

OFFSETTING BEHAVIOR AND THE BENEFITS
OF FOOD SAFETY POLICIES IN VEGETABLE
PREPARATION AND CONSUMPTION

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Offsetting Behavior and the Benefits of Food Safety Policies

in Vegetable Preparation and Consumption

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ABSTRACT

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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 consumers' perception of risk. 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 harm to potential victims. The total effect of such food-safety policies looked at in terms of reduction of foodborne illness, mortality, and food-related diseases may possibly be smaller than the forecasted effect because of failure to consider offsetting behavior. Attenuation and possibly reversal of the direct policy effect on expected injuries may arise because of offsetting behavior.

This study combines both theoretical and empirical models to test the presence of dominant or partial offsetting behavior (OB) 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. Our findings indicate that food-safety information that has an effect on outrage and locus of control, both factors which have an effect on consumers' perception of risk, will lead consumers to become lax in response to this food-safety policy.

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TABLE OF CONTENTS

ABSTRACT	iii
ACKNOWLEDGEMENTS.....	iv
LISTS OF TABLES	vii
LISTS OF FIGURES.....	viii
LISTS OF APPENDIX TABLES	ix
CHAPTER I. INTRODUCTION	1
Background Information on Offsetting Behavior	1
Detailed Examples of Major Policies and Outcomes Exhibiting Offsetting Behavior.....	7
Statement of Problem.....	8
Food-Safety Policies and Recalls in the Vegetable Sector	11
Goal, Objectives, and Hypothesis	12
Evidence of Offsetting Behavior in Vegetable Preparation and Consumption	13
Organization of the Study	14
CHAPTER II. LITERATURE REVIEW	15
Comparative Analysis of Food-Safety Policies	15
Benefits and Costs of Food-Safety Regulation	20
Benefits of Food-Safety Regulation.....	22
Costs of Food-Safety Regulation	24
Offsetting Behavior and Food-Safety Information	26

CHAPTER III. METHODOLOGY AND DATA31

Theoretical Framework 31

Dominant Offsetting Behavior 35

Partial Offsetting Behavior 38

Empirical Analysis 38

Risk Tolerance Index as a Measure of Offsetting Behavior 40

Risk Tolerance and Integration of Food-Safety Risk Information 43

The Tobit Model..... 45

Survey Data 46

Description of Survey and Data Collection Procedure 47

Risk Index and Perception of Risk..... 48

CHAPTER IV. RESULTS 49

Estimation of Risk Tolerance Index Using Factor Analysis..... 49

Descriptive Statistics and ANOVA Analysis..... 51

When Consumers are given Negative Food-Safety Information 53

When Consumers are given Positive Food-Safety Information 54

Risk Tolerance Index and Offsetting Behavior..... 56

Offsetting Behavior and the Benefits of Food-Safety Information 57

CHAPTER V. SUMMARY AND CONCLUSIONS 61

Policy Implication and Suggestion..... 63

REFERENCES 66

APPENDIX 80

LIST OF TABLES

<u>Table</u>	<u>Page</u>
4.1 Factor Loadings and Factor Score Coefficients for Loaded Questions	49
4.2 Means and Standard Deviation for Loaded Questions According to Category.....	50
4.3 Changes in Mean of Preparation Style Preference and Perception of Risk	52
4.4 Hypothesis Test Results for the No and Negative Information Stages	53
4.5 Hypothesis Test Results for the Negative and Positive Information Stages	54
4.6 Summary of Tobit Regression Regarding the Offsetting Behavior.....	56
4.7 Summary of Tobit Regression Regarding the Change in Information Stage.....	57

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1.1 Trends: Foodborne Disease Outbreak Surveillance System.....	10
2.1 Change in Perceived Risk with Positive Information After an Unfavorable Shock	29

LIST OF APPENDIX TABLES

<u>Table</u>	<u>Page</u>
A1. Variables Used in the Tobit Models	80
A2. Food Safety Information Provided to Questionnaire Respondents	81

CHAPTER I

INTRODUCTION

Background Information on Offsetting Behavior

Food-safety related worries occur at all levels of the supply chain of food crops, livestock, and related products: 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 potential victims from accidents and other harmful events. Some regulatory economic studies have theoretically (Peltzman, 1975; Hause, 2006) and empirically (Peterson and Hoffer, 1994; Blomquist, 1988) observed reductions, and in some instances, reversal of direct policy effects on expected harm may occur because of offsetting behavior (OB) 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. If the effect of offsetting behavior is overlooked, the expected outcome of food-safety policy implementation will be misleading.

Most empirical studies undertaken thus far have focused their attention on issues mostly related to traffic accidents (Lave and Weber, 1970; Peltzman, 1975), the effect of health policies on the way of life-dependent disorders and death (Wilde, 1994), and workplace and consumer product accidents (Viscusi, 1984a, 1984b, 1985, 1992). In his study of automobile safety regulations, Peltzman (1975) argued that improved automobile safety regulations would lead to offsetting behavior by drivers, as such increasing the probability of an accident, and possibly the expected accident loss. He suggested that the enhancement in automobile occupant safety is entirely offset by the heightened danger to

non-occupants. Pedestrians, bicyclists, and motorcyclists could be at significantly higher risk. Graham (1984) found drivers' behavioral response originating from an increase in pedestrians-cyclist deaths which supports the suggestion advanced in Peltzman (1975).

Despite continuing argument about the popularity and magnitude of the offsetting behavior effect, its existence is unquestionable. Notably, there was a 10% increase in head injury from bicycle accidents witnessed between 1990 and 2000 despite the mandatory implementation of bicycle helmets (Barnes, 2001). Wearing helmets affects cyclists' behavior (Hillman, 1993). Cyclist wearing helmets might ride recklessly due to their perception of increased safety consequently reducing or negating the benefits of helmet utilization (Hillman, 1993).

Helmet usage has been associated with increased number of neck injuries and fatalities thereby decreasing some of the beneficial effects of its usage (Goldstein, 1986). Factors which increase the likelihood of a bicycle accident are associated with increases in the likelihood of helmet use (Rodgers, 1996). Motorcycle riders encouraged to put on helmets might take greater risk in riding; which might increase both the gravity and possibility of an accident occurring (Adams, 1983).

The majority of road improvements allow greater speed which could counterbalance the associated safety improvements of the road (Wilde, 1994; Assum *et al.*, 1999). They observed that motorists drove faster with improved road conditions. Milton and Mannering (1998) found out that increasing the number of lanes on a given road segment might be responsible for the increase number of road accidents.

Keeler (1993) following research from Peltzman (1975) offered evidence that policies aimed at lowering rural speed limits had no influence in reducing the number of

road fatalities. He attributed this non reduction in fatalities to offsetting behavior. Mahalel and Szternfeld (1986) proposed that if drivers' perceptions caused them to underrate the complexities related with the driving task, the outcome could be an upsurge in accidents. Anti- lock brakes led to closer following in traffic by drivers putting them at a higher risk of getting an accident (Sagberg *et al*, 1997). They concluded that this was a manifestation of riskier behavior by victims and drivers in the face of progress in safety. Evans (1996) and Lund and O'Neill (1986) found evidence that accident reducing devices that provide dynamic reaction mechanisms may influence drivers' actions thus increase the probability of an accident. Rumar (1976) came out with the findings that drivers with studded tires drove with higher speed.

Seat belt usage from seat-belt laws increases non vehicle occupant fatalities (Garbacz, 1990a, 1992a). Garbacz (1992b) suggested that front seat belt laws put the unbelted rear seat passenger at greater risk. He confirmed his suggestion by pointing to the increase in rear-seat passenger fatalities in those states with front seat-belt laws. Evans and Graham, (1991) found evidence of offsetting behavior linked with the usage of seat belts. They found out that mandatory seat belt use in fact increased the number of non vehicle occupant deaths. They however concluded that the lifesaving effects of such regulation overwhelm any risk to non-occupants. Offsetting behavior can reverse the results of any improvement achieved by a safety habit. Calkins and Zlatoper (2001) found out that drivers exhibited offsetting behavior in the form of increased driving speed and reckless driving after a mandatory seat belt law was passed thereby increasing the potential for accidents occurring.

Hoffer and Miller (1992) noticed an increase in the relative frequency of insurance claims for 16 out of the 21 car models that had adopted airbags for the 1990 model year. This increase in insurance claims and severity of collision was confirmed by Mirnazari and Henning (1999). They found out that there was a 4.6% increase in insurance and severity of collision for air-bag equipped vehicles compared to those that had not adopted the airbag technology. Vehicle lines that adopted airbags in 1990 and 1992 incurred approximately 7 percent higher relative personal injury insurance claims in the initial year of airbag adoption (Peterson *et al.*, 1995). The relative injury and absolute collision losses are never lessened and usually worsen significantly for air-bag equipped cars relative to belt only equipped cars after airbag adoption (Peterson and Hoffer, 1994). Peterson and Hoffer (1996) reported analogous results for a Highway Loss Data Institute Index of collision frequency. They concluded that their results supported the idea that driver behavior becomes more risky to compensate for a sense of improvement in vehicle safety.

Another example of offsetting behavior that has been proposed to arise from the presence of an air bag is a decrease in seat belt use (Evans, 1991). He proposed that under the principle of “risk homeostasis” (Wilde, 1982, 1985, 1988) a driver of an air bag equipped vehicle may be willing to give up the additional benefit of a seat belt if he thinks that an air bag provides a higher level of protection relative to that of a seat belt. Evans (1991) concluded that the driver may thus wrongfully presume that the air bag alone provides an adequate level of protection. In their study of the effectiveness of the New Jersey seat belt law, Asch *et al.* (1991) found out that although injury severity declined, accident occurrence increased significantly after the law was enacted. Chirinko and Harper (1993) arrived at the same conclusion after replicating previous studies by Asch *et al.*

(1991). They also concluded that accidents tend to increase with improved automobile safety regulations.

