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A Revealed and Stated Preference Latent Class Model to Examine Homogenous Subgroup Consumer Behavior Responses to Information and Food Safety Technology Treatments.

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Abstract The combination and joint estimation of revealed and stated preference (RP/SP) data approach to examining consumer preferences to relevant policy-based measures has exclusively considered aggregate data and behavior of the average individual. However, in policy-based analyses, where the research is often driven by understanding how different individuals react to different or similar scenarios, a preferred approach would be to analyze preferences of homogenous population subgroups. We accomplish this by developing a latent class RP/SP analysis that examines whether homogenous subgroups (or classes) of the population, based on individual health and behavioral characteristics, respond differently to health-risk information and new food safety technology. The ongoing efforts by the U.S. Food and Drug Administration to reduce illness and death associated with consuming raw Gulf of Mexico oysters provide an ideal platform for the analysis as the health risks only relate to a very specific subgroup of consumer. Results from the probabilistic latent class model indicate that the vulnerable at-risk consumers respond differently to the information treatments than other subgroups, illustrating why educational information brochures have had little impact on reducing annual deaths from consuming raw oysters. Also, findings across all subgroups provide strong empirical evidence that the new FDA policy requiring processing technology to be used in oyster production will have detrimental effects on the oyster industry.

Keywords Food safety technology, health-risk information, latent class analysis, revealed preference, stated preference

Introduction

In the 1990s, a combination and joint estimation of revealed preference and stated preference (RP/SP) data approach to non-market valuation was developed. As the contrasting strengths of allowing the measurement of preferences outside of an individual's historical experience while also anchoring the stated preference responses to actual behavior were validated, researchers developed RP/SP models to value a variety of environmental amenities.[1,2] Typically, research utilizing RP/SP models also examines the welfare effects of changes in consumer preferences to relevant policy-based measures.[3] Yet, as these studies consider individuals' preferences in the population aggregate, welfare estimates are provided based on the average person in the sample. As different SP scenarios may affect individuals' preferences in different ways, considerable information regarding the behavior of subgroups within the sample is not observed. Specifically for policy-based analyses, where the research is often

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[1] For example, Adamowicz, Louviere, and Williams (1994) used joint estimation to examine recreation site choice; Whitehead et al. (2008) valued beach access; Morgan and Huth (2010) measured cave diving trip demand; Butry and Pattanayak (2011) considered the impact of tropical forest logging.

[2] See Whitehead et al. (2008) for a review of this literature

[3] For example, Whitehead, Haab, and Huang (2000) combined RP/SP data to examine the changes in recreation demand from quality improvements; Parsons and Stefanova (2011) valued short-term site closures; and Dumas, Herstine, and Whitehead (2011) estimated the benefits from dredging the Atlantic Intracoastal Waterway.

driven by understanding how different individuals react to different or similar scenarios, interpretation of aggregate data may be tenuous.

Despite the increased popularity of RP/SP demand models, no work has considered the role of individuals' heterogeneous preferences on consumer behavior in this framework. The purpose of this research is to extend previous RP/SP work by developing a Latent Class Analysis (LCA) that examines whether homogenous subgroups (or classes) of the population, based on individual health and behavioral characteristics, respond differently to health-risk information and new food safety technology. Our application is to the oyster industry and attempts by the U.S. Food and Drug Administration (FDA) and Interstate Shellfish and Sanitation Conference (ISSC) to reduce the annual number of deaths from consuming raw, Gulf of Mexico oysters.[4] Approximately 15 to 20 consumers die each year in the U.S. from consuming raw oysters infected by a bacterium (*Vibrio vulnificus*). As the ingestion of the *V. vulnificus* bacteria typically poses little risk of illness when consumed by a healthy adult with a normally functioning immune system, most consumers are not at risk from a *V. vulnificus* infection. However, there is a small percentage of the oyster consumer population that are immune-compromised (such as those with chronic liver disease, iron overload disease, diabetes, cancer, or HIV/AIDS). For these individuals, consumption of raw Gulf of Mexico oysters infected by *V. vulnificus* can be fatal. Over

[4] The ISSC comprises representatives from the shellfish industry and both federal (FDA and Center for Disease Control) and state governments, and is the primary body for regulatory oversight on matters involving molluscan shellfish.

the last decade, in conjunction with the ISSC, the FDA has invested significant resources in an attempt to reduce the incidence of food borne *V. vulnificus*-related illness. Initial efforts primarily involved educating vulnerable consumers via disseminating *V. vulnificus* fact sheets or brochures detailing the risks associated with raw oyster consumption. However, despite these educational outreach initiatives, the frequency of *V. vulnificus* illness at the national level has largely remained constant. The first component of the analysis is to examine whether this information can be presented in a different media form and/or sourced to other entities to influence oyster consumer behavior. We develop a LCA to specifically examine responses from consumer subgroups to different information treatments with a focus on immune-compromised consumers that are specifically at risk from consuming raw Gulf oysters. Overall, we examine which information treatment type and source combination is the most effective at highlighting the health risks to this group from consuming raw oysters, and altering their consumption behavior.

