumption that a policy such as PR/HACCP is implemented in the vegetable sector. Fig 1.1 presents the general trend in foodborne disease outbreaks from 1983 to 2004. The trend in the diagram coincided with the 1996 establishment of PR/HACCP in the meat and poultry sectors and the 1998 publication of the "Guide to Minimize Microbial Safety Hazards for Fruits and Vegetables" in the fruit and vegetable sector.

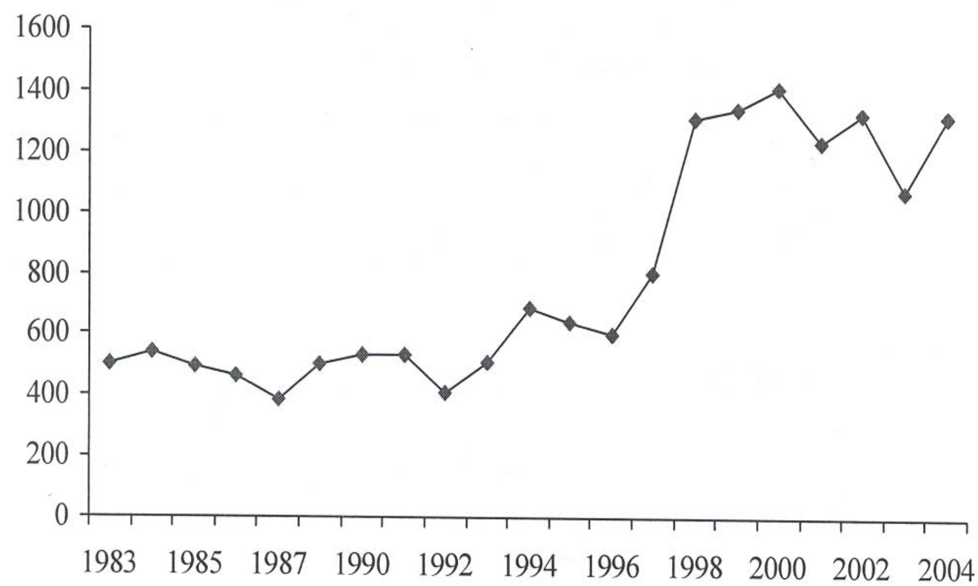

Figure 1.1: Trends: Foodborne Disease Outbreak Surveillance System.
Source: CDC (1983-2004).

More than 200 known diseases are transmitted through foodborne illnesses including viruses, bacteria, parasites, toxins and metals (Bryan, 1982). These foodborne illnesses represent a significant burden on the U.S. population and health system as a whole, causing approximately 76 million illnesses, 325,000 hospitalizations and 5,000 deaths annually (Kennedy *et al*., 1999). The annual costs associated with illnesses and deaths are estimated to be between $5 and $6 billion (Swanger and Rutherford, 2004).

Benefits and Costs of Food-Safety Regulation

Presumably, the impact of OB is plausible and sometimes significant when policies are put in place to reduce harm to potential victims. Putting policies in place entails expenditures and expected benefits, hence appraisal of the costs and benefits of food safety policies is necessary. Arrow *et al*. (1996) proposed that interventions should be undertaken only if they are designed to produce over all positive net benefits. Following increasing pressure to sustain consumer's trust, regulatory structures and government authorities are confronted with new and ongoing food-safety challenges (Henson and Caswell, 1999). Regulatory Impact Assessment (RIA), which is based on benefit-cost analysis, is becoming a primary part of the U.S. government policy structure process (Antle, 2000). U.S policy requires RIA of all policies with likely influence of at least $100 million (Morall, 1997).

Benefits of Food-Safety Regulation

Antle (1999) pointed that the eventual benefit of improved food-safety regulations is a reduction in the likelihood of illnesses and deaths associated with the consumption of food contaminated with microbial pathogens and related hazards. Superior food quality would sustain consumer health and provide restoration in the face of injury (van Ravenswaay, 1995). Due to the diversity of quality of food product attributes and the non existence of market for benefits to be evaluated, a series of approaches exists to value the benefits of improved food-safety (Caswell, 1998). The lack of information related to food attributes makes the evaluation even more complex (Kinsey, 1993).

Contingent valuation and experimental market models have been used to derive expressions of willingness to pay (WTP) (Brown *et al*., 2005), averting behavior cost (Eom, 1995), resource expenditures of medical costs and labor productivity for reduced risk morbidity and mortality (Roberts, 1991) or the cost of illness approach (COI) (Kenkel, 1994). Evaluating the increased entry to foreign markets is an increasingly used method for evaluating the benefits of food-safety regulations (Roberts and DeRemer, 1997).

Costs of Food-Safety Regulation

Given market incentives to improve food-safety, firms will possibly implement hazard control measures in an effort to achieve strategic benefits (Stigler, 1971) in perspective of further severe regulations (Segerson, 1999). The combination of both public and private motivations to enhance food-safety, coupled with the response of industry in regards to regulation, complicates the estimation of the cost of food-safety regulation (Unnevehr and Jensen, 2001). From a general perspective, the cost of food-safety regulation may include a blend of associated administrative costs, quality guarantee plans undertaken voluntarily, and government mandated regulatory standards (Antle, 2000). Various methods have been used to estimate the cost of food-safety regulation.

Using an accounting approach, the Food Safety Inspection Service (FSIS) estimated that the four years execution costs of PR/HACCP in the meat and poultry sector stand between $305 and $357 million (FSIS, 1996). Jensen and Unnevehr (1999) applied an economic engineering approach and found that the cost of pathogen mitigation strategies in pork processing were in the scale of $0.03 to $0.2 per carcass of hog. Klein and Brester (1997) used econometric analysis to estimate a cost function to evaluate the impact of the USDA's zero-tolerance for fecal contamination in the cost of production. From their findings, the cost of the zero tolerance order for meat plants was approximately $3 billion with expectations for this to decrease as firms gain economies of scope. The estimation approach used to value the benefits and cost of food safety regulations seen so far have not taken OB into account and are thus liable to error. There is need to estimate the true benefits of food-safety regulations.