Peterson, Hoffer, and Millner (1995) examined police accident reports for deadly two-vehicle' accident involving an airbag equipped automobile occurring in Virginia in 1993. They came out with the findings that in 73 percent of such accidents, the air airbag-equipped vehicle was found to be at fault. Relative injury claims experienced of particular vehicle lines change when a model has been redesigned significantly or has incorporated a major safety feature such as an airbag (Highway Loss Data Institute, 1993b)

Despite its preponderance and existence in the automobile industry, offsetting behavior also exist in other areas. Viscusi (1984a, 1984b, 1985, 1992) proposed that people may overestimate how safe a safety device is in mitigating accident risks by so doing, their protective actions might diminish. The probability of people leaving medicine containers open after the initiation of safety caps has soared, bringing about an increase in child poisoning from associated products (Viscusi, 1984a, 1984b, 1985, 1992). Child protective mechanism on lighter devices decreased risk perception, parental anxiety with lighter protection, and the necessity for consumer care heightening the potential for a mishap (Viscusi and Cavallo, 1996).

Peltzman (2001) proposed that when a medical innovation overcomes a well-known health risk, the direct outcome is improved health standard. He argued that the changed health risk from such an innovation may alter individual behavior. Time, effort and other resources allocated to avoid risk that has been eradicated will now be free for other activities, including those having additional mortality risk (Peltzman, 2001). The 1962 amendments of the U.S. Food Drug and Cosmetic Acts which were enacted to uplift

individuals' wellbeing led to increased consumer's losses instead of improving welfare as originally planned (Peltzman, 1973a, 1976b).

The Occupational Health and Safety Act (OSHA) of 1970 (29 USC 667, 18) was established nationwide to protect workers from job-related death, injury, and illnesses. It was described as the "Most significant legislative achievement for workers" (MacLaury (1984), however, some studies aimed at evaluating the effects of OSHA have not found any considerable benefits from its implementation.

Offsetting behavior has also been shown to be exhibited by workers in various workplace settings. Firm-level safety measures, whether embarked on autonomously or because of industry wide regulations affect actions undertaken by workers' negatively (Viscusi, 1979). Safety improvement measures by firms cause employees to reduce their own safety precautions thus increasing the occurrence of injuries (Viscusi, 1979).

Increased safety regulation to improve working conditions for workers actually increases occupational death rate (Klick and Stratmann, 2003). They observed that when workplace safety measures improved, workers took more risk and completely moved away from personal safety precautions. Klick and Stratmann (2003) attributed this unpredictable result to an occupational "Peltzman effect" (Peltzman, 1975).

Viscusi (1986) studied Workplace Safety Regulations in the U.S. manufacturing industry for 10 years and found little evidence of safety benefits resulting from such regulations. McCaffrey (1983); Ruser and Smith (1991) carrying out their research for the same period, arrived at similar conclusions as that from Viscusi (1986). In their research using an expanded plant-level data set Gray and Mendeloff (2002) suggested that the effect of workplace safety regulations dropped significantly during the 1990s.

The main objective of the farm policy is to stabilize farm income. However, despite the enactment of these policies, farm failures are rising (Featherstone *et al.*, 1998). Gabriel and Baker (1980) proposed that policies which decrease business risk raise financial risk due to larger borrowing. In line with the evaluations by Gabriel and Baker (1980), Collins (1985) presented a theoretical model of optimal leverage and illustrated that policies that reduced risk on the other hand raising income caused farmers to increase their liability relative to their assets.

Robinson and Barry (1987) studied the theoretical farm-level reaction to Commodity Credit Corporation Loan programs. They went forth to hypothesize that credit loan programs could lead to increased debt-asset ratio by farmers. These examples suggest a case of offsetting behavior where policies were implemented to enhance the financial position of farmers instead led them to take more risk (increased debt-to-asset) hence the increased number of farm failures witnessed. Given the above aspects where offsetting behavior is inherent, there is reason to suggest that offsetting behavior could be present in food preparation and consumption considering that society is constantly being made aware of progress made in food safety.

Detailed Examples of Major Policies and Outcomes Exhibiting Offsetting Behavior

The Food and Drug Administration (FDA) of the Department of Health and Human Services and the Food Safety Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA) which has the responsibility to ensure that meat, poultry and egg products are safe and accurately labeled (USDA, FSIS, 1996) in 1996 introduced new mandatory food safety regulations. This was following repeated discoveries of *E. coli* O157:H7 and *Salmonella* in the US. Food supply chain (Antle, 2000). This modern

regulation called the Pathogen Reduction/ Hazard Analysis and Critical Control Points (PR/HACCP) was to ensure the safety of meat and poultry products. The (PR/HACCP) mandated the establishment of critical control points (CCPs) in food production and processing operations, establishing regular testing for possible dangerous products.

A significant drop in pathogen levels was witnessed in the meat and poultry sectors by the year 2000, after the mandatory adoption of PR/HACCP (CDC, 2006). Reduction in pathogen levels included: 30% reduction in *Campylobacter*, a 9% reduction in *Salmonella*, a 32% reduction in *Listeria*, and a 29% reduction in *E. coli* O157:H7 (CDC, 2006). This evaluation also indicated that there was a 41% increase in *Vibrio* a bacterial pathogen frequently associated with raw fish or sea food (filter feeders) (CDC, 2006).

Despite reduction in the level of most pathogens, the number of outbreaks from retail facilities has increased noticeably (CDC, 2006). There were a significant number of outbreaks in the vegetable sector in 2006, after the major fall in 2003 (CDC, 2006). Nationally, the number of all food borne illness outbreaks per year has increased relatively even though pathogen prevalence is lower. This difference between lower pathogen levels and increasing outbreaks may suggest the presence of offsetting behavior in food-safety.

Statement of Problem

More than 200 known diseases are transmitted through food with causes of food borne illnesses including viruses, bacteria, parasites, toxins, and metals (Bryan, 1982). Food borne illnesses associated with the pathogen outbreak (examples include: *Salmonella*, *Listeria*, and *E. coli*) in the food chain represent a significant burden on the U.S. population and the public health system as a whole. Foodborne diseases are estimated to cause approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the

United States annually (Kennedy *et al.*, 1999). The costs associated with these illnesses and deaths in the form of direct medical expenses and lost productivity are estimated to be between \$5 and \$6 billion annually (Mead *et al.*, 1999; Swanger and Rutherford, 2004) with an annual total societal cost of \$6-\$37.1 billion to the U.S. economy (Buzby *et al.*, 2001).

A huge number of pathogens presently that are responsible for most illnesses (e.g. *Campylobacter jejuni*, *E. coli* O157:H7, *Listeria monocytogenes*, and *Cyclospora cayetanensis*) were not recognized as causes of food borne illness merely 20 years ago (Mead *et al.*, 1999). Known pathogens are responsible for approximately 14 million illnesses, 60,000 hospitalizations, and 1,800 deaths with *Salmonella*, *Listeria* and *Toxoplasma* causing 1,500 deaths annually.

Outbreaks of food borne diseases have had an important influence on the development of public health policy (Palmer *et al.*, 2000). The 1993 *E. coli* O157:H7 outbreak and previous food borne disease outbreaks led to public outrage which motivated government/regulators and the various industries (beef, fish, and vegetables and fruits) to put in place stringent mechanisms which include: HACCP for the beef industry, HACCP for all marine food and the Industry Guide to Minimize Microbial Food Safety Hazards in Fruits and vegetables. Despite these stringent measures, there is still an increasing trend in the number of pathogen outbreaks witnessed annually. Figure 1.1 presents the general trend in foodborne illness outbreaks from 1983 to 2004. A steady and sharp increase is witnessed from 1996 to 2000 after which a relative decrease is observed. This noticeable increase coincided with the implementation of HACCP in the meat and poultry sector and the Implementation of the "Guide to Minimize Microbial Food Safety Hazards in Fresh Fruits

and vegetables” in 1998. This suggest a case of offsetting behavior where policy implementation to reduce mortality and morbidity from food consumption are reduced or reversed.

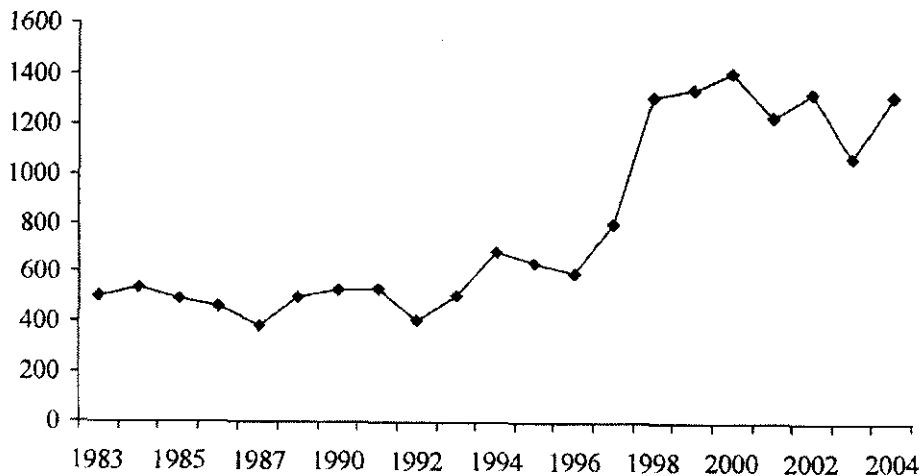


Figure 1.1: Trends: Foodborne Disease Outbreak Surveillance System.
Source: CDC (1983-2004).

