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Offsetting Behavior and the Benefits of Food Safety Policies

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Abstract

The net effect of food policies, viewed in terms of reduction of foodborne illness, death and food related diseases from obesity, may sometimes be much smaller than the predicted effect because of failure to account for offsetting behavior (OB). Theoretical and empirical models are developed and tested to determine the presence of dominant or partial OB in food safety policies. Results reveal that information that affects outrage and other determinants of risk perception will cause consumers to relax their vigilance in response to the food safety policy. This behavioral anomaly indicates a serious deviation from rational choice and may help explain the growing gap between the decrease in pathogen levels recorded after hazard analysis of critical control points implementation in meat processing plants and the number of outbreaks of food poisoning cases caused by foodborne pathogens.

Key Words: Offsetting behavior, food safety policies, risk perception, discrete choice models

Offsetting Behavior and the Benefits of Food Safety Policies

William Nganje, Dragan Miljkovic, Daniel Voica, and Benjamin Onyango[1]

Introduction

The net effect of food policies, viewed in terms of reduction of foodborne illness and death and food related diseases, may sometimes be much smaller than the predicted effect because of failure to account for offsetting behavior (OB). Many safety and health policies are adopted to reduce harm to potential victims from accidents and other harmful events. Economists have theoretically (Peltzman; Hause) and empirically (Crandall; Yun) recognized attenuation and sometimes even reversal of the direct policy effect on expected harm may occur because of OB by potential victims as the victims reduce their level of care in response to the policy. When policy makers ignore OB, where it is significant, the predicted policy effect will be overstated.

Empirical studies so far have addressed problems mostly related to safety in the automobile industry (e.g., Peltzman; Barnes), or the effect of health policies on lifestyle-dependent disease and mortality (Wilde). For instance, a most notable example of OB is an increase in the head injury rates from bicycle accidents by 10% between 1990 and 2000 despite the much wider use of bicycle helmets. According to Hause, some safety analysts think this occurs, at least partly, due to riskier behavior by the victims.

There is no reason to assume that OB is not present with respect to food consumption policies, considering that the public is generally made aware of the progress being made in food safety regulations. For instance, it is well known that ground beef and poultry are more likely to contain pathogens such as *E. coli* and *Salmonella* than is steak (*e.g.,* Food Marketing Institute and American Meat Institute). However, the publicity of improved food safety procedures in meat and poultry processing, particularly that the prevalence of most foodborne pathogens substantially decrease after implementing mandatory pathogen reduction/hazard analysis of critical control points (PR/HACCP) (Food Net), may induce irrational food mishandling and consumption of rare burgers rather than well-done burgers or steak.

The social impact of food borne diseases caused by lax or irrational consumer behavior cannot be disregarded because of the significant financial burden on victims and their families and the serious ethical perspectives. The cost to society is also important and cannot be ignored. For instance, *E. coli* O157 alone causes approximately 73,000 illnesses, 2,000 hospitalizations and over 60 deaths in the United States each year. The associated economic cost of *E. coli* 0157 is estimated to be $405 million annually: $30 million in medical cost, $5 million in lost productivity and $370 million for premature deaths (Frenzen *et al.*).

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The benefits of food safety information and policies have been evaluated in several studies (e.g., Antle; Nganje and Mazzocco; USDA-ERS). Other studies have indirectly addressed issues related to food safety information and consumers' willingness to pay for improved food safety (*e.g.*, Brown et al.). These studies have produced conflicting results and the theoretical and empirical models have focused on cost-benefit type analyses and consumers' willingness to pay for improved food safety. For example, a survey by the USDA-ERS found that firms perceive PR/HACCP as beneficial in improving consumer confidence and product reputation. Antle used a quality loss cost function approach and concluded that the cost of PR/HACCP should be explicitly accounted for to avoid overestimation of its benefits, as outlined in the final pathogen reduction rule. Brown *et al.* used an experimental auction approach to conclude that food safety information about potential illness from consuming a food product had no significant impact on consumers' willingness to pay for improvements in food safety. The Brown *et al.* study also did not explicitly model food safety information that impacts all four attributes of perceived risk: outrage, perceived locus of control, personal health characteristics, and demographic characteristics. In this study we make a distinction between general food safety information and food safety information that reveals all attributes of perceived risk. The main objective of this paper is to explore whether OB exists specifically with respect to food policy information, and to derive implications for the marginal benefits of food safety policies.

Food Safety Policies and OB

In 1996, the Food Safety Inspection Service (FSIS) introduced new mandatory food safety regulations following repeated discoveries of E. *coli* and *Salmonella* in the U.S. food supply in the 1980s and early 1990s. The new regulations called Pathogen Reduction/Hazard Analysis and Critical Control Points (PR/HACCP) mandated the establishment of critical control points (CCPs) in food production and processing operations and established testing routines for potentially hazardous food products to ensure the safety of meat and poultry products. By 2000, these regulations had been implemented by meat and poultry processors. Figure 1 (Centers for Disease Control (CDC) FoodNet, April 2006) reveals that pathogen levels decreased after the adoption of mandatory PR/HACCP in meat and poultry processing including a 30% reduction in *Camplylobacter*, a 9% reduction in *Salmonella*, a 32% reduction in *Listeria* and a 29% reduction in *E. coli* O157 (CDC, 2006). However, the CDC figures also show that there has been an increase of 41% in *Vibro*, a bacterial pathogen most commonly found in raw fish and other seafood.