Offsetting Behavior and Food-Safety Information

Food is an essential contributor to physical welfare and a main supplier of pleasure, worry, and stress (Rozin *et al*., 1996). Incidents of chemical and bacterial contamination of food receive great attention (Foster and Just, 1989). Perceived product quality after an adverse event plays an important role in consumer's consumption decision (Swartz and Strand, 1981). Consumer perception plays an integral role in valuation of food-safety and nutrition; hence it should be taken into consideration whenever such evaluations are to be made. Perceptions and beliefs are formed by knowledge, which is a result of exposure to information sources and personal effort in getting it (McIntosh *et al*., 1994). The risk perceived by individuals depends on information about the quality and safety of a product that can be gained from a variety of sources including among others media coverage, friends and personal experience (Buzby and Ready, 1996). A consumer's risk perception is likely to be unbalanced and short lasting, and to vary over time as a result of both positive and negative views (Lui *et al*., 1998). Consumers can learn about a particular risk and change their risk perception after receiving new information (Smith and Johnson, 1988). Figure 1.2 shows an illustration of change in perception.

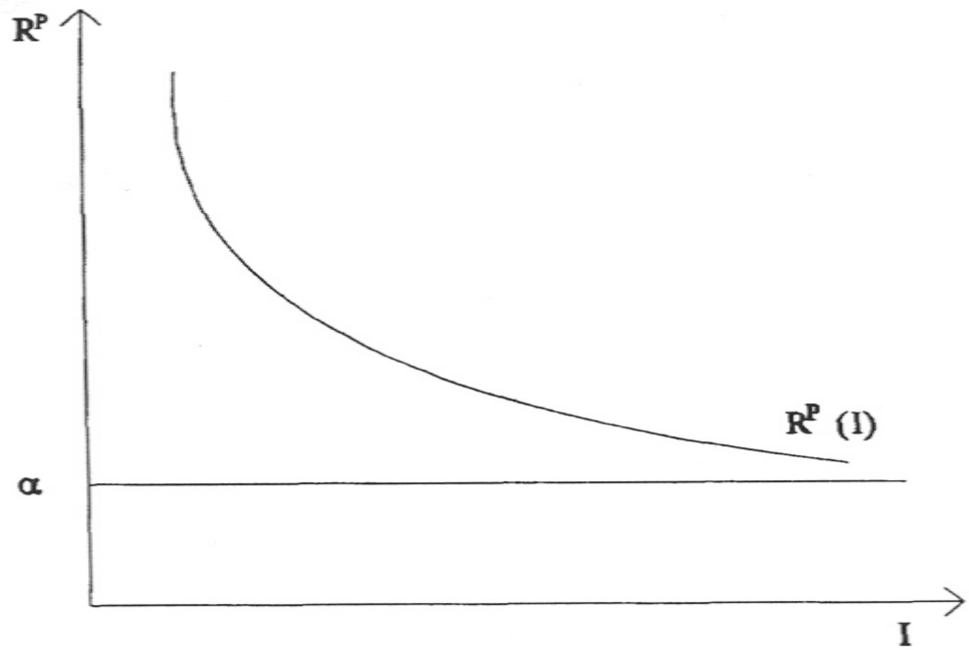

Figure 1.2: Change in Perceived Risk with Positive Information after an Unfavorable Shock.
Source: Lui *et al*. (1998).

In figure 1.2, news of a contamination report causes the perceived risk R^p to move away from the original risk perception. New favorable information helps consumers to slowly adjust their risk perception back down to the objective level indicated by α. Lichenstein *et al*. (1978) suggested, from a psychological perspective, that the unbalanced emphasis on negative media report relative to positive report could lead individuals to overestimate health risk. Trust in risk management institutions may play a vital role in shaping consumer's perception of risk (Wynne, 1980). It is essential from an economic stand point, to evaluate the link between the trust consumers place on institutions or food suppliers and government/regulators on consumer's purchasing behavior (Bocker and Hanf, 2000).

Onyango *et al*. (2007), writing after the 2006 nationwide spinach recall, suggested that trust in private and public institutions associated with food-safety have considerable impact on consumer food-safety perception. This influence is displayed by the public trust of those regulatory agencies responsible with food-safety (e.g. U.S. Department of Agriculture (USDA), Centers for Disease Control (CDC) and the Food and Drug Administration (FDA). This trust consumers place on policies presents an avenue for the evaluation of OB. OB is implied by reduced concern by consumers in reaction to positive information about the impact of policies aimed at mitigating the risk of contamination.

Theoretical Framework

Peterson *et al*. (1995) and Poitras and Sutter (2002) advanced that prior to building up a suitable theory on OB, it is essential to make clear certain concerns associated with command and control policies, sorting issues which develop due to information asymmetry and OB. Direct interventions involve command and control principles for implementation which utilize sampling techniques to check a product's quality (Hathaway, 1995). Control interventions directly state actions to be undertaken in realizing improved final products; these are widely identified as Good Manufacturing Processes (GMPs) (Hathaway, 1995). Poitras and Sutter (2002) claimed that the mandatory car safety inspection proved futile because of its command control design. They suggested that this design increased consumer costs. To them, the ineffectiveness was not due to alteration in consumer's payoff due to OB.