Some advances have been undertaken in reducing the incidence of food borne infections originating from four main pathogens including; *Listeria*, *Campylobacter*, *Shigella*, and *Yersinia*. Shiga toxin-producing *E. coli* has declined and is approaching levels targeted by national health objectives (CDC, 2006). Onyango *et al.* (2006) advanced that the 2006 *E. coli* 0157:H7 outbreak in spinach, which was responsible for more than 200 reported cases of illness and three deaths and previous outbreaks, have somehow upset and wear down the public’s trust in the regulatory agencies and belief they had in the safety of the food supply chain. Holistically, consumers still have trust in the system. This self

assurance might reduce their participation in ensuring that the food (vegetables) they prepare and hence consume is safe.

Food-Safety Policies and Recalls in the Vegetable Sector

In 1998, due to an increase in reported outbreaks of food borne illnesses associated with both domestic and imported fresh fruits and vegetables, the U.S. Food and Drug Administration (USDA) published the “Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables” (FDA, CFSAN, 1998). This move was to support continuing efforts to develop national guidelines for food safety of fruits and vegetables. This document is intended to serve as guidance only. It is meant to address microbial food safety hazards and good agricultural practices common to the growing, harvesting, packing, and transportation of most fruits and vegetables sold and consumed in an unprocessed or minimally processed (raw) form (FDA, CFSAN, 1998).

Food recalls play a significant part in ensuring food safety. Recalls involve the removal of a food product from circulation by the producing firm when there is reason to believe that this product is contaminated or misbranded (Title 21 CFR 7.3 (g)). Recalls as such are voluntary but regulated by the FDA. The Food and Drug Administration Under (title 21 CFR 7) has guidelines for companies to follow when recalling adulterated products from circulation. These guidelines categorize recalls into one of three classes according to the level (descending order) of hazard involved. These are class I, II, and III recalls.

In its regulatory role of scrutinizing foods under recall, the Center for Food Safety and Applied Nutrition (CFSAN) of the U.S. Food and Drug Administration (FDA) observed an increase in the number of recalls of dried spices (any aromatic vegetable

substance in whole, broken or in ground form) due to adulteration. While only two such recalls occurred during the 1990s, 16 recalls were witnessed from 2000 through the first quarter of 2004 (Vibha *et al.*, 2006).

A noticeable increase in the number of recalls has been witnessed in the vegetable (fresh cut) sector. Some of these have been blamed on the non mandatory nature of good agricultural practice across the industry (Krauter, 2007). The 2003 green onion hepatitis A outbreak that originated from Mexico and the recent 2006 *E. coli*O157:H7 and *Salmonella* nationwide outbreaks (Onyango *et al.*, 2007) that led to recalls of varying magnitude are some major examples.

Goal, Objectives, and Hypothesis

The goal of this study is to develop risk tolerance indexes using factor analysis and use them to model the impact of information on consumers' perception of risk, handling and, preparation of vegetables when more stringent measures are put in place by government for the safety of vegetables. Emphasis is put on how positive and negative information impact risk perceptions, handling, and preparation practices. The specific objectives of this research are:

- To examine the relationship between food-safety associated risk tolerance and consumers' perception of risk.
- To evaluate and model the impact of both positive and negative information on consumers' 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 offsetting behavior in the preparation and consumption of vegetables.
- To provide guidelines and scope for policy makers to take into account offsetting behavior where it is significant, such that predicted food safety policy effects can be more accurately stated.

The hypothesis of this study is that there is no offsetting behavior exhibited by consumers in their preparation and consumption of vegetables. That is, putting in place of measures (PR/HACCP) to minimize the level of pathogen in vegetables actually does not change consumers' perceptions in such a way that they become less cautious on how they prepare and consume their vegetables. Specifically, we would test the null hypothesis that offsetting behavior does not exist in vegetable preparation and consumption with positive food safety information from policy.

Evidence of Offsetting Behavior in Vegetable Preparation and Consumption

Apart from the health benefits associated with regular consumption of vegetables, it presents other particular characteristics which make it suitable for our analysis.

- Vegetables are consumed in an unprocessed or minimal processed (raw) form.
- Vegetables are responsible for an increasing number of outbreaks.

There exists a large collection of literature on offsetting behavior dealing principally with traffic accident and mortality (Peltzman, 1975; Sagberg *et al.*, 1997), workplace safety (Viscusi, 1986; Klick and Stratmann, 2003) and consumer products accidents and mortality (Viscusi, 1984a, 1984b, 1985, 1992).

Taking these studies into account and considering the potential relevance of offsetting behavior where the implementation of policies alters consumers' behavior, certain observations can lead us to imply that offsetting behavior maybe present in the food sector and hence in the preparation and consumption of vegetables. Additionally, the increase trend of the number of nationwide recalls witnessed in recent years might be an indication of the presence of offsetting behavior in food-safety. Despite measures implemented in the form of regulations and guidelines to mitigate the level of pathogens

found in vegetables, the number of outbreaks and contaminations are on the rise instead of lessening.

Organization of the Study

This study is divided into five chapters. Chapter I presented a general background on areas where offsetting behavior exists and detailed examples in the food sector which suggest the existence of offsetting behavior in food safety. Chapter II reviews the food-safety policies in the different sectors, providing the benefits and cost of these regulations. It also provides insight on how information shapes consumers' perception of risk. Chapter III presents methods. It describes the offsetting behavior theoretical framework, empirical procedures, and the data used for the study. Chapter IV presents Results. Chapter V summarizes and concludes the study with implications and suggestions.

CHAPTER II

LITERATURE REVIEW

Comparative Analysis of Food-Safety Policies

Intervention should be undertaken only if regulations can be designed in such a way that they produce positive over all benefits (Arrow *et al.*, 1996). However, current outbreaks of food borne illnesses have increased fears about the effectiveness of protective measures designed and put in place to guarantee food safety (Antle, 1995; Caswell, 1991). Motivations for producers to embark on protective actions can be provided either through private quality control systems or through a public system (Segerson, 1999). Private quality control works through the market (e.g., reputation or certification and labeling) while the public system is determined by public policy design (e.g., direct regulation of processes or product quality) (Caswell and Henson, 1997; Henson *et al.*, 1999).

Caswell (1988) suggested that though the Federal Government has a long record of regulation of food quality and safety, there has been a movement towards increased regulation in recent years probably due to the sporadic outbreaks witnessed in the past few years. Food-safety policy is currently based on a combination of voluntary measures undertaken by producers and regulatory measures imposed by government (Segerson, 1999). The Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) mandated firms in the food-processing sector, including the meat and poultry sector and the seafood sector, to implement Pathogen Reduction/Hazard Analysis and Critical Control Point (HACCP) in 1996 and 1994, respectively, and provided a document titled the “Guidance to Minimize Microbial Food Safety Hazards for Fresh Fruits and

Vegetable” (Morris, 1997; FDA, CFSAN, 1998). HACCP was also proposed for the fresh fruit juice industry in 1998.

HACCP is regarded in the food industry as an effective tactic to setup good production, sanitation, and manufacturing practices that enhance the safety of food (Pierson and Corlett, 1992). The International Commission on Microbial Specifications for Foods (ICMF, 1988) stated that the HACCP framework establishes process control through the identification of stages in the production process that are most vital to monitor and control. Its preventive approach of consideration is seen as more cost-effective (ICMSF, 1988) and useful to control any stage in the food system intended to provide adequate feedback to for necessary corrective action.

The National Advisory Committee on Microbial Criteria for Foods (NACMCF, 1992) provided the basic steps vital in developing and operating an HACCP plan. These steps include

- Evaluate the hazard, outline the steps in the process where a major exposure can occur, and explain the prevention measure.
- Ascertain critical control points (CCPs) in the process.
- Set up critical limits for each CCP.
- Institute procedures to check each CCP.
- Determine corrective actions to be taken while observing any departure from the CCP limits.
- Set up record keeping for the HACCP system.
- Determine steps to ensure the HACCP system is effective.

By strategically emphasizing the need to put emphasis on inspections at CCPs, HACCP improves the scientific basis for safety and control processes, with evaluation at

CCP undertaken by using efficient and effective indicators (Unnevehr and Jensen, 1998). They also advanced that these indicators are a more cost-effective approach relative to product sampling which is more costly and possibly will not provide appropriate results. Any point in the food processing chain from primary materials, unfinished to finished product where improper control could lead to food contamination is what is termed a CCP (Pierson and Corlett, 1992).

The application of HACCP as a regulatory standard to a whole industry, a sector, and at different points in a supply network is distinctive. Firstly, it can be linked to a system-wide risk assessment (NRC, 1985; Hathaway, 1995) which makes possible the identification of potential hazards and the scientific measure for reducing the risks presented by them. Secondly, it may be connected to a peculiar standard for food safety which is necessary for the allocation of critical limits at CCPs (Unnevehr and Jensen, 1996).

The two characteristics of HACCP have inference for the cost/benefit analysis of regulation, for recognition of HACCP in international trade (Caswell and Hooker, 1996) and its public health implication (Satcher, 2000). These attributes notwithstanding, there is an ongoing argument as to whether mandatory HACCP systems are necessary since some firms have chosen to voluntarily undertake the HACCP plan (Caswell and Henson, 1997). They advanced doubts as to whether voluntary measure would ensure adequate consumer protection.