Due to the ineffectiveness of the current brochures on reducing the incidence of *V. vulnificus*-related deaths, the FDA recently proposed a controversial new policy designed to improve oyster safety and reduce illnesses and human mortalities from consuming raw Gulf oysters.[5] The policy, initially set to be effective in May 2011, required raw Gulf oysters, intended for sale in the half-shell market during the summer

[5] The announcement was made at the biennial meeting of the Interstate Shellfish and Sanitation Conference (ISSC). A presentation at the meeting from the FDA detailing the plan can be retrieved at <http://www.fda.gov/NewsEvents/Speeches/ucm187015.htm>

months to be treated by post-harvest processing (PHP) methods to reduce the presence of *V. vulnificus* to non-detectable levels. Due to concerns associated with the potential negative economic impact of implementing the policy without first examining consumers' acceptance of a PHP oyster, the proposed mandate received a backlash of criticism from the ISSC and industry representatives.[6,7] Based on these concerns, the FDA has since issued a letter postponing implementation until research into the consequences of such a ban can be completed.[8] The second component of the analysis develops a standard RP/SP framework to examine consumers' response to a policy of processing all raw oysters before market on oyster consumer behavior. Data for both models are drawn from an internet-based survey of oyster consumers across states in which consumers have died from a *V. vulnificus* infection.

The rest of the paper is organized as follows. We begin by discussing the consumer health-risk issues posed by *V. vulnificus* before detailing the relevant food safety and consumer behavior literature. The survey design is described before outlining the methodological framework for explaining consumer responses to health-risk information and technological innovation. Finally, results from a pooled RP/SP demand model and a LCA that examines the behavioral responses to information

[6] The formal response by the ISSC to the FDA can be retrieved at <http://www.issc.org/client_resources/usfda%20letter%20from%20issc%20november%202%202009.pdf>

[7] A response from representatives of the East Coast Shellfish Growers Association, Pacific Coast Shellfish Growers Association, Gulf Oyster Industry Council is available at <http://www.ecsga.org/Pages/Issues/Human_Health/FDA_OysterBanPressRelease10-09.pdf>

[8] The letter announcing the postponement of the ban can be retrieved at <http://www.issc.org/client_resources/fda%2001-26-2010%20letter%20to%20issc.pdf>

treatments of homogenous oyster consumer subgroups are presented, together with concluding remarks.

V. vulnificus and Health Risk

V. vulnificus is a gram-negative bacterium found naturally in coastal waters along the Gulf, Atlantic, and Pacific coasts, although it is most widespread in the warm waters of the Gulf of Mexico. Along with *V. cholera*, *V. vulnificus* is considered to be more lethal than the remainder of the vibrios, inhabiting brackish and salt water, and found in higher concentrations in summer months when coastal waters are warm.[9] Figure 1 shows the monthly *V. vulnificus* cases for the core states based on reported incidences from 1995 to 2010.

Insert Figure 1 Here

V. vulnificus can be transmitted to humans through the consumption of raw shellfish harvested from waters containing the organism with Gulf of Mexico oysters recognized as the primary species of molluscan shellfish associated with *V. vulnificus* illnesses in consumers. As the ingestion of the *V. vulnificus* bacteria typically poses little risk of illness when consumed by a healthy adult with a normally functioning immune system, most consumers are not at risk from *V. vulnificus* infection. However, there is a

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[9] Higher temperature-based concentrations of *V. vulnificus* between May and August is one reason for the common adage among raw oyster consumers to "only eat oysters during the 'R' months."

small percentage of the oyster consumer population that are immune-compromised (such as those with chronic liver disease, cancer, or HIV/AIDS), and as a result, at a greater risk for contracting *V. vulnificus* infections (such as primary septicemia or gastroenteritis) from oyster consumption. Risk of life threatening illness from consuming oysters arises primarily if the oysters are consumed raw or in an undercooked state. While healthy individuals have little life threatening infection risk from eating shellfish, those that are at risk can avoid infection by eating only shellfish that have been thoroughly cooked or post-harvest processed to reduce *V. vulnificus* to non-detectable levels and by avoiding contact with seawater. To provide a sense of the severity of the risk of illness, at an average annual rate, approximately 50 consumers become seriously ill from *V. vulnificus*, of which about 20 die (Mead et al. 1999) but the goal of the FDA is to reduce the annual death count to nine or below.