This study considers the mandatory application of food safety information from PR/HACCP that is based on performance standards in the fresh vegetable sector which hitherto is non mandatory. Such a move will help evaluate whether consumers become lax in reaction to information of the potential impact of implementing such a policy. The theoretical model of OB is directly related to that presented by Nganje *et al*. (2007) where the expected accident loss model by Hause (2006) is expanded to incorporate two measures. The first measure is OB which, in this case, is represented by consumer's perception of risks. The second measure encompasses consumer behavior regarding safe vegetable preparation and consumption. The theoretical model is represented in Equation 1.

$$A(x,y) \equiv \pi(y)L(y) \tag{1}$$

The theoretical model above can be decomposed into two components. The first component is a production function of expected accident loss which represents the cost of illness or death from a foodborne illness. The second component is an objective function which describes a potential victim's tradeoff between utilizing avoidance expenditure, y, to reduce the likelihood of getting sick or deciding to purchase other goods.

$A(x,y)$ is the cost of illness or death caused by a food borne illness. The level of food safety is given by x (in this situation representing the assumption that a performance policy standard like PR/HACCP exists in the vegetable sector). y is the monetary equivalence of consumer hazard avoidance behavior. $\pi(y)$ is the probability of a foodborne illness or death occurring, and $L(x)$ represents the monetary equivalent loss to the victim should illness or death occur. $\pi(y)\pi$ and $L(x)$ are assumed to be non-negative, strictly decreasing, smooth convex functions defined on $x, y \in [0,+\infty]$. The consumer's optimal response for all values of x considered is defined as $y(x>0)$. An assumption that a consumer will choose the optimal hazard avoidance value, y, when given x is also made. In such a scenario, x represents expenditure for employing PR/HACCP, which is mirrored in an average individual's perception of risk. The average individual will, therefore, decide on y (the monetary equivalent of consumer hazard expenditure) given the individuals' perception of risk after x (food safety policy PR/HACCP in this case) has been established by policy. This is obtainable because, by assumption, $L(x) \geq 0$. Equation 2 represents the behavioral assumption of OB.

$$E(C) = I - [A(x, y) + y], \tag{2}$$

where I is the total income.

Equation 2 is the second component in the offsetting behavior model expressing the behavioral assumption that a consumer decides on avoidance expenditure with the aim of maximizing his expected consumption (Hause, 2006). Differentiating equation 2 in terms of y, we arrive at equation 3.

$$MaxE(C) \leftrightarrow Min[A(x, y) + y] \rightarrow \frac{d[A(x, y) + y]}{dy} = \frac{d[\pi(y)L(x) + y]}{dy} = \pi'(y)L(x) + 1 \tag{3}$$

Equation 2 is differentiated with respect to y to arrive at equation (3). This is the case because it is considered that an individual who decides on $A(x, y)$ and obtaining other goods is an average consumer. This individual has only y at his disposal (monetary equivalent of consumer hazard expenditure) and not x (level of food safety regulation in this case PR/HACCP). From his or her viewpoint, x is fixed and taken as a constant. Due to the fact that we are looking for the maximum of expected consumption ($E(C)$) which corresponds to minimizing $[A(x, y) + y]$, there is need to equate the first derivative to zero. Going from our assumptions, we already know that $A(x, y)$ has a minimum and that y is non-negative. By implicit differentiation of our first derivative, we get equation (4).

$$\pi''(y)\frac{dy}{dx}L(x) = -\pi'(y)L'(x) \rightarrow y' = -\left[\frac{\pi'(y)L'(x)}{\pi''(y)L(x)}\right] \tag{4}$$

Definition 1

To present a scenario for the existence of OB, x (the food safety regulation) is set to be zero (that is no information has been given to consumers); as such $y = y(0)$ and the expected accident loss therefore becomes $\pi[y(0)]L(0)$. As a result of the adoption of PR/HACCP, new information gets into the hands of the consumer, consequently, expenditures $x^1 > 0$ (e.g. PR/HACCP application and monitoring expenditures). It follows that consumer's offsetting behavior occurs if equation (5) below is satisfied.

$$\pi[y(x^1)]L(x^1) > \pi[y(0)]L(x^1). \tag{5}$$

Proposition 1

Food safety policies expenditures x always cause offsetting behavior by consumers in the representation of expected hazard loss.

Proof of Proposition 1

Examining the sign of y' from equation (4) leads us to equation 6

$$y' = -\left(\frac{L'(x)\pi'(y)}{L\pi'}\right) < 0, \forall x, y \geq 0 \tag{6}$$

As $\pi(x)$ and $L(y)$ by assumption are non-negative, ($L(x) \geq 0$ and $\pi(y) \geq 0$) strictly decrease and smooth functions as such ($L'(x) < 0$ and $\pi(y) < 0$) and again ($L''(x) > 0$ and $\pi''(y) > 0$. It is expected that the average consumer believes the risk of getting sick from food borne disease is reduced because of new safety information from the implemented regulation. Individual's health hazard avoidance expenditure should reduce consequently. This is intuitive since $y(x)$ is a decreasing function of x (having a negative slope $y' < 0$). This result concurs with the fact that an increase of x from zero to x^1 will mean a consequent reduction of y from $y(0)$ to $y(x^1)$. This implies that with new information, the probability of a food safety hazard occurring increases (π will increase from $\pi[y(0)]$ to $\pi[y(x^1)]$. The above result is a case of offsetting behavior.

Dominant Offsetting Behavior

Definition 2

Consumer's offsetting behavior is dominant if it more than completely offsets the reduction in expected health hazard loss from the direct effect of the food safety policy.

Proposition 2

If an increase in x signifies dominant offsetting behavior to the consumer, the level of food safety regulation x is an inferior factor in improving the health hazard loss to consumers as a result of a food borne illness.