Throughout the past two decades, the amount of produce consumed per capita has been increasing steadily generating a heightened likelihood for produce-related foodborne diseases (Sewell and Farber, 2001). Half of the produce associated outbreaks may be

attributed to kitchen level cross contamination, the rest may be attributed to produce already contaminated with *E. coli* before purchase (Ranagek *et al.*, 2005). Between 1982 and 2002, out of the 350 outbreaks witnessed in 49 states, about one fifth were attributed to fresh produce with the principal vector being *E. coli* O157:H7 (Ranagek *et al.*, 2005). The increase in reported outbreaks of food borne illness associated with both domestic and imported fresh fruits and vegetables led the U.S. Department of Agriculture (USDA) and the Food and Drug Administration (FDA) to issue “Guidance for Industry- Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables” (FDA, CFSAN, 1998)

This guide was to serve as guidance only, to assist growers and packers to continue to improve the safety of domestic and imported products (FDA, CFSAN, 1998). It carried no regulatory, legal or enforcement weight. However it is recommended in the document that every producer of fresh fruits and vegetable consider the implementation of these risk reduction strategies outlined in the guideline appropriate to their operation. Retail buyers are beginning to demand that suppliers of fresh product adhere to the guidelines and show proof by documentation of practices and third party audits. The guide recognizes eight principles of food safety within the areas of growing, harvesting, and transportation of fresh product which are termed; Good Agricultural Practices (GAP) which is analogous to Good Manufacturing Practices (GMP) required for the processing industry.

These principles under the “Guide to Minimize Microbial Hazard for Fresh Fruits and Vegetables” (pp. 5) (FDA, CFSAN, 1998) are given as follows:

- “Prevention of microbial contamination of fresh produce is favored over reliance on corrective action after contamination has occurred.” (pp. 5).

- “To minimize microbial food safety hazards in fresh produce, growers, packers or shippers should use good practice in the area over which they have control.”(pp. 5).
- “Fresh produce can become microbiologically contaminated at any point along the farm- to -table food chain. The major source of microbial contamination with fresh produce is associated with human or animal feces.” (pp. 5).
- “Whenever water comes into contact with produce, its source and quality dictate the potential for contamination. Minimize the potential of microbial contamination from water.” (pp. 5).
- “Practices using animal manure or municipal biosolid waste should be managed closely to minimize the potential for microbial contamination of fresh produce.” (pp. 5).
- “Workers hygiene and sanitation practices during production, harvest, sorting, packing and transport play a critical role in minimizing the potential for microbial contamination of fresh produce.” (pp. 5)
- “Follow all applicable local, state, and Federal laws and regulations, or corresponding or similar laws, regulations or standards for agricultural practices for operators outside the U.S., for agricultural practices.” (pp. 5).
- “Accountability at all levels of the agricultural environment (farm, packing facility, distribution center, and transport operation) is important to a successful food safety program. There must be qualified personnel and effective monitoring to ensure that all elements of the program function correctly and to help track produce back through the distribution channel to the producer.” (pp. 5).

Based on these principles, specific guidance for pathogen reduction is provided for the following areas:

- Manures and municipal biosolids
- Agricultural water
- Processing water
- Health and sanitation
- Sanitation and trace back.

FDA efforts to protect fruits and vegetables from contamination have been very limited (Onyango *et al.*, 2007). They noted that in 2005, the FDA conducted 4,573 on-site inspections of agricultural processing sites. In 2006 they were supposed to conduct 3,400 inspections indicating a 25% drop. A general public concern is that the regulatory agencies should increase their vigilance in order to uplift the genuine and perceived food safety issues in the fruits and vegetable sector (Onyango *et al.*, 2007)

In the face of the apparent inadequacy of the regulatory agencies, the state of California, the origin of the recent 2006 spinach outbreak which led to a nationwide recall is pushing towards enacting changes in food-safety regulation to enhance the safety of consumers (Krauter, 2007). The regional Director for the U.S. Food Drug Administration for the pacific region indicated that current agricultural practices in the fruits and vegetable sectors are inadequate in preventing contamination (Krauter, 2007). He emphasized the need for mandating good agricultural practices across the industry which so far is voluntary or self-regulatory.

Benefits and Costs of Food-Safety Regulation

The recurrent detection of fresh or frozen vegetables, fish, meat, and poultry infected with pathogens such as *E. coli* 0157, *Campylobacter*, *Listeria*, and *Salmonella* has been of great concern to government and regulatory agencies. This has led the Food and Drug Administration (FDA) of the Department of Health and Human Services and the Food Safety Inspection Service (FSIS) of the U.S. Department of Agriculture to mandate new quality control regulations and testing in the meat sector (USDA, FSIS 1996) and for the FDA and the CFSAN (FDA, CFSAN, 1998) to provide guidelines for the safety of fruits and vegetable. The new regulations are intended to uplift the inspection system that

has been acknowledged to be lacking in the prevention of microbial contamination in the meat sector (National Research Council, 1985) and in the fruits and vegetable sector (FDA, CFSAN, 1998).

Antle (1999) indicated the design of food-safety regulations in the past was undertaken by government regulators and food technologists, they neither took into account economic efficiency nor the potential allocation effects of regulations associated with food safety. Regulatory structures and authorities are confronted with new and ongoing food safety challenges (Henson and Caswell, 1999).

These challenges involve dealing with new likely food borne risks like genetically modified organisms while at the same time looking for ways to improve control of existing risks like *E. coli* O157 (Henson and Caswell, 1999). This follows ever increasing pressure for improved control as a means of sustaining consumers' trust in the safety of the food supply due to frequent "food scares" (Henson and Caswell, 1999, USDA, 1995). Another view is that existing food-safety regulations from an economics perspective are considered unreliable creating the need for more efficient regulation which rely on performance principles (Antle, 1995).

The change in consumers' worries from food sufficiency to food quality particularly the safety of meat and poultry products (USDA, 1995) and the struggle by most governments to reduce the estimated costs of government plans and enhance the effectiveness and international viability of their economies (Jacobs, 1997) has influenced the way food-safety regulations are structured, developed and implemented (Antle, 1999). These changes have lead to the performance of Regulatory Impact Assessment (RIA) in the public decision making framework. Demsetz (1969) provided the groundwork for RIA

based on benefit-cost analysis. RIA based on benefit-cost analysis is becoming an integral part of the U.S. government policy structuring process (Antle, 2000). Morall (1997) stated that U.S. policy requires RIA of all policies with potential influence of at least \$100 million.

Economists are in favor of standards for benefit-cost analysis of environmental, health and safety regulation in perspective of its application in federal regulations, (Arrow *et al.*, 1996). Regulations in the food safety field in the past have not necessarily been on the grounds of the benefit-cost concept (Antle, 1995, 1996). The rise in demand for regulatory accountability has led to the growth in governments' demand for risk assessment and benefit-cost analysis for proposed and existing regulations which are aimed at safeguarding the wellbeing of the general public (Caswell, 2000). From an economic view point, regulations should not be put into practice if their benefits do not exceed their cost (Asch, 1988). The Government Performance and Results Act (GPRA, 1993) required agencies to conceive effective regulations which are required to satisfy benefit-cost appraisals at both the agency level and Presidential Office of Management and Budget level.

Benefits of Food-Safety Regulation

The ultimate benefits of food safety regulations are reduction in the likelihood of deaths and illnesses associated with the consumption of foods that could be contaminated with microbial pathogens and other related hazards (Antle, 1999). Superior food quality provision helps protect and sustain consumers' health against external health dangers, providing restoration in the advent of impairment (van Ravenswaay, 1995). The theoretical evaluation of the benefits of food-safety regulations has as economic foundation approach

that have been built up to model and assess reductions in health risk (Caswell, 1998; van Ravenswaay, 1995).

Due to the multitude of quality attributes of food products and the lack of market value for benefits to be calculated, a series of approaches have been advanced to value the benefits of safer food (Caswell, 1998). These factors coupled with the lack of information related to attributes make market estimations of the benefits of food safety difficult (Henson and Trail, 1993; Kinsey, 1993). Antle (1999) indicated that an individual's need for risky foods is reliant on the individuals' income, market prices, the associated actual risk, the observed risk, the likelihood of exposure and the individuals' vulnerability to the risk.

Contingent valuation and experimental market models have been used to derive expressions for willingness to pay (WTP) (Brown *et al.*, 2005; Lin and Milon, 1995; Buzby, Ready and Skees, 1995; Hayes *et al.*, 1995) averting behavior cost (Eom, 1995), resource expenditures on medical costs and labor productivity (Roberts, 1991) for reduced risk morbidity and mortality. Models for willingness to pay tend to suggest that willingness to pay for reduced morbidity has four simple components has four components including; cost of treating the illness, forgone income from lost work time, costs of averting illness; and the disvalue of illness (Harrington and Portney, 1987; Berger *et al.*, 1994).

The most widely used approach to value morbidity is to estimate the cost of illness (COI) (Kenkel, 1994; CAST, 1994). This approach involves the measurement of the medical cost of an illness plus the foregone market income due to lost work time. The cost of illness (COI) approach tends to be sensitive to the worth attributed to the life recovered (Buzby *et al.*, 1996). The USDA Economic Research Service (ERS) used the cost of illness

(COI) method to estimate the annual resource expenditure for illnesses caused by four food-borne pathogens (*Salmonella*, *Campylobacter*, *E. coli* 0157 and *Listeria*) targeted by the FSIS HACCP proposal (Buzby *et al.*, 1996). The annual food-borne disease costs in the HACCP proposal stood at \$1.1-\$4.1 billion. They suggested that this estimate was a partial measure of society's opportunity cost. If these food-borne illnesses were reduced these resources would be reallocated.

The Food Safety Inspection Service (FSIS) regulatory impact assessment concluded that over a 20-year time horizon, the benefits of HACCP implementation would be on the scale of \$0.99 to \$3.69 billion yearly with the assumption that the regulation was effective in eliminating the risks of illness and death from pathogen contamination. ERS discounted this amount over this period at 7%, and estimated the public health benefits from HACCP to be between \$7.13 and \$26.59 billion.

The Food Safety and Inspection Service (FSIS) asserted that the net benefits of food-safety regulations were probably positive for all amounts of regulatory effectiveness (Crutchfield *et al.*, 1997). Evaluating the increased entry to foreign markets is another increasingly used method for evaluating the benefits of food-safety regulations (Roberts and DeRemer, 1997). The estimation of the benefits of food-safety regulations presented so far have not taken into account offsetting behavior therefore are liable to errors. There is need to estimate the true benefits of food-safety regulations.