While thoroughly cooking oysters removes all *V. vulnificus* risk, a popular and traditional method is to consume oysters "raw on the half shell." These oysters are harvested, sorted/washed, and boxed by the processor, then shipped at approved temperatures to the retail market, before finally being consumed raw by the consumer. Due to the potential health risks associated with consumption of raw oysters, this process is regulated by the FDA under the National Shellfish Sanitation Program (NSSP). Of particular interest to the FDA, who oversee the regulation and monitoring of health and sanitation issues concerning raw molluscan shellfish consumption, is the incidence of illness associated with *V. vulnificus*. In 2001, under the NSSP, the FDA and ISSC adopted a seven-year *Vibrio vulnificus* Risk Management Plan for Oysters with a specific goal to reduce the annual incidence of *Vibrio vulnificus*-related illness by 60 percent by 2008. A primary component of the plan was to produce and disseminate *V. vulnificus* fact sheets or brochures detailing the risks associated with raw oyster consumption in an attempt to educate at-risk consumers. Another element was to encourage the use of PHP technologies for reducing *V. vulnificus* bacteria levels.[10] Despite this and other various efforts, the frequency of *V. vulnificus* illness at the national level remained constant. In October, 2009, disappointed with the progress being made under the NSSP *V. vulnificus* plan, the FDA announced a controversial reformulation of its policy on control of *V. vulnificus* in raw oysters, requiring the use of PHP for Gulf oysters intended for the raw half-shell market during the months of April through October, with an effective date of May 2011. Beyond the initial unease from the ISSC and industry representatives about the FDA's unilateral decision, industry concern surrounded consumers' acceptance of a treated oyster product and the potential negative impact on the oyster industry. Based on these concerns, the FDA has since issued a letter postponing implementation until additional research into the consequences of such a ban could be completed.

Background

[10] There are four FDA-approved oyster processing methods that may be used to reduce *V. vulnificus* bacteria in oysters to non-detectable levels: irradiation, individual quick-freezing (IQF), cool pasteurization, and hydrostatic pressure.

Research examining consumer response to favorable or unfavorable health-risk or product contamination information suggests that information is subjectively evaluated by consumers and impacts risk perceptions, attitudes, and ultimately behavior. Research findings have demonstrated that negative media coverage can cause consumers to react defensively and reduce their demand for the good, e.g., news of a ban on harvesting oysters from contaminated waters decreased oyster demand (Swartz and Strand 1981). Similar behavior was observed following news of a heptachlor contamination of milk in Hawaii (Smith, van Ravenswaay, and Thompson 1988), cholesterol media coverage associated with egg consumption (Brown and Schrader 1990), and news of domoic acid contamination of mussels (Wessells and Anderson 1990). Consequently, consumers accrue welfare losses, or avoidance costs as the negative news associated with consumption of the good heightens risk perceptions and decreases consumer demand. Researchers, interested in examining potential policy implications, have also considered the effect of positive counter-information treatments, designed to reassure consumers about the product's safety, on risk perceptions and consumer behavior. Generally, these studies find that counter-information treatments have a negligible effect on consumer demand, so welfare losses persist.[11]

[11] For example, Fox, Hayes, and Shogren (2002) explored how both positive and negative information impacted consumers' willingness to pay for irradiated pork in a repeated-trial, second price auction framework. They found that negative information consistently dominated consumer behavior. Parsons et

In a RP/SP framework, we quantify the effects of different positive and negative information treatments on oyster consumer behavior. Three positive information treatments were provided to respondents, all designed to present the facts associated with *V. vulnificus*; the necessary health conditions required to be considered at-risk; potential illnesses; diagnosis and treatment; and risk prevention recommendations. The first is the actual *V. vulnificus* brochure fact sheet entitled "The Risk of Eating Raw Molluscan Shellfish Containing *Vibrio vulnificus*," produced by the ISSC.[12] The second is a video treatment designed, developed, and produced to provide the same information as the brochure. The purpose of providing two different treatments is to test whether the media form of the information influences consumer behavior. With four out of five U.S. adults online, streaming video is a relatively new tool for information