Proof of Proposition 2

Dominant offsetting behavior occurs if the inequality $A[x^1, y(x^1)] > A[0, y(0)]$ is satisfied and in line with definition, a factor of production is inferior if higher output uses less of the factor. All elements within the range of function A correspond to a harmful (loss) event for individuals and society as a whole. Therefore $-A$, the negative value embodies a gain to individuals and society at large. If a rise in x brings about dominant offsetting behavior, x must be an inferior factor in the production of $-A$; more of x means less of $-A$.

To detect the conditions necessary for dominant offsetting behavior, the marginal effect of x is divided into the direct effect of x (e.g. the reduction in health hazard loss after the new food safety policy has been implemented) and the indirect offsetting behavior of x on y. To do this, we proceed to define the marginal effect of x as follows: $A(x) = A[x, y(x)]$, and move forward to take total derivative to arrive at equation (7).

$$\left[\frac{dA(x)}{dx}\right] = A_x\left(1 - \left[\frac{\frac{A_{xy}}{A_{yy}}}{\frac{A_X}{A_y}}\right]\right) \tag{7}$$

$\left(\frac{\frac{A_{xy}}{A_{yy}}}{\frac{A_x}{A_y}}\right)$ is the consumer's marginal offsetting behavior. It evaluates by what proportion the direct marginal effect of x on A is decreased by the victim's offsetting behavior. If the marginal offsetting behavior is greater than 1 for $0 < x < x^*$, this means dominant offsetting behavior for food safety policy x^*. This is the case due to the fact that $1 - \left(\frac{\frac{A_{xy}}{A_{yy}}}{\frac{A_x}{A_y}}\right)$ will be negative, which is multiplied by A_x and becomes positive.

Consequently, $\left[\frac{dA(x)}{dx}\right]$ is positive, leading to the conclusion that the function $A(x) = A[x, y(x)]$ will rise for x^* relative to x ultimately causing dominant offsetting behavior. Substituting equation (1) into equation (7) leads to equation (8).

$$\frac{dA(x)}{dx} \equiv \pi L'\left[1 - \frac{\left((\pi')^2\right)}{\pi\pi''}\right] \tag{8}$$

Where $\frac{\left((\pi')^2\right)}{\pi\pi''}$ is the reduction of the marginal direct effect of x due to OB which is dependent on y and not x.

Partial Offsetting Behavior

Consumer's OB is partial if it less than absolutely counterbalances the decrease in expected health hazard loss from the direct impact of the food safety policy. If the marginal offsetting behavior is less than 1 for $0 < x < x^*$, this implies partial offsetting behavior for food safety policy x^* due to the fact $1 - \frac{\left(\frac{A_{xy}}{A_{yy}}\right)}{\left(\frac{A_x}{A_y}\right)}$ will be positive.

Multiplying this expression by A_x causes the expression to become negative. Showing that in this situation, the expression; $\left[\frac{dA(x)}{dx}\right]$ is negative. The function $A(x) = A[x, y(x)]$ will decrease for x^* in comparison to x, resulting in partial offsetting behavior for the food safety policy. The consumer's marginal offsetting behavior $\frac{\left(\frac{A_{xy}}{A_{yy}}\right)}{\left(\frac{A_x}{A_Y}\right)}$ is positive since ($A_{xy} > 0, A_{yy} > 0, A_x < 0$, and $A_y < 0$).

Empirical Analysis

Consumer's perception of foodborne risk is affected by locus of control (measures undertaken to enhance safety), personal health influence (past experience with a foodborne illness), outrage (simply explained as the fear of the unknown), and demographic characteristics (e.g., age, income, and education) (Nganje *et al*., 2005). The initial perceived risks of individuals are often unobservable, they can however be obtained through survey methods (Smith *et al*., 1990). A survey based on the factors that influence individuals foodborne related risk perception handling, and preparation practices was carried out. Factor analysis was used to create risk tolerance indexes for each of the factor that influence consumer's risk perception. Factor analysis is a statistical approach that entails compressing information contained in a large number of original variables into a smaller set of measurement (factors) with a minimal loss of information (Hair *et al*., 1992). Only those factors that had significant enough contribution were used to carry out the empirical analysis.

Two models were used to evaluate the subject's OB, using the consumer's perception of risk and behavior on safe food handling and consumption preferences as proxies for OB. This evaluation was carried out using a discrete choice, Tobit regression. Simplified equations for our model are shown on equations 9 and 10:

$$OB = f\,(BH, I) \qquad (9)$$

$$BH = f\,(RP), \qquad (10)$$

where *BH* is change in consumer behavior, *RP* is risk perception, and *I* food-safety information.

Risk Tolerance Index as a Measure of Offsetting Behavior

If consumer's risk tolerance can be described by their response to a particular question, that question can serve as a proxy for actual food-safety risk tolerance (Brown *et al*., 2005). The food-safety risk tolerance measure used is a compound measure that blends several variables associated with consumer's food-safety risk perceptions. It is assumed that the value of the indexes is a reflection of consumer's actual food-safety risk tolerance. Compound indexes are suitable in such an evaluation given that they overcome measurement errors found in a single variable and characterize the various aspects of a concept (Hair *et al*., 1998).

Risk Tolerance and the Integration of Food-Safety Risk Information

The risk tolerance index is a representation of how individual subject's perception of risk fluctuates. Information plays an important role in this relationship. Consumer's propensity to absorb new information into their risk perception and respond to it could be related to their risk tolerance. Empirically, consumer's objective risk perceptions can neither be practically evaluated nor recuperated from consumption activities (Lui *et al*., 1998). There is a need to utilize a suitable evaluation method that can capture such a hidden trend involving a latent variable like a subject's perception of risk. The Tobit model devised by Tobin (1958) is a suitable model to capture latent variables (e.g., change in an individual's perception in this case).