Costs of Food-Safety Regulation

Existing policies intended to improve food-safety are reliant on public regulations and market incentives. Given the market incentives to improve food-safety, firms possibly will implement hazard control measures in an effort to achieve strategic benefits (Stigler,

1971; Peltzman, 1976) in perspective of further severe regulation (Segerson, 1999). The combination of both private and public motivations to enhance food-safety coupled with the self-motivated response of industry towards regulation complicates makes the estimation of the cost of food-safety regulations complicated (Unnevehr and Jensen, 2001).

Going from a general perspective, the costs of food-safety regulation may be a combination of, associated administrative costs, quality guarantee plans undertaken voluntarily to enhance market share, or conform to industry's and government mandated regulatory standards (Antle, 2000) or holistically to fulfill consumers' demand. At the plant-level, these costs include; assessing and developing control procedures, anti microbial treatments, record keeping, employee training, and microbial testing (FSIS).

Analysis of the costs of food-safety regulation starts at the point of the production process (plant level), and it requires taking into account production processes that allow for higher quality products (Antle, 1999). A significant amount of studies have been undertaken to evaluate the cost structure of meat and various food processing plants and potential costs that food-safety regulation cause plants to incur using different approaches.

In the United States, approximations of the cost of conformity of the mandatory HACCP in the seafood, meat, and poultry industries were an essential element of the final Regulatory Impact Assessment (RIA) (FSIS, 1996; Crutchfield *et al.*, 1997). The FDA and the FSIS projected the costs of mandatory HACCP regulations for their Regulatory Impact Assessment (RIA) applying an accounting approach (FDA, 1994; FSIS, 1996). They estimated the four year execution of HACCP in the meat and poultry sector to stand at between \$305 and \$357 million. The accounting method for the evaluation of HACCP has been used in some evaluation studies (e.g. Colatore and Caswell, 1998).

French (1977) presented the application of the economic-engineering approach to examine the cost structure of processing processes. Jensen and Unnevehr (1999) applied the economic-engineering approach to estimate the cost of carcass rinses, sanitizing sprays, steam vacuums and water pasteurization in pork processing. They found out that the cost of specific pathogen mitigation strategies are in the scale of \$0.03 to \$0.20 for each carcass of hogs with the most favorable mix of strategies being as high as \$0.47 per carcass. Holistically, they concluded that the costs of pathogen mitigation undertakings correspond to less than 2% of processing costs

Klein and Brester (1997) used an econometrics techniques estimated a cost function to evaluate USDA's zero-tolerance for fecal contamination on the cost of production so as to show how this order could impact productivity and costs. They found out that cost of production increased with increased safety. They estimated the costs of the zero-tolerance order for meat plants to be approximately \$3 billion with expectations for these costs to reduce over time as a result of economies of scope. Antle (1999) studied the U.S. beef, pork, and chicken slaughter and processing plants and found out that more stringent food safety regulations is associated with increased costs of production. Using the Census of Manufacturers data to estimate total cost function for beef, pork and miscellaneous meat products, Ollinger (1998) discovered that cost of production was linked to rising safety. His results were similar with those of Antle (1999) that higher product safety is associated with increased cost of production.

Offsetting Behavior and Food-Safety Information

Food is an important provider of physical welfare and a main supplier of pleasure, worry and stress (Rozin et al., 1996). Due to their large economic impact (e.g. sales loss

and welfare effects), incidents of chemical and bacterial contamination of food receive great attention (Foster and Just, 1989). Perceived product quality after an adverse event plays a crucial part in individual's consumption decisions (Swartz and Strand, 1981) which arise because consumers are faced with a wide range of competitively priced food products of consistently high quality. Consumer's concerns about food-related risks appear to induce them to embark on some type of protective action to reduce health risk (Swartz and Strand, 1981; Foster and Just, 1989; Eom, 1994).

Although these studies present significant evidence on consumer's revealed preference for safer and healthier food, a good number of valuation research studies on food-safety and nutrition have failed to take into account consumers' risk perception into the behavioral structure (Eom, 1995). Perceptions and beliefs are formed by knowledge, which is as a result of exposure to information sources and individual effort in getting it (McIntosh *et al.*, 1994). The risks perceived by consumers depends on information about the quality and safety of a product that can be received from a variety of sources including media coverage (Powell and Griffiths, 1994; Buzby and Ready, 1996), friends and personal experience and with both negative and positive information having varying influence (Liu *et al.*, 1998). Some psychological science studies have recognized forty-seven factors that affect consumers' perception of risk which are concerned with if the risk is "alarming, unmanageable, tragic and not counterbalanced by compensating benefits" (Covello, 1983). Perception of risk is also responsive to views about the agent or organization responsible for a particular task (Ipsos-Reid, 2001).

A consumers' risk perception is likely to be unbalanced, short lasting and to vary over time as a result of both positive and negative news (Liu *et al.*, 1998). Consumers can

therefore learn about a particular risk and change their risk perceptions after getting new information (Viscusi and O'Connor, 1984; Smith and Johnson, 1988). In Figure 2.1, 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 .

Negative media reporting of food contamination occurrence can result in sales losses with the provision of positive information after such an incident having policy inferences for producers and public institutions (Swartz and strand, 1981; Johnson, 1988; Smith *et al.*, 1988). Lichtenstein *et al.* (1978) suggested from a psychological perspective that the unbalanced emphasis on “negative” media report relative to a “positive” report could lead individuals’ to overestimate health risks. Psychology and economics studies carried out by Rowe *et al.* (2000) and Smith *et al.* (1988), respectively, indicated that information from media coverage of a food-safety incident might increase the fear of a hazard compared to the level of the outbreak. They all concluded that the nature of information notwithstanding, the risks perceived by an individual is based upon the volume of coverage that will lead to a negative response from the public as a whole.

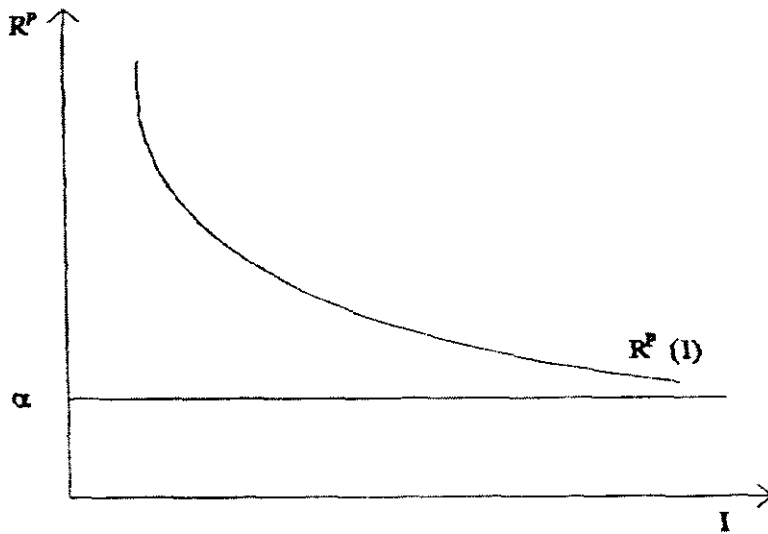


Figure 2.1: Change in Perceived Risk with Positive Information After an Unfavorable Shock.

Source: Lui *et al.* (1998).

Wynne (1980) proposed that trust in risk management institutions maybe a vital factor in shaping perceptions and risk taking. Slovic (1993) found out that there was a link between trust and risk perception. Trust is therefore viewed as one requirement for effective risk communication (Kasperson *et al.*, 1992). Lui *et al.* (1998) evaluated and found out that there exist a link between trust, risk and food safety concern given media and other related information. From an economic perspective, it is necessary to evaluate the link between trust consumers place on “institutions” or food suppliers and government/regulators on consumers 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 linked with food safety have considerable impact on an individual’s food safety perception. This influence is displayed by the public’s trust of those regulatory agencies associated with food safety (e.g., U.S. Department of

agriculture (USDA), Centers for Disease Control (CDC) and the Food and Drug Administration (FDA)). Goodacre *et al.* (1999) looked at surveys of public opinion carried out by the U.S. Food Marketing Institute in 1996 and concluded that most consumers were confident that the food they purchased was safe for consumption.

The results presented in Onyango *et al.* (2006) coupled with studies by Goodacre *et al.* (1999) implied that consumers in the United States have trust in government actions and regulation aimed at the enhancement of food safety. This presents an avenue for the evaluation of offsetting behavior. Offsetting behavior is implied by reduced concern by consumers in reaction to positive information about the impact of policies aimed at mitigating the risk of contamination.

CHAPTER III

METHODOLOGY AND DATA

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 to command and control policies, sorting issues which develop due to information asymmetry and OB. Direct interventions involve command and control principles for implementation which utilizes 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 consumers' cost. To them, the ineffectiveness was not due to alteration in consumers' payoff due to offsetting behavior.

Peterson *et al.* (1995) went further and indicated that the principal policy failure with air-bag equipped cars was as a consequence of the sorting problem. They argued that the ineffectiveness of the program to reduce accidents occurred due to the fact that reckless drivers initially bought the safety equipped cars as such as non aggressive drivers progressively possessed air bag equipped cars, the rate of accident occurrence for such cars deteriorated. This study has as motivation the application of food safety information from PR/HACCP that is based on performance standards in the fresh vegetable sector where such a policy is nonexistent. Such a move will help us to evaluate if consumers become lax in reaction to information of the potential impact of the implementation of such a policy.