One critical observation is that a dichotomy exists between pathogen levels and increasing incidents of outbreaks of food-borne illnesses from retail facilities (CDC FoodNet, 2006). Figure 2 shows that the trend in multi-state outbreaks from 1990-2004 (CDC 2006) has significantly increased. The number of outbreaks has increased since the early 1990s, peaking in 2000. After 2000, there has been some reduction, but in 2003 there was another large increase in the number of outbreaks. Nationwide, the number of all food borne illness outbreaks per year has increased (Figure 3). In this figure, one can see that the general trend in outbreaks is increasing, even though the pathogen prevalence is lower. The dichotomy between reduced pathogen prevalence and the increased frequency of outbreaks suggests the possibility of OB influences and the need for policy makers to understand more clearly how incentives along the supply chain can be developed and implemented to provide more effective food safety policies.

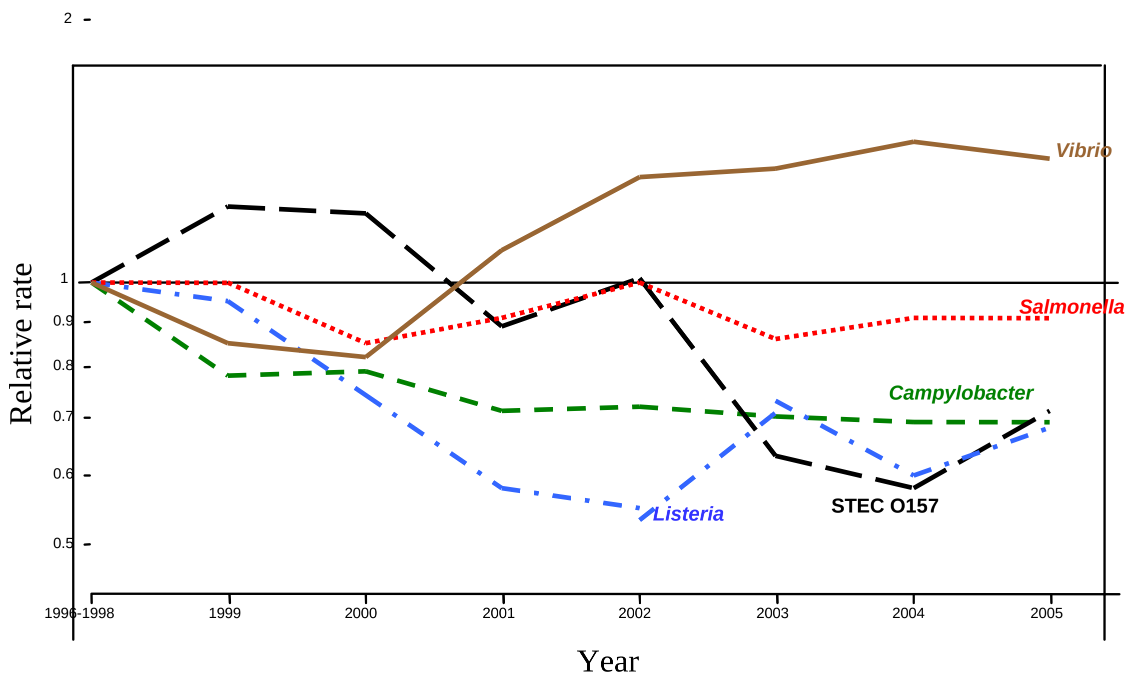

Figure 1 Trends: Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of meat infection with *Campylobacter*, STEC O157, *Listeria*, *Salmonella* & *Vibrio*, by year. (Source, CDC)

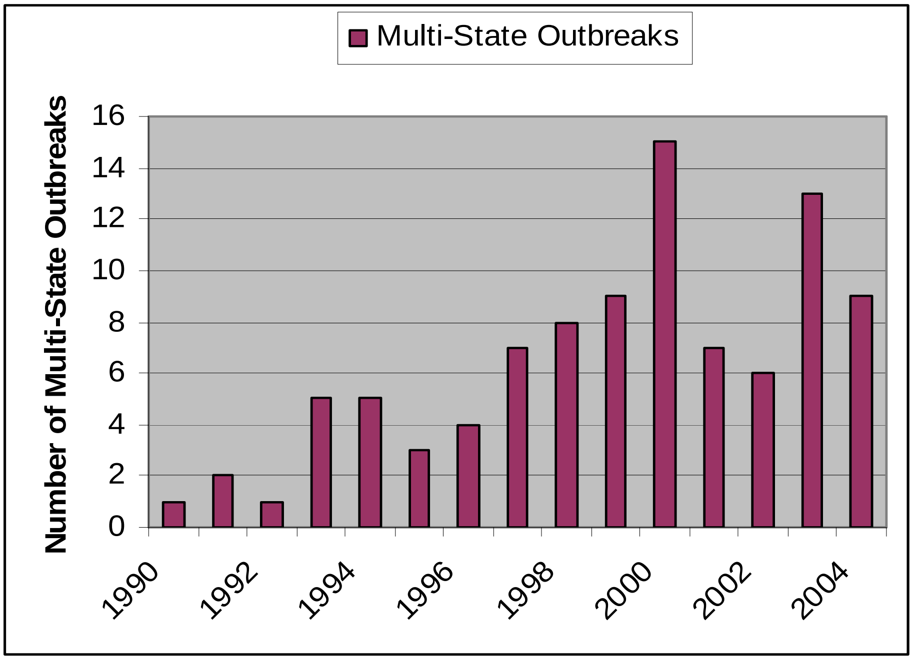

Figure 2 Trends: Number of multi-state outbreaks, 1990-2004. (Source, CDC)