The Tobit Model

The stochastic model of the Tobit regression and decomposition adopted from Greene (2003), Fen and Schmidt (1984) and McDonald and Moffitt (1980) is represented in equation 11.

$$Y_t = X_t\beta + \varpi_t \text{, if } X_t\beta + \varpi_t > 0 \qquad (11)$$
$$Y_t = 0, \qquad \text{if} \quad X_t\beta + \varpi_t \leq 0 \qquad t = 1,2,.........V$$

Where V is the number of variables, Y_t is the dependent variable, X_t is a vector of independent variables, β is a vector of unknown coefficients, and ϖ is an independently distributed error term which is assumed to be normal with zero mean and constant variance σ^2. The Tobit model assumes that there exists an underlying random index which is observed only when it is positive, as such making it an unobserved latent variable.

Empirical Test

A total of 2,583 respondents participated in the experiment. All participants involved in the experiment were older than eighteen years of age, and specified that they eat fresh vegetables a least three times each week. The experiment involved a cross section of ethnic groups. Approximately 68.22% of participants indicated being white, 17.89% black, 10.76% being Hispanic, 1.94% Asian, and 1.24% being Native American and others who never indicated their race. A matched sample design was utilized to get rid of the variation between samples as a source of sampling error. Subjects were asked a particular question thrice about their preparation style preference for vegetables and their perception of risk at a two-week interval. Three experiments were conducted to elicit consumer preference and risk perception.

In the initial experiment, the questionnaire was structured in a manner that no specific allusion was made to food safety. The second experiment involved the provision of negative food safety information to respondents. The third experiment involved giving the respondents positive food-safety information. Positive and negative information given to the respondents was obtained from newsletter articles which is an efficient source of food-safety information.

Negative Information: The U.S. Centers for Disease Control boosted its estimate of the food borne pathogens danger. It is estimated that 5000 people die from food related illness. The Most recently publicized outbreaks are the 2003 green onion Hepatitis A and the 2006 *E. coli* O157: H7 and *Salmonella* nationwide outbreaks (Onyango *et al*., 2007).

Positive Information: Through advances in food safety, the United States has the safest food supply in the world (Agweek-October 28, 2002).

Table 1.1: Factor Loadings and Factor Score Coefficients for Loaded Questions.

Variables	Factor Loadings	Score Coefficients
Q 16	.744	.634
Q 17	.752	.580
Q 19	.500	.403
Q 28	.644	.476
Q 31	.547	.436

*Description of variables can be found in Table A1.

Table 1.2: Means and Standard Deviations for Loaded Questions.

		No Information		Negative Information		Positive Information	
Categories	Variables	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Locus of Control	Q 16	2.311	1.047	2.295	1.041	2.262	1.054
	Q 17	2.315	0.783	2.299	0.775	2.304	0.783
	Q 19	1.984	1.311	1.990	1.300	2.072	1.358
Personal Health influence	Q 28	3.187	.911	3.199	0.886	3.075	0.888
Outrage	Q 31	1.057	0.256	1.070	0.274	1.060	0.265

Table 1.3: Change in Mean of Preparation Style Preference and Perception of Risk.

	No Information		Negative Information		Positive Information	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Preparation style preference (Q 17)	2.315	0.783	2.299	0.775	2.304	0.784
Consumer's perception (Q 18)	1.680	0.016	0.693	0.024	1.631	0.025

Descriptive Statistics and ANOVA Analysis

To access if there is any alteration in the subject's preparation style for the variables, the means and variances for perception of risk and preparation style preference were calculated. Table 1.3 shows results for the change in mean values for the subject's preparation style preference or convenience and their perception of risk.

Following from Table 1.3, the mean values of the preparation style preference for spinach vary for the three different information stages of the experiment. It decreases from 2.315 (when no mention of food safety is made) to 2.299 (as negative information on outbreaks and impact of *E. coli* O157 is provided) then increases slightly to 2.304 (when positive information from HACCP is made available). The mean value of consumer's perception of risk about the spinach they consume varies significantly with the change in information stages. It decreases from 1.680 (with no information) to a low of 0.693 (with negative information on outbreaks and the consequences of *E. coli* O157: H7) and then increases considerably to 1.631 (with the provision of positive information from PR/HACCP).

With the change in means of preparation style preference and perception observed across information stages observed above, there is a need to statistically test whether the changes observed in the subject's risk tolerance are statistically significant. Two hypotheses are tested in line with the data from the three different experiments. The analysis of variance (ANOVA) method can help determine if two or more samples have the same mean or average. The results of the ANOVA test to statistically analyze the change in consumer's mean perception observed in the different information stages is presented in Tables 1.4 and 1.5. The null hypothesis advanced in both cases is that the mean of the preparation preference of spinach are equal for all information stages.

Table 1.4: Hypothesis Test Results for the No and Negative Information Stages.

ANOVA						
Source of Variation	SS	DF	MS	F	P-Value	F-Critical
Between Groups	686.628	1	686.628	1176.841	0.000	3.845
Within Groups	1645.33	2820	0.584			
Total	2331.957	2821				

Comparing the change in consumer's mean perception for the no information and the negative information stages, the null hypothesis advanced is rejected at the 1% level of significance with a p-value of 7.5E-216. In line with the result above, there is therefore enough evidence to suggest that no information and the negative information stages of the experiment have means that are statistically different from each other. Consumer's perception therefore changes when negative information about the impact of consuming spinach contaminated with *E. coli* O157:H7 is given to them. In a similar manner, we test the second null hypothesis that the mean values of negative food safety information from the effect of the lethal *E. coli* O157:H7 and that for positive information from PR/HACCP are equal.

Table 1.5: Hypothesis Test Results for the Negative and Positive Information Stages.