The theoretical model on OB for this study follows directly from that presented by Nganje *et al.* (2007). To present the theoretical model of offsetting behavior, the expected accident loss model by Hause (2006) was expanded to incorporate two measures. The first measure is offsetting behavior which, in this case, is represented by consumers' perception of risks. The second measure encompasses consumers' behavior regarding safe vegetable preparation and consumption. The theoretical model is represented in Equation 1.

$$A(x, y) \equiv \pi(y)L(y) \quad (1)$$

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. $\pi(y)$ and $L(x)$ are assumed to be non-negative, strictly decreasing, smooth convex functions defined on $x, y \in [0, +\infty]$. The consumers' optimal response for all values of x considered is defined as $y(x > 0)$. An assumption that a consumer will choose his 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 his 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 offsetting behavior.

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

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.

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

Equation 2 is differentiated with respect to y to arrive at equation (3) 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).

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

Definition 1

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

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

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

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

As $\pi(x)$ and $L(y)$ by assumption are non-negative, ($L(x) \geq 0$ and $\pi(y) \geq 0$) strictly decreasing and smooth functions as such ($L'(x) < 0$ and $\pi'(y) < 0$) and again ($L''(x) > 0$ and $\pi''(y) > 0$). It is expect that if an average consumer believes that the risk related with getting sick from food borne disease is reduced because of new safety information from implemented regulation, then it seems that such an 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

Consumers' 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, therefore 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, then x must be an inferior factor in the production of $-A$, more of x means less of $-A$.

In order 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 have 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).

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

$\left(\frac{A_{xy}}{A_{yy}} \frac{A_y}{A_x} \right)$, is the consumers' marginal offsetting behavior. It evaluates by what proportion

the direct marginal effect of x on A is decreased by the victims' offsetting behavior. If the marginal offsetting behavior is greater than 1 for $0 < x < x^*$, this will mean dominant

offsetting behavior for food safety policy x^* . This is the case due to the fact that $1 - \left(\frac{A_{xy}}{A_{yy}} \frac{A_y}{A_x} \right)$

will be negative, which is multiplied by A_x and becomes positive. Consequently,

$\left[\frac{dA(x)}{dx} \right]$ is positive, leading us to arrive at the conclusion that the function

$A(x) = A[x, y(x)]$ will rise for x^* relative to x ultimately causing dominant offsetting

behavior. We substitute equation (1) into equation (7) to get equation (8).

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

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

Proposition 3

If the log of the likelihood of a food borne illness or death incidence function is concave and decreasing, the offsetting behavior is dominant. If the log of the probability or death occurrence function is convex and decreasing, then the offsetting behavior is partial.

Proof of Proposition 3

$\log[\pi(y)]$ is a decreasing function $\forall y \geq 0$ since $\pi' < 0$ and $\frac{d \log[\pi(y)]}{dy} = \frac{\pi'}{\pi} < 0$.

Again, if $\log[y]$, is concave, then $\frac{d^2 \log[\pi(y)]}{dy^2} = \frac{d\left(\frac{\pi'}{\pi}\right)}{dy} = \frac{\pi''\pi - ((\pi')^2)}{\pi^2} < 0$, multiplying

this expression by $\frac{\pi^2}{\pi \pi''}$ we arrive at $\frac{\pi''\pi - ((\pi')^2)}{\pi^2} * \frac{\pi^2}{\pi \pi''} = 1 - \frac{((\pi')^2)}{\pi \pi''} < 0$. For the reason

that $\frac{\pi^2}{\pi \pi''}$ is positive and therefore the inequality sign remains the same. We thus have

that $\frac{dA(x)}{dx} \equiv \pi L' \left[1 - \frac{((\pi')^2)}{\pi \pi''} \right] > 0$. This denotes dominant offsetting behavior if the previous

expression is multiplied once small by $\pi > 0, L' < 0$.

Partial Offsetting Behavior

Consumers' offsetting behavior 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 consumers' marginal offsetting behavior; $\frac{\left(\frac{A_{xy}}{A_{yy}}\right)}{\left(\frac{A_x}{A_y}\right)}$ is positive since

$(A_{xy} > 0, A_{yy} > 0, A_x < 0, \text{ and } A_y < 0)$.

Empirical Analysis

While U.S. food supplies are usually recognized as safe, there has been an increase in reported outbreaks associated with both domestic and imported fresh fruits and vegetables (FDA, CFSAN, 1998). This trend is an indication that food borne diseases are not uncommon since a huge number of food borne pathogens are presently known to cause diseases in humans (Buzby *et al.*, 2001). Such sporadic and often publicized food borne disease outbreaks create an environment of fear in consumers.

Viscusi and Magat (1987) showed that the impact of stronger informational content on preventive measure is based on the implied endowed (objective) risk compared to the consumers' subjective risk. They went forth and said consumers' risk associated decisions need some appraisal but such an assessment is complex; since consumers develop subjective probabilities based on their beliefs of a particular hazard.

Consumers' perception of food borne risk is affected by the following factors: locus of control, personal health influence, outrage and demographic characteristics (Eom, 1995; Nganje *et al.*, 2005). An important subject in the evaluation of consumers' perception of risk stems from the fact that the initial perceived risks of individuals are frequently unobservable, they can however be obtained through survey methods (Smith *et al.*, 1990). In this study, a survey based on questions on factors that affect consumers' foodborne related risk perception, handling, and preparation practices was carried out. Survey and related questions are found on table A1 of the appendix section.

Factor analysis was used to create risk tolerance indexes for each of the factors that influence consumers' perception of risk. Only those factors that had significant enough contribution were used to carry out the empirical analysis. Two models were used to evaluate subjects' offsetting behavior. This evaluation was carried out using consumers' perception of risk and behavior on safe food handling and consumption as proxies for offsetting behavior. A regression was carried out using the risk indexes and food policy related information. This was done using a discrete choice model (Tobit Model). This regression model was used because it is suitable for latent variables which are most often truncated and censored (Greene, 2003), perception of risk in this case. Simplified equations for our empirical model are shown on equations 9 and 10 below:

$$OB = f(BH, I) \tag{9}$$

$$BH = f(RP), \tag{10}$$

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 consumers' risk tolerance can be described by their response to a particular question, then that particular question can serve as a proxy for actual food safety risk tolerance (Brown *et al*, 2005). It is also possible to build indexes taking into account responses from numerous scaled items as a compound measure of risk tolerance. The food-safety risk tolerance measure used in this study is a compound measure that blends several variables associated with consumers' food-safety, risk associated perceptions and behaviors. It is assumed in this study that the value of the indexes reveals consumers' actual food-safety risk tolerance.

Compound indexes are used in this study due to their peculiar characteristic. They surmount some of the measurement errors that are intrinsic in single variables as well as characterizing the various aspects of a concept (Hair *et al.*, 1998). Responses collected after the survey which was based on the various factors that affect consumers' perception of food safety risk (including perceived locus of control, personal health influence, demographics characteristics and outrage) as specified in Nganje *et al.* (2005)

The factor analysis method employed is similar to that carried out by Brown *et al.* (2005) which tested the consumers' willingness to pay for improved food safety. Here, the relative risk index of consumers' food safety perception and the composite measure containing all four variable categories is arrived at by creating a factor index corresponding

to each factor of risk perception. This approach used to build up a risk tolerance index defines “items” and the “latent” variables” (Brown *et al.*, 2005). Items characterize component of the scale (e.g. the survey questions). The latent variable, risk tolerance, sets of item scores and is a principal element that cannot be determined precisely (DeVellis, 1991). 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).

Factor analysis investigates whether a number of variables of interest, $Y_1, Y_2, Y_3, \dots, Y_n$, are linearly related to smaller number of unobserved variables, $F_1, F_2, F_3, \dots, F_n$.

The relationship between these variables can be expressed as equations 11 to 14:

$$Y_1 = \beta_{10} + \beta_{11}F_1 + \varpi_1 \tag{11}$$

$$Y_2 = \beta_{20} + \beta_{21}F_2 + \varpi_2 \tag{12}$$

$$Y_3 = \beta_{30} + \beta_{31}F_3 + \varpi_3 \tag{13}$$

$$Y_n = \beta_{n0} + \beta_{n1}F_n + \varpi_n \tag{14}$$

The error terms $\varpi_1, \varpi_2, \varpi_3$ and ϖ_n from the equations above is an indication that the hypothesized relationships are not absolute. In the factor analysis literature, the β parameters are called factor loadings. Looking at the above equations, it seems that the loadings can be estimated and therefore the expectations tested by regressing each Y_i against each factor. Such an approach is not possible because the generated variables are unobservable.

Two assumptions are made for the procedure that creates the observation on the Y_i variables:

- The error terms ϖ_i are independent of one another and as such the expected value of the error term $E(\varpi_i) = 0$ and variance $Var(\varpi_i) = \sigma^2$.
- The unobservable factors are independent of each other and hence the error terms. Therefore, $E(F_i) = 0$ and $Var(F_i) = 0$.

The factor means and the variances are expressed in the standardized form. Since each observable variable is a linear function of independent factors and error terms, we have:

$$Y_i = \beta_{i0} + \beta_{i1} + \varpi_i \quad (15)$$

The variance of each independent variable can be calculated as

$$Var(Y_i) = \beta_{i1}^2 Var(F_1) + Var(\varpi_i) \quad (16)$$

We get

$$Var(Y_i) = \beta_{i1}^2 + \varpi_i \quad (17)$$

The variance is divided into two parts,

- β_{i1}^2 , the communality, is the part that is justified by the common factors, F_1 .
- ϖ_i^2 , the specific variance is the part of the variance of the independent variable that is not accounted for by the common factors. If generated factors are absolute predictors of the independent variable, then $\varpi_1 = \varpi = \varpi_3 = 0$.