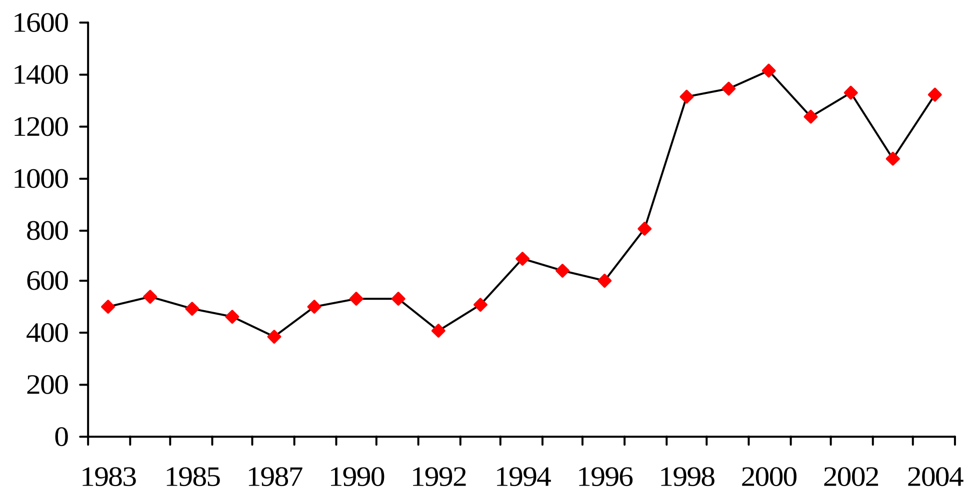

Figure 3 Trends: Food borne Disease Outbreak Surveillance System. (Source, CDC)

Several factors cause the creation of a gap of food safety regulations from farm to fork. First, separate agencies are responsible for food safety along the farm-to-fork continuum. For example, the FSIS is responsible at the processing and packaging level while Food and Drug Administration (FDA) is responsible for food safety regulations at the retail level. Second, the implementation of PR/HACCP at the pre-harvest or retail levels in the United States is optional. Even though HACCP is mandatory at the processing level, there are still significant levels of outbreaks occurring in the United States. The trend in food borne illness outbreaks are upward even though pathogen prevalence has been decreasing since the PR/HACCP final rule in 1996. While some of these increases are due to viral pathogens, bacterial pathogens still create a significant amount of the food borne illness cases each year. This could be because performance standards at the processing level need to be tightened. It could also signal a need for PR/HACCP at the retail level or the presence of OB.

Currently, some food service and retail facilities are implementing various forms of intervention, including voluntary PR/HACCP (Lehrke). Three strategies for pathogen reduction are currently being used at the retail level. These strategies involve different combinations of testing by the United States Department of Agriculture (USDA) and/or outside firms, maintaining hygiene standards with standard operating procedures (SOPs), and testing performed by the retail firm itself. All food handing operations are required to maintain SOP standards and to have random checks conducted periodically by the USDA. Some retail firms choose to go beyond the mere legal requirements to contract with a private firm (e.g., Fresh Check) to performed pathogen testing. A third strategy is voluntary PR/HACCP, where firms develop and maintain a HACCP plan. However, consumers may not fully comprehend what strategies these firms have implemented and their trust of firms using inspection with PR/HACCP may make them more lax about food mishandling and consumption of riskier products.

Therefore, it is important to understand how OB may be relevant in food safety applications and when policy changes will affect consumer risk behavior. For instance, it is well known that ground beef is more likely to contain pathogens such as E-coli than non-ground cuts (e.g., steak). Yet beef burgers are among the most popular foods in America. The safe way to prepare ground beef requires the temperature during cooking in the center of the beef patty to exceed 160 degrees F (Food Marketing Institute and American Meat Institute). Given the publicity about improved food safety procedures in the last 10-15 years that have reduced the risk of consuming contaminated meat (Antle), the question is “are consumers overconfident that food (e.g., beef) is completely safe?” Are they dropping their guard and decreasing their consumption of well-done, safer meat, because the information they receive about improved food safety leads them to assume that the meat is safe and should allow them to consume the rare meat they may prefer?

It seems that consumer choice in this situation is impacted by three factors: (1) the timing of the decision, (2) having more information, and (3) the complexity of a production and marketing process that includes multiple stages, each of which affect the quality of the final product. The timing of the decision refers to the situation in which the decision maker anticipates obtaining information before taking an action. In this context, one can distinguish between ex-ante decision making, (a decision is made before information is revealed and it is contingent on the content of the information to be received) and ex-post decision making, (the decision maker waits until the information is received before making a decision). In standard choice problems with fully rational decision makers, this distinction does not make any difference (Rubinstein).