ANOVA						
Source of Variation	SS	DF	MS	F	P-value	F-Critical
Between Groups	363.046	1	363.046	531.039	0.000	6.648
Within Groups	1361.835	1992	0.684			
Total	1724.881	1993				

Comparing the variation in consumer's mean perception from the negative to the positive information stages, the null hypothesis of equality of mean perception was rejected at the 1% level of significance with a p-value of 0.000. There is enough evidence to suggest that both negative and positive information stages have means that are statistically different from each other. This also implies that subjects adjust their perception as soon as information on the positive effect of PR/HACCP is given to them.

The analysis of variance results suggest that consumer's became less vigilant in light of the hazard of *E. coli* O157:H7 because of their perception that a greater part of the threat from pathogens in spinach was mitigated by the implementation of PR/HACCP. The above results are in accordance with Onyango *et al*. (2007) who after the 2006 nationwide spinach recalls found that consumers have trust in government actions and engagement with regards to food safety issues. Holistically, these results suggest the presence of OB where a food safety policy is enacted to decrease the number of possible victim's contamination from *E. coli* O157 and other bacteria which cause food poisoning. Here OB is shown in the consumer's lessened care in the face of articulated policy. Food safety fears fade away because of policies put in place and as such the function played by consumer's level of alertness in preparation of spinach declines while secondary characteristics become their preoccupation.

To evaluate whether the offsetting behavior is dominant or partial, we need further analysis for elucidation. To do this two regression models were carried out to test the hypothesis that dominant OB may be what is obtainable from the subject's reaction to food safety information. Dominant OB in this light would signify that the marginal effect of information concerning the positive HACCP policy impact leads subject's preparation style preference for spinach to rise to at least the level before any information on food safety was made available. Marginal benefit analysis will help us deduce whether the OB is dominant or partial.

Table 1.6: Summary of Tobit Regression Regarding the Offsetting Behavior.

Variables	Coefficients	Marginal Effect
Factor 1: Locus of Control	-0.033* (0.019)	-0.030*
Factor 2: Personal Health Influence	0.031* (0.019)	0.029*
Factor 3: Outrage	-0.049*** (0.019)	-0.045***
D1	1.682*** (0.026)	1.528***
D2	1.666*** (0.040)	1.514***
Sigma	0.974*** (0.014)	

*** and * denote significance at 1% and 10%, respectively.

Results from Table 1.6 indicate that the dummy variables which represent the two information stages D1 and D2 are statistically significant at the 1% level of significance. This confirms the important role information plays in our evaluation of offsetting behavior. Outrage is significant at the 5% level. A reduction in the number of times spinach is consumed in a week leads to lowered perception of risk with no information and negative food safety information. The personal health influence is significant at 10%. This suggests that the higher the age of a consumer, the higher their perception of risk. Thus as subjects grow older, they become more cautious about how they prepare and consume their vegetables. Increased age will mean a greater risk of getting sick from consuming contaminated vegetables, a possible reason why older consumers are more careful in the way they prepare and consume their vegetables.

Table 1.7: Summary of Tobit Regression Regarding the Change in Information Stage.

Variable	Coefficient	Marginal Effect
Factor 2: Personal Health Influence	0.031* (0.019)	0.029*
Locus of Control * Information Stage	-0.017* (0.010)	-0.016*
Outrage* Information Stage	-0.034*** (0.010)	-0.030***
D1	1.681*** (0.026)	1.528***
D2	1.665*** (0.040)	1.514***
Sigma	0.973*** (0.014)	

***, **, and * denote significance at 1%, 5%, and 10%, respectively.

The marginal effect results shown in Table 1.7 indicate that the marginal increase in positive food safety information will reduce the likelihood of consuming spinach with safe attributes and the frequency of consuming spinach per week by 1.57% and 3.04% corresponds with regard to locus of control and outrage. Intuitively, these results indicate that positive information affects two of the factors in the risk tolerance that are under the control of a consumer (locus of control and outrage) which can lead to dominant OB in response to food safety policy. This is obtainable given that the consequence of marginal changes in food policy information is a more than balanced variation in consumers' risk perception hence behavior. The above results concur with theoretical results presented by Hause (2006), and lend a hand to the fact that various media outlets (e.g., newspapers, newsletters, the television and radio) are able to change consumer's perception of risk and hence the outcome of food safety policies on the basis of the information conveyed about foodborne illnesses and policies put in place for their mitigation.

SUMMARY AND CONCLUSION

Food-safety policy information from food safety regulations coupled with consumer's food-safety risk tolerance affect consumer's perception of risk. Construction of food safety risk tolerance indexes facilitated the examination of the relationship between risk tolerance indexes and the subjects perception of risk. Our findings show the presence of OB in the preparation and consumption of vegetables assuming that a mandatory policy similar to PR/HACCP is implemented in the vegetable sector. The variables under the control of consumers increase the possibility of consuming contaminated spinach. Locus of control and outrage will decrease the prospect of consumers eating safer spinach by 2.98% and 4.48% respectively.

Hause (2006) stressed that the ultimate effect of policy is an empirical subject. He also pointed out that the welfare inference of OB relies mainly on whether the decline in victim accident avoidance expenditure is considered a social gain or loss. With this in mind, an efficient analysis of the impact of a safety policy on expected accident loss and accident rates necessarily needs to consider the potential effects of OB. In perspective of the push towards a mandatory policy in the vegetable sector, OB should be taken into account before the impact of the regulation can be stated. Failure to do so will lead to exaggeration of policy impact and hence mislead consumers further compromising their health. OB should be taken into account to enhance the accountability and potential effect of enforced food-safety policies and regulations.

REFERENCES

Antle, J. M. 1999. "Benefits and Costs of Food Safety Regulation." *Food Policy* 24(6):605-623.