The covariance of any two observable variables is calculated as

$$Y_i = \beta_{i0} + \beta_{i1}F_1 + \varpi_i + (0)\varpi_j \quad \text{And} \quad Y_j = \beta_{j0} + \beta_{j1}F_1 + \varpi_j + (0)\varpi_i$$

$$Cov(Y_i, Y_j) = \beta_{i1}\beta_{j1}Var(F_1) + (1)(0)Var(\varpi_i) + (0)(1)Var(\varpi_j)$$

$$= \beta_{i1}\beta_{j1}$$

The factor loadings are not exclusive; there is an infinite number that gives similar theoretical variance and covariance. The principal component method, following Hotelling (1933) is the most commonly used approach in estimating the first set of factor loadings. This approach looks for values of the loadings that lead the estimate of the total communality as closest as possible to the total of the observed variance without taking the covariance into consideration. The larger the magnitude of the communality, the more accurately the suggested factors is justified as explaining the independent variables under consideration. Consider that N observed variables are given as $Y_1, Y_2, Y_3, \dots, Y_n$. The principal component analysis approach applies an orthogonal transformation to these observed variables to give rise to a new set of uncorrelated variables $F_1, F_2, F_3, \dots, F_n$. These are chosen in such a way that F_{n-1} has maximum variance and F_{n+1} has maximum variance subject to been uncorrelated to F_{n-1} . Let the transformed variables be represented by F_w . These transformed variables are standardized to obtain an updated set which can be represented by Z_w . The fundamental equation in a principal component analysis can be stated as equation 18:

$$Y_i = \sum P_{iw} Z_w (i, w = 1, 2, 3, \dots, n), \quad (18)$$

where Z_w represents the w -th component and P_{iw} is the weight of the w -th component in the i -th variable. The principal component analysis is linear, additive, and justified only when variables in question are measured using similar units of measurement.

Risk Tolerance and the Integration of Food-Safety Risk Information

The risk tolerance index is a representation of how individual subjects' perception of risk fluctuates. The part played by information in this relationship is necessarily central.

Consumers' propensity to absorb new information into their risk perception and respond to it could be related to their risk tolerance. Lui *et al.* (1998) in their research described consumers' risk-perception adjustment as a subjective average of risk from previous beliefs and affirmed risk established on the basis of new information received. Consumers may gradually change their perceptions when positive information is made available to them following a contamination. Positive and negative information may perhaps have varying effects on perceptions (Lui *et al.*, 1998).

Empirically, consumers' 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 subjects' perception of risk. The Tobit model devised by Tobin (1958) is suitable model to capture latent variables (e.g., change in individuals' perception). This model has been used extensively to evaluate latent variables such as willingness to pay (Brown *et al.*, 2005), clustered and censored dependent variables such as number of hours worked (Quester and Greene, 1982), household purchase of durable goods (Tobin, 1958), number of arrests after prison release (Witte, 1980) and number of extramarital affairs (Fair, 1977, 1978). Conventional regression methods fail to take into account the qualitative difference between limit (zero) and no limit (continuous) observations (Greene, 2003). This special quality of the Tobit model is the reason for its application in this study which involves a latent variable (perception of risk).

The Tobit Model

The stochastic model of the Tobit regression and decomposition from Greene (2003), Fen and Schmidt (1984) and McDonald and Moffitt (1980) is represented on equation 19 to 23.

$$Y_t = X_t\beta + \varpi_t, \quad \text{if } X_t\beta + \varpi_t > 0 \quad (19)$$

$$Y_t = 0, \quad \text{if } X_t\beta + \varpi_t \leq 0 \quad t = 1, 2, \dots, V$$

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. The expected value of the dependent variable as indicated from Tobin (1958) is given as equation 20

$$E(Y) = X\beta F(z) + \sigma f(z), \quad (20)$$

where $z = \frac{X\beta}{\sigma}$, $f(z)$ represents the unit normal density and $F(Z)$ stands for the

cumulative normal distribution. The expected values of the dependent variables given that they are above the limit can be represented as equation 2:

$$E^a Y = X\beta + \frac{\sigma f(z)}{F(z)} \quad (21)$$

Given the relationship expressed on equation (21) above, the connection between expected value of an entire data set and the expected value given that observations are above the limit is given in equation (22)

$$EY = F(z)E\overset{a}{Y} \quad (22)$$

Looking at the slight change of the expected value of the independent variable on the expected value of the dependent variable, we arrive at equation (23)

$$\frac{\partial EY}{\partial X} = F(z) \left(\frac{\partial E\overset{a}{Y}}{\partial X} \right) + E\overset{a}{Y} \left(\frac{\partial F(z)}{\partial x} \right) \quad (23)$$

The partial derivative from equation 23 indicates that the slight change in the expected value of the independent variable on the expected value of the dependent variable has two different parts.

- The first part is the change in the dependent variable above the limit, subject to the probability of it being above the limit.
- The second part is the change in the probability of being further than the limit subject to the value of the dependent variable when it is above the limit.

To carry out empirical functions with the Tobit model, we assume that the approximate values for the vector of coefficients β and its standard deviation σ are known. Every term on equation 23 can be estimated at a particular $X\beta$ value usually at the mean of the independent variable. The expected value of the dependent variable given that they are above the limit $E\overset{a}{Y}$ can be calculated from equation 21 given that the value of $F(z)$ is obtainable from statistical tables.

Survey Data

The data for this thesis are primary data from a nationwide online survey. It was conducted using the Zoomerang database. A total of 2,583 respondents participated in the experiment. Survey questions can be found in Table A1.

Description of Survey and Data Collection Procedure

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. With approximately 68.22% being whites, 17.89% blacks, 10.76% being Hispanics, 1.94% Asian, and 1.24% indicating that they were Native Americans and others, who never indicated their race. A matched sample design was utilized so as to get rid of the variation between samples as a source of sampling error. Subjects were therefore asked a particular question thrice about their preparation style preference for vegetables and their perception of risk, at a two weeks interval.

Questionnaires included questions on factors that influence an individuals' perception of risk, the four categories involved are: locus of control (measures taken to mitigate the risk of consumption by consumers of producers), personal health characteristic (includes age, source of obtaining food safety information, and experience of food borne illness), outrage (fear of the unknown) and demographic characteristic (education and ethnicity). In the initial experiment, the questionnaire was structured in a manner such that no specific allusion was made for food safety. The second experiment involved the provision of negative food safety information to respondents. The third and final experiment involved giving the respondents positive food-safety information. Positive and negative information given to the respondents was obtained from newsletter articles, an efficient source of food-safety information. Food-safety related information provided to subjects is found in Table A2.

Risk Index and Perception of Risk

If the risk tolerance index reflects consumers' true valuation, then individuals can be generally described as risk averse and risk takers. Risk-adverse consumers are those who are skeptical about policies put in place to prevent the contamination of food by foodborne pathogens and other toxic materials. They are willing to take additional precautionary measures in the preparation and handling of their food. Risk takers are those who believe that the food supply is free from foodborne pathogens and, therefore, do not take any additional preventive measures in the handling and preparation of their food. The risk tolerance index is, thus, a reflection of individuals' food-safety perception.

CHAPTER IV

RESULTS

Estimation of Risk Tolerance Index Using Factor Analysis

A total of three experiments were conducted. Factor analysis was used to create a risk tolerance index for the four factors that influence consumers' perception of risk based on available food safety information. Based on the factor analysis, the questions that had significant contribution going by the factor loadings are presented on Table 4.1.

The locus of control factor includes variables associated with questions, 16, 17, and 19 (Q 16, Q17, and Q19). Personal health influence is associated with question 28 (Q28). The outrage factor is linked with question 31 (Q31).

Table 4.1: 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.

Locus of control involves all actions and measures taken along various stages of the food supply chain to enhance the safety of food in this case vegetables (spinach). An example is the implementation of mandatory HACCP at the farm, retail and processing

level. If consumers believe the locus of control in vegetable production is weak, their perception of risk for vegetables will be high. They will regard vegetables as less safe and will therefore forgo or limit their consumption. This led us to suggest that the locus of control factor in our analysis will have an inverse relationship with perception of risk.

The second factor health influence describes if a consumer has had any past experience of illness from the consumption of vegetables or if any close family members or friends have fallen sick from vegetable consumption. We expect the health influence with the reception of positive food safety information to have an inverse relationship with the perception of risk. A bad health influence in a normal situation would lead to an increased perception of risk, however positive food safety information might change consumers' perception leading to an inverse relationship.

The third factor, outrage is simply defined as the fear of the unknown. Consumers will consume more of a product they are familiar with than go for what they are unfamiliar with. The expectation here is that as consumers get positive food safety information from policy implementation; they become more tolerant consuming other vegetable (e.g. brands) which they did not consume before. We expect an inverse relationship between perception of risk and outrage. If such an inverse relationship is obtainable from our analysis then we shall proceed to conclude that offsetting behavior exist in vegetable preparation and consumption. The mean responses and standard deviations of loaded question according to their categories are presented in Table 4.2.

Table 4.2: Means and Standard Deviations for Loaded Questions According to Category.

Categories	Variables	No Information		Negative Information		Positive Information	
		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
	Q19	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

Descriptive Statistics and ANOVA Analysis

To access if there is any alteration in subjects' preparation style for our strategic variables, we went further to calculate the means and variances for perception of risk and preparation style preference. Table 4.3 shows the results for the change in mean values for subjects' preparation style preference or convenience and their perception of risk.

Following from Table 4.3, 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).

Table 4.3: Change in Mean of Preparation Style Preference and Perception of Risk

Variable	No Information		Negative Information		Positive Information	
	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
Consumers' perception. (Q 18)	1.680	0.016	0.693	0.024	1.631	0.025

The mean values of consumers 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 need to statistically test whether the changes observed in subjects risk tolerance are statistically significant. Two hypotheses are tested in line with the data from the three different experiments. Analysis of variance (ANOVA) method, a step up from the t-test can help determine if two or more samples have the same mean or average. The null hypothesis is that the mean perception consumers have for spinach when information concerning the possible effect of the fatal *E. coli* O157:H7 that is found in spinach and when additional information vis-à-vis positive development in food safety due to implementation of PR/HACCP has been made accessible to subjects are equal.