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al. (2006) developed a RP/SP model to estimate changes in per-meal consumer surplus estimates for seafood consumers following a health risk announcement and the welfare-mitigating effects of different positive information treatments. They estimated aggregate welfare losses of approximately $60 million per month across the Mid-Atlantic region following news of a local harmful algal bloom (HAB) event. They also found that positive information treatments in the form of brochures, designed to reassure consumers of the safety of consuming seafood following the HAB event had no impact on consumer demand; thus, the welfare losses persisted.

[12] The *V. vulnificus* fact sheet can be retrieved from <http://www.issc.org/client_resources/Education/English_Vv_Risk.pdf>

dissemination.[13] Two professional actors and a videographer were hired to shoot a three-minute video, which disseminated the same *V. vulnificus* information as the ISSC brochure.[14,15] That is, we wanted the severity of the threat, or fear appeal, from consuming raw oysters to be constant across the brochure and standard video treatments. In the social psychology literature, Protection Motivation Theory (PMT) describes adaptive and maladaptive coping behaviors of individuals to health threats (see Rogers 1975). Within this literature, it has been shown that the severity of the threat and how vulnerable an individual is to the threat can change the probability of behavioral modification (Maddux and Rogers 1983; Abraham et al. 1994). The third information treatment is an alternative video that was created and is identical to the standard video with the exception that the level of threat was reduced by not mentioning the possibility of death from consuming raw oysters. Instead, only the possibility for illness was disseminated. Analyzing oyster demand behavior in response

[13] To our knowledge, no other food safety research has considered measuring the impact of streaming video online on consumer behavior.

[14] The concept of the video is that a couple, while sitting in a waiting area outside a seafood restaurant, waiting to order and go in for their meal, pick up the *V. vulnificus* brochure fact sheet and read through it. The man in the video recently discovered that he was borderline diabetic and as they are about to order oysters on the half shell, they read and discuss the contents of the brochure.

[15] The full video is available for viewing at http://vimeo.com/7035554

to both video treatments will provide an examination of changes in consumer behavioral responses based on the severity of a threat.

As well as varying the media form across the *V. vulnificus* information treatments, the source of the information content was also varied. Again referring to the social psychology literature, the role of the source of information, and in particular, source credibility has been shown to influence consumer behavior with the potential to create the asymmetrical effects associated with negative and positive information treatments (for example, see Hovland and Weiss 1951; Johnson and Steiner 1968; Sternthal, Lynn, and Dholakia 1978). Findings from this area of research indicate that more credible sources of information are more likely to induce greater behavioral compliance. Others have demonstrated that third-party information (from independent or not-for-profit groups without a financial interest in influencing consumer behavior) has a greater impact on consumer behavior than information from interested parties (Huffman et al. 2002; Rousu et al. 2004). These findings are also supported by research into the demand for ecolabelling and genetically modified food products that find consumers to be generally distrusting of information attributed to government organizations but can be influenced by independent third party information (Milgrom and Roberts 1986; Huffman and Tegene 2002; Huffman et al. 2004; Johnston et al. 2001; Morgan et al. 2009).

Another associated issue is whether consumers perceive the provider of the information to have conflicting responsibilities. That is, some public sector institutions have been identified by the public as a risk information generator as well as a risk regulator, with the dual responsibility of communicating risk information for which it has responsibility to regulate (Eiser et al. 2002). In such circumstances, the public may perceive some degree of vested interest with the public institution disseminating risk information and discount the information accordingly. For the brochure and video treatments, to test for source credibility effects, we varied information treatments across four different source groups. These are (1) no source (the control group); (2) the FDA; (3) the ISSC; and (4) a researcher-created fictitious not-for-profit group called the American Shellfish Foundation (ASF). By randomly varying the treatments and source type across respondents, we examine and quantify the most effective informational treatment, by source type, that influences oyster consumer demand.