___. 1995. *Choice and Efficiency in Food Safety Policy*. Washington, DC: The AEI Press.

___. 2000. "No Such Thing as a Free Safe Lunch: The Cost of Food Safety Regulation in the Meat Industry." *American Journal of Agricultural Economics* 82(2):310-322.

Arrow, K. J., Croppe, M .L., Eads, G. C., Hahn, R. W., Lave, L. B., Noll, R. G., Portney, P. R., Schalensee, R., Smith, V. K., and Stavins, R. N. 1996. "Is There a Role for Benefit-Cost Analysis in Environmental, Health and Safety Regulation?" *Science* 272(5259):221-222.

Blomquist, G, C. 1988. *The Regulation of Motor Vehicle and Traffic Safety*. Boston: Kluwer Academic Publishers.

Bocker, A., and Hanf, C. H. 2000. "Confidence Lost and-Partially- Regained: Consumer Response to Food Scares *Economic*." *Journal of Economic Behavior and Organization* 43(4): 471-485.

Brown, J., Cranfield, J. A., and Henson, S. 2005. "Relating Consumer Willingness-to-Pay for Food Safety Risk Tolerance: An experimental approach." *Canadian Journal of Agricultural Economics* 53(2-3):249-263.

Bryan. F. L. 1982. *Disease Transmitted by Foods*, 3rd. ed. Atlanta: U.S. Department of Health and Human Service, Public Health Service, Centers for Disease Control, Center for Professional Development and Training.

Buzby, J. C., and Ready, R. C. 1996. "Do Consumers Trust Food Safety Information?" *Food Review*, January-April, pp. 46-49.

Caswell, J. A. 1988. *Federal and State Regulations of Food Product Safety and Quality: A Selected, Partially Annotated Bibliography*. Washington DC: U.S. Department of Agriculture, ERS For. Bibliographies and Literature of Agriculture. Rep. 70,

___. 1998. "Valuing the Benefits and Costs of Improved Food Safety and Nutrition." *The Australian Journal of Agricultural and Resource Economics* 42(4): 409-424.

Center for Disease Control. 2006. *Preliminary FoodNet Data on the Incidence of Food Borne Illnesses-Selected Sites, United States, 2005, Morbidity and Mortality Weekly Report*. Atlanta GA, April.

Eom, Y. S. 1995. “Setting the Stage: Research Perspectives and Theoretical Models.” In Caswell, J. A, Ed. *Valuing Food Safety and Nutrition.* Boulder CO: Westview Press, pp. 27-49.

Food and Drug Administration, Center for Food Safety and Applied Nutrition. FDA, CFSAN). 1998. *Guidance to Minimize Microbial Hazards for Fresh Fruits and Vegetables*. Washington DC, October.

Food and Drug Administration, Center for Food Safety and Applied Nutrition (FDA, CFSAN). 2002. “*FDA Recall Policy for Cosmetics*.” *Title 21 of the Code of Federal Regulations (CFR), Section 7.3 (g) (Title 21 CFR 7.3 (g)*). Washington DC, July.

Foster, W., and Just, R. E. 1989. “Measuring Welfare Effects of Product Contamination with Consumer Uncertainty.” *Journal of Environmental Economics and Management* 17(3): 266-283.

Hair, J. F., Anderson, R. E., Tathan, R. L., and Black, W. C. 1998. *Multivariate Data Analysis*. New Jersey: Prentice-Hall Inc.

Hathaway, S. C. (1995). “Harmonization of International Requirements under HACCP-Based Food Control Systems.” *Food Control* 6(5):267-276.

Hause, J. C. 2006. “Offsetting Behavior and the Benefits of Safety Regulations.” *Economic Inquiry* 44(4):689-698.

Henson, S., and Caswell, J. A. 1999. “Food Safety Regulation: An Overview of Contemporary Issues”. *Food Policy* 24(6):589-603.

Jensen, H., and Unnevehr, L. 1999. HACCP in Pork Processing: Costs and Benefits.” Working paper, Center for Agricultural and Rural Development., Iowa State University.

Kenkel, D. 1994. “Cost of Illness Approach.” In G, Tolley., D, Kenkel., R, Fabian, Eds. *Valuing Health for Policy*: *An Economic Approach.* Chicago IL: The University of Chicago Press, pp. 42-71.

Kinsey, J. 1993. “GATT and the Economics of Food Safety.” *Food Policy* 18(2):163-176.

Klein, N. L., and Brester, G.W. 1997. "Economic Impacts of the Zero Tolerance Directive on the Cost Structure of Beef Packing Companies." Paper Presented at the WAEA Meetings, Reno/Sparks, Nevada, 13-16 July 1997.

Krauter, B. 2007. *Stakes are High for Leafy Green Industry: USDA Official Warns of Possible Federal Regulations. Statement by California Regional Director of US_FDA.* Sacramento CA, February.

Lave, L. B., and Weber, E. W. 1970. "A Benefit-Cost Analysis of Auto-Safety Features." *Applied Economics* 2 (4):265-275.

Lui, S., Huang J-C., and Brown, G. L. 1998. "Information and Risk Perception: A Dynamic Adjustment Process." *Risk Analysis* 18(6):689-699.

McIntosh, W. A., Christensen, L. B., and Acuff, G. R. 1994. "Perceptions of Risks of Eating Undercooked Meat and Willingness to Change Cooking Practices." *Appetite* 22(1):83-96.

Miljkovic, D., Nganje, W., and Onyango, B. 2008. "Food Safety Offsetting Behavior and the Benefits of Food Safety Regulation." *Journal of Food Safety*, In Press.

Morall III, J. F. 1997. "An Assessment of the U.S. Regulatory Impact Analysis Program. Regulatory Impact Analysis: Best Practices in OECD Countries". Paris: Organization for Economic Corporation and Development.