When Consumers Are Given Negative Food-Safety Information

Table 4.4 represents the ANOVA results comparing the change in consumers' 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. Consumers' 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 effect of the lethal *E. coli* O157:H7 and that for positive information from PR/HACCP are equal. Table 4.5 shows ANOVA result for the hypothesis test between negative and positive information stages.

Table 4.4: 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				

When Consumers Are Given Positive Food-Safety Information

Table 4.5 represents the ANOVA analysis results comparing the variation in consumers' mean perception from the negative to the positive information stages. Here also, the null hypothesis 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.

Table 4.5: 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				

The analysis of variance results suggest that consumers' became less vigilant in light with 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 complete trust in government actions and engagement with regards to food safety issues. Holistically, these results suggest the presence of offsetting behavior where a food safety policy is enacted to decrease the number of possible victims' contamination from *E. coli* O157 and other bacteria which cause food poisoning. Here offsetting behavior is shown in the consumers' 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 consumers' 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. Dominant offsetting behavior in this light would signify that the marginal effect of information concerning the positive HACCP policy impact leads subjects' 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 offsetting behavior is dominant or partial. For marginal benefit analysis, two Tobit regressions were carried out to test the hypothesis that dominant offsetting behavior may be what is obtainable from subjects' reaction to food safety information.

Risk Tolerance Index and Offsetting Behavior

The results for the model with the three risk tolerance indexes factors and the dummy variables representing the general (no information) and the negative information experiments are as shown in Table 4.6. Results indicate that the dummy variables which represent the two information stages D1 and D2 are statistically significant at the 1% level of significance. This goes to confirm 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 suggest contrary to expectations 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 the consuming contaminated vegetables, a possible

reason why older consumers are more careful in the way they prepare and consume their vegetables.

Table 4.6: 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.

Offsetting Behavior and the Benefits of Food-Safety Information

Information interaction terms are introduced for the variables that are directly related to consumers' behavior (outrage and locus of control) so as to carry out further evaluations. Results for this analysis are presented on Table 4.7. The quadratic interaction

term between locus of control, outrage and the information stages is evaluated. As with the former regression, the information stage variables are significant at the 1% level showing that the information stages play a vital role in our evaluation of offsetting behavior. The magnitude and the sign of the personal health influence are consistent with the former results. It is significant at the 10% level. This further confirms the fact that as subjects grow older, they remained cautious despite the reception of positive food safety information.

The coefficient of the first quadratic interaction term locus of control* Information stage is negative and significant at the 10% level. When positive information from food policy is given to subjects, the probability of consuming well prepared spinach decreases noticeably. High risk attributes like the origin, and other characteristics (bagged, already cut or frozen) are no longer considered consumers.

The second interaction term Outrage* Information stage is negative and significant at the 1% level. The negative signs on these variables go to confirm the presence of offsetting behavior. As positive information from policies reaches consumers, the possibility of choosing spinach with characteristics that present a lower risk of contamination diminishes conspicuously confirming, the presence of offsetting behavior in food safety.

Table 4.7: 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 effects results shown in Table 4.7 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% correspondingly with regards to locus of control and outrage. Intuitively, these results indicate that positive information that affects two of the factors in the risk tolerance that are under the control of a consumer (locus of control and outrage) can lead to dominant offsetting behavior 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 consumers' 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.

CHAPTER V

SUMMARY AND CONCLUSIONS

Food-safety risk tolerance index and food-safety policy information from food safety regulations affect consumers' perception of risk. Construction of food safety risk tolerance indexes facilitated the examination of the relationship between risk tolerance indexes and subjects perception of risk. Food safety tolerance indexes were created from survey questions based on the factors that affect individuals' perception of risk following Nganje *et al.* (2003). Data for this involved an online survey carried out using the zoomerang database. The food safety perception of risk related questions which enabled the construction of the risk tolerance were collected for the No Information, Negative Information, and Positive Information stages. Factor analysis was used to create factor scores and loadings. From the factor loadings of the factor analysis results, it was found out that three out the four factors that affect consumers' perception of risk had significant enough contribution to fit into our analysis. These three factors were locus of control, personal health influence and outrage. The demographic factor did not have sufficient contribution and hence it was dropped. Factors scores were used as an indication of how variables contribute to the explanation of the common underlying factor. The next step was to access how these risk tolerance indexes affect subjects' perception of risk.

Negative information involved the health impact of consuming vegetables contaminated with the fatal *E. coli* 0157. Positive information involved the positive trends in food safety. A preliminary analysis of variance (ANOVA) was carried out to evaluate the hypothesis that the means between the different information stages are the same. The results rejected the null hypothesis of equality in means between the No Information and

Negative Information stages and between the Negative information and Positive Information stages. This one factor (ANOVA) analyses provide us with evidence that there is a statistically significant change in subjects' perception of risk when information about the deadly *E. coli* and positive trend in food safety is given to them. Given these results, we went further to exam to what extent or the degree to which the risk tolerance indexes affect consumers' perception of risk. To do this, we used a Tobit regression since our dependent variable qualifies as a latent variable.

From our analysis it was found that as consumers get older given no information and negative information their likelihood of choosing to consume safe spinach increase by 2.85%. There is the possibility that older consumers have gathered experience from the past which enhances their consumption habits and the conviction of the safety they place on the vegetables they consume. The variables which are 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. Possible indications for this is that when consumers are aware of the source of their spinach or have extra information on the treatment of the spinach they consume (e.g., if they were washed, sorted, canned or frozen), they are likely to become more negligent concerning food-safety and are more inclined to consuming unsafe spinach.

The quadratic interaction between the risk factors that are under the control of consumers that is locus of control*food-safety information and outrage*food-safety information remained unchanged in terms of their signs. Changes were however noticed in the levels of significance. The personal health influence factor remains significant at the 10% level of significance and the sign of the coefficient also remains positive. This goes to

further confirm the fact that as consumers become older they are more cautious about positive information from policy. A possible reason could be that given their experience gathered over the years and their susceptible to food borne illness, older consumers are more cautious in their assimilation of information and hence the way they prepare their spinach. These results also suggest that marginal increase in the positive effect of PR/HACCP decrease the potential of subjects consuming safe spinach by 1.58% and 3.04% for locus of control and outrage correspondingly. It is also worthy of notice here that demographic factors such as ethnicity, education and income were not included in the model.

The preliminary analysis of variance (ANOVA) results carried out which indicated the change in consumers mean perception of risk from the different information stages coupled with the Tobit regression results validate the presence of offsetting behavior in the preparation and consumption of vegetable. Dominant offsetting behavior is associated to the risk tolerant indexes directly related to locus of control and outrage. These variables that are under the control of consumers may cause dominant offsetting behavior due to marginal changes in policy information resulting to a more than equal change in consumers' perception of risk and behavior.

Policy Implication and Suggestion

Given the increase in the number of recalls, outbreaks, contaminations, and deaths associated with the consumption of vegetable witnessed in recent years despite voluntary measures undertaken by some producers (voluntary HACCP), there is concern that existing agricultural practices in the vegetable sector have not been effective in preventing *E. coli* illnesses. Due to the sporadic and roughly distributed nature of microbial contamination of

vegetable, there have been calls emphasizing the necessity for the establishment of mandatory good agricultural practices (GAP) or more scientific methods (like the widely recognized and tested PR/HACCP) in the vegetable sector. This method of ensuring food safety is suggested because it provides evidence of how and where contamination is most likely to occur. Some of these above mentioned methods are presently implemented as voluntary pathogen mitigation approaches. Other groups are highly in favor of self-regulation putting forward the argument that the mandatory regulatory method will be too costly for smaller producers and could therefore bear heavily on them financially. Seemingly, there seems to be an agreement towards mandatory policy implementation given recent outbreaks.

Our findings show the presence of offsetting behavior in the preparation and consumption of spinach given that a mandatory policy like PR/HACCP is implemented in the vegetable sector. Such a move carries with it significant policy implications. We will therefore proceed to make clear the policy implications of our findings. Hause (2006) stresses the fact that the ultimate effect of policy is an empirical subject. He also pointed out that the welfare inference of offsetting behavior relies mainly on whether the decline in victims' accident avoidance expenditure is considered a social gain or not. With this in mind, an efficient analysis of the impact of a safety policy on expected accident loss and accident rates necessarily needs to take into consideration the effects of offsetting behavior whenever it is significant. This study blends together the theoretical and empirical analysis to expand the offsetting behavior literature to examine the marginal benefits of food safety policies

This study points to the fact that in perspective of the push towards a mandatory policy in the vegetable sector, offsetting behavior 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. Offsetting behavior should be taken into account, such as to enhance accountability of enforced food safety policies and regulations. Further research would be to evaluate the benefits and costs of food-safety policies with the incorporation of offsetting behavior.

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APPENDIX

Table A1. Variables Used in the Tobit Models

Variable	Description
DEPENDENT VARIABLE	
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

Table A2. Food Safety Information Provided to Questionnaire Respondents

Type	Information
Negative	<p>The U.S. Centers for Disease Control boosted its estimate of the dangers of food borne pathogens. It is estimated that 5000 people die from food related illness. The Most recently publicized outbreaks are the 2003 green onions Hepatitis A and the 2006 <i>E. coli</i> O157: H7 and <i>Salmonella</i> nationwide outbreaks (Onyango <i>et al.</i>, 2007)</p>
Positive	<p>Through advances in food safety, the United States has the safest food supply in the world (Agweek-October 28, 2002)</p>