Having more information, based on basic intuition and rational choice theory, should be an advantage for the decision maker. However, there are situations when not having access to some information is a “blessing” for the decision maker. Sometimes decision maker’s lack of information may “guarantee” that she will not make a certain choice, whereas without this guarantee she would have made a choice that is harmful to her (Geanakoplos 1989; 1994).

The complexity of a production and marketing process that includes multiple stages, which affect the attributes of the final product, may also contribute to deviation from rational choice (not consistently selecting safer products). We assume that the food handling process consists of three stages: (1) meat processing, (2) transport to retailers and retailing, and (3) the preparation and consumption of meat in households and restaurants. We also propose that the reason to introduce safety measures in the food industry is to ensure safe food consumption and not merely to reduce pathogens in the food processing system that may not be correlated with food recalls and outbreaks.

However, mandatory food safety measures are generally undertaken at the stage where contamination is most likely to occur (meat processing) and the improvements are measured by lowering levels of pathogens in the products at the processing plants. That does not automatically mean that the meat supply at the retail and consumer levels remains as safe as it is at the processing plant level unless we implicitly assume perfect handling of meat products during subsequent distribution and handling stages that ensures the same low level of pathogen bacteria in meat purchased by consumers and later consumed. However, when information about increased food safety in processing plants is made public, consumers may assume that this improved safety level continues to fully apply to the product they buy in retail stores and later consume. In the following section, we develop the theory of OB in food safety. Next, we conduct experiments to empirically test the theoretical results.

Theoretical Model

It is important to distinguish issues related to command and control policies, sorting problems, and OB before a valid theory can be developed (Peterson *et al.*; Poitras and Sutter). In the case of mandatory car safety inspections, Poitras and Sutter argued that this policy was ineffective due to its command and control design that resulted in added costs to consumers and not because of changes in consumers’ payoffs due to offsetting behavior. Peterson *et al.* also pointed out that the initial policy failure with air-bag equipped cars resulted from sorting issues. Failure of the program to lessen injuries happened initially not because cars equipped with air bags have a higher probability to be involved in a car crash, but due to the fact that aggressive drivers purchased the safety-equipped cars first and, as non aggressive drivers slowly joined the air bag owners' pool, accident rates for these cars declined. In this study, we focus on food safety information from PR/HACCP that is based on performance standards (i.e., firms determine their critical control points to meet pathogen performance standards mandated by the regulation and the USDA monitors the firm's HACCP plan) and consider the lax reaction from consumers or retailers who are not mandated to follow PR/HACCP standards.

We have expanded the expected accident loss model of Hause with the coefficient of diminishing returns (which measures quantitatively the marginal offset to food policy) to include two measures of offsetting behavior: perception of risks and consumer behavior towards safe food preparation and consumption. The theoretical model, in equation 1, has two components: 1) a "production function" of expected accidental loss, which in our case will represent the cost of illness or death from a food borne illness, and 2) an objective function which describes the victim's tradeoff between using avoidance expenditure, y, to reduce the probability of getting sick or choosing to purchase other goods.

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

where $A(x, y)$ is the cost of illness or death generated by a food borne illness. The function A is a "bad" (a pernicious event for individual and society) which implies that -*A*, the negative values, are a "good". The level of food safety regulations is x (in our case represented by PR/HACCP enforcing and monitoring expenditures), y is the monetary equivalent of consumer hazard avoidance behavior, $\pi(y)$ is the probability of a food borne illness or death occurring, and $L(x)$ is the monetary equivalent loss to the victim if illness or death occurs. We assume that $\pi(y)$ and $L(x)$ are non-negative, strictly decreasing smooth convex functions defined on $x, y \in [0,+\infty)$. This implies that the first derivatives A_y, A_x<0 such that the function A is decreasing and A_{yy}, A_{xx}>0 such that the function A is convex. The consumer's best response for all values of x considered is defined as $y(x) > 0$. It is also assumed that a consumer will choose his optimal hazard avoidance expenditure value, *y*, when given x. In this case, *x* is represented by expenditures for implementing PR/HACCP, which is reflected in the perception of risk of an average individual. The average individual will then select *y* given his perception of risk after *x* has been determined by policy. This is because $L(x) \geq 0$ by assumption.

The second component in the OB model, expressed in equation 2, is the behavioral assumption that a consumer chooses avoidance expenditure to maximize expected consumption (Hause).

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

where I is the total income.