Nganje, W. E., Kaitibe, S and Taban, T. 2005. "Multinomial Logit Models Comparing Consumers' and Producers' Risk Perception of Specialty Meat." *Agribusiness* 21(3): 375-390.

Nganje, W., Miljkovic, D., Voica, D., and Onyango, B. 2007. " Offsetting Behavior and the Benefits of Food Safety Policies." North Dakota State University Agr. Exp. Sta. Bull. No 616.

Onyango, B., Miljkovic, D., Hallman, W., Nganje, W., Coundry, S., and Cuite, C. 2007. "Food Recalls and Food Safety Perceptions: The September 2006 Spinach Recall Case." Selected Paper Presented at the AAEA Annual Meetings, Portland OR, July 28-31.

Palmer, S., Parry. S., Perry, D., Smith, R., Evans, M., Nehaul, L., Roberts, R., Walapu, M., and Wright, D. 2000. "The Role of Outbreaks in Developing Food Safety Policy: Population Based Surveillance of Salmonella Outbreaks in Wales 1986-1998." *Epidemiology and Infection* 125(3):467-472.

Peltzman, S. 1975. "The Effects of Automobile Safety Regulation." *The Journal of Political Economy* 83(4):677-795.

Peterson, S. P., Hoffer, G. E., and Millner, E. 1995. “Are Drivers of Air-Bag Equipped Cars More Aggressive? A Test of the Offsetting Behavior Hypothesis.” *Journal of Law and Economics* 38(2):265-279.

Poitras, M., and Sutter, D. 2002. “Policy Infectiveness or Offsetting Behavior? An Analysis of Vehicle Safety Inspections.” *Southern Economic Journal* 68(4):922-934.

“Proper HACCP Implementation will make a Good Tool Better.” *AgWeek Magazine*, October, pp. 25.

Roberts, T. 1991. “A Survey of Estimated Risks of Human Illness and Costs of Microbial Foodborne Disease.” *Agribusiness* 9(1):5-23.

Roberts, T. 1991. “A Survey of Estimated Risks of Human Illness and Costs of Microbial Foodborne Disease.” *Agribusiness* 9(1):5-23.

Rozin, P., Fischler, C., Imada, S., Sarubin, A., and Wrzesniewski, A. 1999. “Attitude to Food and the Role of Food in Life in the USA, Japan, Flemish Belgium, and France: Possible Implications for the Diet-Health Debate.” *Appetite* 33(2):163-180.

Segerson, K. 1999.” Mandatory Versus Voluntary Approaches to Food Safety.” *Agribusiness* 15(1):53-70.

Smith, V. K., Desvousges, W. H., Johnson, F. R., and Fischer, A. 1990. “Can Public Information Programs Affect Risk Perceptions?” *Journal of Policy Analysis and Management* 9(1):41-59.

Stigler, G. J. 1971. “The Theory of Economic Regulation.” *Bell Journal of Economics and Management Science* 2(1):3-21.

Swartz, D. G., and Strand, I. V, Jr. 1981. “Avoidance Costs Associated with Imperfect Information: The Case of Kepon.” *Land Economics* 57(2):139-150.

Swanger, N., and Rutherford, D. G. 2004. “Foodborne Illness: The Risk Environment for Chain Restaurants in the United States” *International Journal for Hospitality Management* 23(1):71-85.

Tobin, J. 1958. Estimation of Relationship for Limited Dependent Variables.” *Econometrica* 26: 215-231.

Unnevehr and Jensen, H. H. 2001. *Industry Compliance Costs: What Would They Look Like in Risk Based Integrated Food System*? Ames, Iowa: Center for Agricultural and Rural Development, Iowa State University.

U.S. Department of Agriculture, Food Safety and Inspection Service. (USDA, FSIS). 2001 *Recall Case Archive*. Washington DC, November.

U.S. Department of Agriculture, Food Safety Inspection Service, 1996. *The Final Rule on Pathogen Reduction and HACCP*. Washington DC, July.

Viscusi, K. W. 1985. “Consumer Behavior and the Safety Effects of Products Regulation.”*Journal of Law and Economics* 28(3):527-533.

Wilde, G. J. S. 1994. *Target Risk*. Toronto: PDE Publications

Wynne, B. 1980. “Technology, Risk and Participation: On the Social Treatment of Uncertainty”. In J. Conrad, Ed. *Society, Technology and Risk Assessment* New York NY: Academic Press, pp. 83-107.

APPENDIX

Table A1. Survey Questions

Variable Description
DEPENDENT VARIBLE Q18. How will you rank your perception for safety for spinach products? 1=Safe; 2=Somewhat safe; 3=Not safe; 4=Other LOCUS OF CONTROL Q16. How do you like your spinach? 1=Fresh bulk; 2=Fresh prepack; 3=Frozen; 4=Canned Q17. What is your preference for convenience? 1=Sort; 2=Wash; 3=Ready to eat; Q19. What is the preference for the source of your spinach? 1= Produced locally; 2= Imported from other States; 3=Imported from other country DEMOGRAPHICS Q29. Which of the following best describes your ethnicity? 1=Hispanic; 2=White; 3=Black/African American 4=Asian; 5=Indian American/Others Q32. What is your highest level of education? 1=College educated; 2=High school PERSONAL HEALTH INFLUENCE Q28. Please select your age 1=18-21; 2=22-34; 3=35-54; 4=55-64. Q33. Where do you obtain information about food safety? 1=Newspaper; 2=TV; 3=Food labels; 4=I don’t know Q35. Has any member of your family ever suffered from severe food Poisoning? 1=Yes; 2=No OUTRAGE Q31. How often do you consume spinach per week? 1=1-3; 2=4-6; 3=7 plus