(3) $$Max E(C) \Leftrightarrow Min[A(x,y)+y] \Rightarrow \frac{d[A(x,y)+y]}{dy} = \frac{d[\pi(y)L(x)+y]}{dy} = \pi'(y)L(x)+1=0$$

The above expression is differentiated with respect to *y* and not *x*, because it is assumed that an average consumer (individual) makes the trade off between reducing A(x,y) and purchasing other goods. This individual has control of *y*, not *x*. From his/her perspective *x* is fixed and given. Because we want to find the maximum of E(C), which is equivalent with finding the minimum of [A(x,y)+y], we need to equate the first derivative to zero. By assumption we know that A(x,y) has a minimum and that y is nonnegative. By implicit differentiation of $\pi'(y)L(x)+1=0$ we obtain equation 4:

(4) $$\pi''(y)\frac{dy}{dx}L(x) = -\pi'(y)L'(x) \Rightarrow y' = -\left(\frac{\pi'(y)L'(x)}{\pi''(y)L(x)}\right)$$

Definition 1: Initially *x* is set to be zero (no information has been given to consumers) so that $y = y(0)$ and the expected accident loss is $\pi[y(0)]L(0)$. After PR/HACCP has been adopted and consequently new information reaches consumers, we will have expenditures $x^1 > 0$ (for instance PR/HACCP implementation and monitoring expenditures). Then consumer offsetting behavior occurs if equation 5 holds.

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

Proposition 1: Food safety policies expenditures *x* always induce offsetting behavior by consumers in the model of expected health hazard loss.

Proof of Proposition 1: Before the proof of proposition 1 is given, a discussion of the sign of y' is of utmost importance for clarification. $y' = -\left(\frac{L'(x)\pi'(y)}{L\pi''}\right) < 0, \forall x, y \geq 0$, because $\pi(y), L(x)$ are assumed to be nonnegative, strictly decreasing ($L'(x) < 0, \pi'(y) < 0$) and smooth convex functions ($L''(x) > 0, \pi''(y) > 0$). One would expect that if an average consumer will perceive that the risk associated with getting sick from food borne diseases has decreased due to new safety information resulting from policy, then this individual's health hazard avoidance expenditure should decrease with it as well. This is reasonable since $y(x)$ is a decreasing function of x (it has a negative slope $y' < 0$). This result agrees with the fact that an increase of x from 0 to x^1 implies a decrease in *y* from $y(0)$ to $y(x^1)$ and in turn implies an increase in the probability of food safety hazard occurring (π will increase from $\pi[y(0)]$ to $\pi[y(x^1)]$). This result suggests the possibility of OB in food safety policies.

Definition 2: Consumers' OB is dominant if it more than completely offsets the decrease in expected health hazard loss from the direct effect of the food safety policy.

Consumer offsetting behavior is partial if it less than completely offsets the decrease in expected health hazard loss from the direct effect of the food safety policy.

Proposition 2: If an increase in *x* indicates dominant OB by the consumer, then the level of food safety regulations *x* is an inferior factor in alleviating the health hazard loss to consumers due to food borne diseases.

Proof of Proposition 2: Dominant offsetting behavior implies $A[x^1, y(x^1)] > A[0, y(0)]$ and by definition, a factor of production is inferior if higher output uses less of the factor. The elements that belong to the range of the function *A* represent a "bad" (pernicious events for individual and society) which implies that -*A*, the negative values, are a "good". If an increase in *x* induces dominant offsetting behavior then *x* must be an inferior factor in the production of -*A* because more of *x* implies less of -*A*. The mathematical derivations of dominant OB are presented in Appendix 1.

Empirical Test for Dominant OB in Food Safety

Three experiments were conducted to test the hypothesis that people exhibit offsetting behavior patterns in response to food safety regulation. A sample of 2,552 respondents from the Zoomerang database participated in the experiment. All subjects indicated that they eat burgers at least three times per month. The sample contained about 50% whites, 25% blacks and 25% Hispanic. All participants were older than 18 years of age. Following matched sample design to eliminate the variation between samples as a source of sampling error, the subjects were asked the same questions three times about their preparation preference for a burger and their perception of risk, at two week intervals. The questionnaire also included questions to elicit information for all four categories of perception of risk: perceived locus of control, personal health characteristic, outrage or fear of the unknown and demographic characteristics. In experiment 1, the questionnaire was framed in a way that no specific reference to food safety was made. In experiment 2, negative food safety information was provided to the respondents. Finally in experiment 3, positive food safety information was given to the consumers.

Positive and negative information presented to the consumers were obtained from newsletter articles, a verified source of food safety information. The positive and negative information are presented below.

> **Positive Information:** *Through advances in food Safety the FSIS/USDA has mandated and implemented pathogen reduction/hazard analysis for critical control points (PR/HACCP), a more science-based inspection system in all beef and poultry slaughter and processing installations. According to USDA, HACCP has been very effective since its adoption in 1995 and contributed to very significant reduction in pathogen bacteria in meat processing plants. Based on this assessment the government officials came to a consensus that* ***the United States has the safest meat processing system and meat supply*** *in the world* (Nganje).

Negative Information: *The government is afraid our love affair with the hamburger will kill us. The U.S. Centers for Disease Control boosted its estimate of E. coli O157 dangers. In 1994, it estimated E. coli O157 be responsible for 62,000 illnesses per year, 1800 hospitalizations, and 52 deaths. E. coli O157 also has a nasty habit of causing permanent organ damage among its survivors for example to your kidneys, liver or eyesight. Cooking a hamburger until it is dry will almost certainly kill any E. coli O157. However, some people want burgers juicy and pink in the middle and that means danger. Hamburger is a particular problem because a few bacteria ground up into a beef patty can proliferate to dangerous levels given time and poor refrigeration. The same few bacteria on the outside of a steak can't multiply rapidly, and the outside of the steak always gets high heat when it is cooked (*Avery).

The two measures of OB used in the survey were consumers' behavior on safe food handling and consumption practices and the benefit of food safety information, elicited when positive and negative information about food safety was provided to the consumers. Consumer behavior was elicited by asking the question "*how do you like your beef burger prepared?"* The choices for this question were 1) well done, 2) medium, and 3) rare. The equations for the empirical analysis are presented in equations 6 and 7.

(6) $\text{OB} = \text{f}(\boldsymbol{BH}, \boldsymbol{I})$,

(7) $BH = \text{f}(\boldsymbol{Rp})$,

where ***BH*** is change in consumer behavior, ***Rp*** is risk perception, and ***I*** is food policy information. By substituting equation 7 into 6, OB can be estimated as a function of risk perception and food policy information.[2] Table 1 provides a summary statistic of all categories of data that affect risk perception: perceived locus of control, personal health influence, outrage, and demographic variables (Nganje, Kaitibi, and Taban; Adu-Nyako and Thompson).

Following the factor analysis procedure of Brown, Cranfield, and Henson, the relative risk index of consumers' food safety risk perception risk was created, a composite measure combining all four variable categories presented in Table 1. A distinction between the Brown, Cranfield and Henson approach from this study is that factors or risk indexes representing each category of risk perception were created (Table 2). This important distinction and contribution ensures that variables that impact perception of risk, given alternative food safety information, are included in the model. The marginal contribution of each factor in conjunction with information relating to

[2] Brown et al. argued that an elicitation of consumers' risk perception from a single question (e.g., "*How safe is your beef burger?*" with response categories of 1-safe, 2-somewhat safe, and 3-not safe) may be inaccurate as there are several variables that affect perception. Instead, variables that affect perception should be used to create a relative risk index that may be used to measure consumers' willingness to pay for increased food safety and other empirical analysis.

food policy is estimated with a discrete choice, Tobit model. The appropriateness of the Tobit model with truncated data is discussed in Brown et al. and Green.

The descriptive statistics and the marginal contribution of the risk indexes on OB as information changes (Tables 3 and 4) are consistent. The mean values of the preparation preference for the hamburgers in three stages of this experiment changed from 1.962 (no food safety information provided) to 1.377 (negative information on outbreaks and effects of E. coli O157 provided) to 1.964 (positive food safety – HACCP information provided). The mean values of consumers' perception of risk for the hamburgers in three stages of this experiment changed from 1.417 (no food safety information provided) to 1.454 (negative information on outbreaks and effects of *E. coli O157* provided) to 1.324 (when positive food safety – HACCP information provided).

Table 1.Food safety and risk perceptions related questions and their mean responses and standard deviations

		General		Negative		Positive	
Categories	Variables*	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Factor 1: Locus	Q2	1.5074	0.6624	1.5409	0.6264	1.4577	0.6714
	Q3	1.1006	0.5508	1.0444	0.4507	1.0360	0.5226
	Q5	2.0680	1.4439	2.0461	1.4201	1.9874	1.4760
Factor 2: Personal Health Influence	Q35	1.8252	0.3798	1.8252	0.3798	1.8252	0.3798
	Q28	3.1626	0.9020	3.1626	0.9020	3.1626	0.9020
Factor 3: Demographics	Q32	2.4401	0.9689	2.4400	0.9689	2.4401	0.9689
	Q29	2.1556	0.71201	2.1556	0.7120	2.1556	0.7120
Factor 4: Outrage	Q33	1.2210	0.4197	1.2210	0.4197	1.2210	0.4197
	Q34	2.0517	0.9298	2.0517	0.9297	2.0517	0.9298

*Qi indicates questions that loaded into the different factors. It was interesting to note that this loading were consistent with the literature on perception of risk. Q2 = How tender do you like your beef prepared? Q3 What is your preference for taste? Q5 = What is your preference for the origin of your beef? Q28 = What is your age? Q29 = What is your ethnicity? Q32 = What is your level of education? Q33= Where do you obtain your source of food safety information? Q34 = Would you consume irradiated meat? Q35 = Has you or any member of your family ever been poison by food pathogens?

Table 2. Factor loadings and factor score coefficients for selected items

	Factor loading	Score coefficient
Q2	0.717	0.497
Q3	0.739	0.515
Q5	0.605	0.43
Q28	0.127	0.112
Q29	0.452	0.385
Q32	0.772	0.679
Q33	0.543	0.477
Q34	0.614	0.508
Q35	0.607	0.534

See Table 1 for how this variables loaded into the different factors.

Two hypotheses have been tested based on data obtained in the experiment. In the first case, the null hypothesis is that the mean values of the preparation style preference for the burgers when information regarding the potential impact of deadly *E. coli O157* that is sometimes found in undercooked hamburgers and when additional information regarding positive trends in food safety due to implementation of PR/HACCP has been presented to the subjects are equal. This null hypothesis was also rejected at the 1% significance level.

In the second case the null hypothesis is that the mean values of consumers' risk perception when information regarding the potential impact of deadly *E. coli O157* that is sometimes found in undercooked hamburgers and when additional information regarding positive trends in food safety due to implementation of PR/HACCP has been presented to the subjects is equal. This null hypothesis was also rejected at the 1% significance level.

The preliminary analysis of variance result implies that subjects became less cautious regarding the *E. coli O157* danger since their perception is that most risk from the bacteria in ground beef was eliminated due to implementation of HACCP. The result is consistent with results in Onyango *et al*. (2007) where it was shown that consumers have full trust in government actions and regulations regarding food safety matters. More importantly, this result presents a clear case of the OB where a food safety policy was enacted to reduce the number of potential victims from *E. coli O157* and other pathogens causing food poisoning cases. OB is indicated in the subjects' reduced care in response to the policy expressed, *i.e.*, food safety concerns diminished due to policies introduced and the role in the subject's level of concern in preparation style preference for burgers decreased while other attributes such as texture and the appearance again seem to have become more important. An in-depth empirical analysis provided in the preceding paragraphs demonstrates whether this OB is dominant or partial. Dominant OB in this case would indicate that the marginal impact of information regarding positive HACCP policy effect caused subjects' preparation style preference for burgers to increase at least to the level that existed before any information on food safety was provided. It is difficult to conclude regarding dominant or partial OB without marginal benefit analysis.

Two regression models were estimated to test the hypothesis that dominant OB may exist in reaction to food safety policy information. The first model (Table 3) has all four factors and two dummy variables representing the "no information experiment" and the negative information experiment. All variables were significant at the 1% or 5% level of significance except the personal health influence factor. Demographic factors, no provision of food safety information, and negative food safety information will increase the likelihood of choosing well cooked burgers. It is possible that ethnicity and educational background promote healthy food habits and confidence to consumer about the knowledge of the food they consume. It is also important to note that negative information about food will lead consumers to be more cautious and choose to consume safer products (i.e., well done burgers). It is interesting to note that locus of control and outrage will decrease the likelihood of consuming well done burgers. It is possible that when consumers are confident about their source of food or have more information about how their food was handled (e.g., irradiated or not), such information tends to makes them more lax about food safety and they tend to consume less well done burgers.

Table 3. Summary of Tobit regression results regarding the offsetting behavior [a]

Variable	Coefficient	Marginal Effect [b]
Factor 1: Locus of control	-0.3811***	-0.3366***
	(0.0254)	
Factor 2: Demographics	0.1099***	0.0970***
	(0.0255)	
Factor 3: Outrage	-0.1948***	-0.1720***
	(0.0255)	
Factor 4: Personal Health Influence	0.0341	0.0301
	(0.0254)	
D1[c]	1.9761***	
	(0.0342)	
D2[d]	1.9089***	
	(0.0533)	
Sigma	1.2849***	
	(0.0179)	

[a] Values in parenthesis are standard errors
[b] Marginal Effects for the risk perceptions measures were computed from regression results
[c] A dummy variable assuming a value of one if the observation is from the no information experiment or zero otherwise.
[d] A dummy variable assuming a value of one if the observation is from the negative information experiment or zero otherwise.
*** Denotes significance at the 1% level.

In Table 4, we explore the idea further by examining the quadratic interaction term between risk factors that consumers have direct control over (e.g., locus of control and personal health influence factor) and food policy information. Although there are slight variations with the significance of the results, the results were mostly consistent with Table 3. The coefficients of the two quadratic interaction terms are negative and significant at the 1% level of significance. As positive information from food policy is provided to consumers, the likelihood of selecting well done burgers decreases significantly, validating the existence of OB in food safety.

The marginal benefits of food safety information from policies can be approximated using the marginal impact estimation (Greene, p. 963). The results of this study indicate that marginal increase in positive food safety information will decrease the probability of consuming well done burgers by 14.18 and 6.68 percent respectively for factor 1 and 4. These results suggest that positive information that affects different risk tolerance indexes directly relating to locus of control and outrage may cause dominant OB in reaction to food safety policy, since marginal changes in policy information could result in more than proportionate change in risk perception and consumer behavior. These empirical results are consistent with the theoretical basis stated above. There is a strong possibility that the media can shape the outcome of food safety policies based on the information they channel to consumers about such policies.

Table 4. Regression results relating the change in information stage [a]

Variable	Coefficient	Marginal Effect [b]
Factor 1: Locus of control	-0.1112**	-0.0985**
	(0.0567)	
Factor 2: Demographics	0.1098***	0.0972***
	(0.0254)	
Factor 3: Outrage	-0.0712	-0.0630
	(0.0574)	
Factor 4: Personal Health Influence	0.0326	0.0289
	(0.0253)	
Locus of control * Information Stage	-0.1601***	-0.1418***
	(0.0302)	
Outrage * Information Stage	-0.0754**	-0.0668**
	(0.0313)	
D1[c]	1.9720***	
	(0.0340)	
D2 [d]	1.9107***	
	(0.0530)	
Sigma	1.2765***	
	(0.0179)	

[a] Values in parenthesis are standard errors
[b] Marginal Effects for the risk perceptions measures were computed from regression results
[c] A dummy variable assuming a value of one if the observation is from the no information experiment or zero otherwise.
[d] A dummy variable assuming a value of one if the observation is from the negative information or zero otherwise.
*** Denotes significance at the 1% level.
** Denotes significance at the 5% level

Conclusions and Suggestions

Hause has suggested that the net effect of policies is ultimately an empirical question. This article combines both theoretical and empirical analysis to extend the OB literature to analyze the marginal benefit of food safety polices (e.g., PR/HACCP). This analysis confirms that people exhibit offsetting behavior as a reaction to policies enacted to improve food safety hazards and protect consumers from getting affected by some of the deadly bacteria found in ground beef. Policy action was introduced ex post, *i.e.*, after subjects in the study adjusted their preferences, accounting for knowledge about the food safety problem. The information, although true, was also at least partially irrelevant since it is related to food safety measures in meat processing plants rather than in retail stores or restaurants, and it is quite possible for meat contamination to occur at any time between the moment when meat leaves the processing facility until it is consumed in households or restaurants. This behavioral anomaly indicates serious deviation from rational choice by consumers, and possibly helps explain the growing gap between the decrease in pathogen bacteria level recorded in meat processing plants and the number of outbreaks of food poisoning cases caused by these bacteria. We understand concurrent research is currently being conducted to address issues of improved technology and tracking and those issues have not been addressed in this research. Research that encourage solution (e.g., policies targeting reduce recalls), rather than problem oriented studies, should be encouraged.

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Appendix 1: Dominant OB

In order to identify the conditions required for the existence of dominant OB, the marginal effect of *x* is separated into the direct effect of *x* (for instance the decrease in health hazard loss after the new food safety policy have been enacted) and the indirect offsetting behavior effect of *x* on *y* (e.g., a consumer chooses to consume more of rare burgers after the new food safety policy have been adopted). Let us define $A(x) = A[x, y(x)]$, and take total derivate to obtain (A1):

$$(A1) \qquad \left[\frac{dA(x)}{dx}\right] = A_x \left\{ 1 - \left[\frac{\left(\frac{A_{xy}}{A_{yy}}\right)}{\left(\frac{A_x}{A_y}\right)} \right] \right\}$$

$\left(\frac{A_{xy}}{A_{yy}}\right) / \left(\frac{A_x}{A_y}\right)$ is the consumer's marginal OB. It measures the ratio by which the direct marginal effect of *x* on A is reduced by victim OB. If the marginal OB is greater then 1 for $0 < x < x^*$, then it will imply dominant OB for food safety policy x^* because $1 - \left(\frac{A_{xy}}{A_{yy}}\right) / \left(\frac{A_x}{A_y}\right)$ will be negative, which when multiplied by A_x will become positive again. But this will imply that $\left[\frac{dA(x)}{dx}\right]$ is positive, which implies that the function $A(x) = A[x, y(x)]$ will increase for x^* compared with *x*, resulting in dominant OB. If marginal offsetting behavior is less than 1, the offsetting behavior is partial for the food safety policy x^*. Also note that $\left(\frac{A_{xy}}{A_{yy}}\right) / \left(\frac{A_x}{A_y}\right)$ is positive because ($A_{xy} > 0, A_{yy} > 0, A_x < 0, A_y < 0$), this is important in the discussion of partial offsetting behavior. We know

$$(A2) \quad \frac{dA(x)}{dx} \equiv \pi L' \left[1 - \frac{(\pi')^2}{\pi \pi''} \right].$$

Expression (A24) is obtained by substituting equation 1 into A1, where $\frac{(\pi')^2}{\pi \pi''}$ is the reduction of the marginal direct effect of *x* due to offsetting behavior, which depends on *y* and not *x*.

Proposition 3: If the log of the probability of a food borne illness or death occurrence function is concave and decreasing, then the offsetting behavior is dominant. If the log of the probability of a food borne illness or death occurrence function is convex and decreasing, then the offsetting behavior is dominant.

Proof of Proposition 3: $\log[\pi(y)]$ is a decreasing function $\forall y \geq 0$. This is because $\pi^{'} < 0$ and $\frac{d\log[\pi(y)]}{dy} = \frac{\pi^{'}}{\pi} < 0$. Next if $\log[\pi(y)]$ is concave then $\frac{d^2\log[\pi(y)]}{dy^2} = \frac{d\frac{\pi^{'}}{\pi}}{dy} = \frac{\pi^{''}\pi - \left(\pi^{'}\right)^2}{\pi^2} < 0$. If we multiply this expression by $\frac{\pi^2}{\pi\pi^{''}}$, we have $\frac{\pi^{''}\pi - \left(\pi^{'}\right)^2}{\pi^2} \cdot \frac{\pi^2}{\pi\pi^{''}} = 1 - \frac{\left(\pi^{'}\right)^2}{\pi\pi^{''}} < 0$. This is because $\frac{\pi^2}{\pi\pi^{''}}$ is positive and so the inequality sign does not changed. We can obtain $\frac{dA(x)}{dx} \equiv \pi L^{'}\left[1 - \frac{\left(\pi^{'}\right)^2}{\pi\pi^{''}}\right] > 0$ which implies dominant OB if we multiply the previous expression again by $\pi > 0, L^{'} < 0$.