To investigate the potential asymmetrical impacts of positive and negative information treatments and to quantify the potential avoidance costs associated with news of the health risks associated with consuming raw oysters, survey respondents are also presented with a news article of a recent consumer illness and death from eating raw Gulf of Mexico oysters. The article is hypothetical but based on actual events. It described a middle-aged man that fell ill from consuming raw oysters, spent a week in hospital but then died from his sickness. At this stage, and again drawing from the PMT literature on behavioral compliance, we varied the location of the incident across respondents. As such, we also investigate whether the location of the death announcement matters to consumers. The PMT literature suggests that individuals are more responsive to a local event than the same incident outside of their region (Neuwirth, Dunwoody, and Griffin 2000). To test this, we disseminated two news treatments. One describes an illness and death in the locality of the respondents' residence while the second depicts an illness and death to a consumer in Chicago, IL, which, based on our geographical sample is a non-local event to all respondents.

Finally, with the recent FDA mandate on PHP oysters on hold pending research into consumer acceptance of processed oysters, we examine consumers' acceptance of PHP oysters. Throughout the 1990s, in line with the rising incidence of food-borne illness, research examining the role of technological innovation in food production developed. To generalize findings from this literature, while the type of technology (such as irradiation or pasteurization) used is likely to be an important factor in explaining consumer acceptance of emerging technologies, it's the tangible benefits of the technology that drive consumer acceptance or rejection of the technology (Frewer et al. 1997; Hamstra and Smink 1996). For raw oyster consumers, understanding the perceived benefits of a PHP oyster is complicated by the fact that most consumers prefer to eat their oysters raw. The perceived benefits from processing the oyster will then be a function, not only of the expected decrease in health risk, but also the perceived change in taste.[16] For the average oyster consumer, as the decrease in risk for treating the oyster is negligible, any perception that treating the oyster will deteriorate the taste/texture of the product may cause the consumer to reject the PHP oyster. Analyzing and quantifying consumer behavior in response to a policy that makes only PHP oysters available in the market will provide important feedback to the current FDA policy. Finally, as processing the oysters will increase producers' costs of production, consumers' oyster demand for PHP oysters and an associated price premium is also measured.

Survey, Sampling, and Study Design

We developed an internet-based survey of oyster consumers (aged 18 and over), sampled from the U.S. Center for Disease Control-designated "case states."[17] These are Florida, Alabama, Mississippi, Louisiana, Texas, and California. Due to a request from Georgia Sea Grant Program, we also sampled consumers in Georgia. The sample was drawn from a panel of online respondents maintained through Online Survey Solutions, Inc. (OSS) and the survey was administered between March and April, 2010.[18]

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[16] Recent work by Bruner et al. (2011) demonstrated that consumers perceive a PHP oyster to taste inferior to a traditional raw oyster.

[17] CDC case states are states in which there are documented cases of *V. vulnificus*-related deaths.

[18] All observations were collected before the BP *Deepwater Horizon* Gulf oil spill.

We were willing to accept the potential for sample bias through using online respondents as the online design was imperative for disseminating the information/source treatments (particularly streaming the video treatment) and for the skip patterns required throughout the survey design. The survey had two parts. First, respondents were asked questions to generate data on attitudes, preferences; awareness and perceptions of oyster consumption health risk; knowledge about oyster consumption health risk; and relevant demographic data. Second, to meet our research objectives, respondents were asked a series of stated preference questions regarding their annual oyster consumption based on current conditions and after having been provided with different information treatments.

Before the stated preference demand elicitation questions, respondents were asked about their current annual consumption frequency to generate pretreatment baseline data for oyster consumption experience. To aid the respondent in determining the annual amount, they were asked how many months in a year they typically consumed an oyster meal, and then, in a typical month in which they ate oyster meals, about how many oyster meals did they eat.[19] The survey software then computed the

[19] Respondents were informed that oyster meals included any meal in which the main course was oysters, or oysters were an important ingredient in the dish (like gumbo), or meals in which they are an oyster appetizer. Pictures were also displayed to provide examples of oyster meals.

annual number of meals and respondents were offered the opportunity to adjust the number if desired.

Respondents were then asked a series of seven stated preference questions to elicit their annual number of oyster meals consumed having been exposed to varying information treatments. The first stated preference question asked respondents whether, compared to the number of meals they revealed they consume in a typical year, did they expect to eat more, less, or the same number of oyster meals next year? Respondents were then prompted to state how many more or less as required. In estimation, inclusion of a stated preference count under existing conditions provides a means to control for potential hypothetical bias in individual responses. After each SP question, respondents were also given a follow-up question asking them to state their perceived chances of getting sick from eating these meals.[20] To derive the oyster demand curve for the sample, respondents were also asked to state whether they would eat more, less, or the same number of meals under both a price increase and a price decrease scenario (while being informed that the price of all other food products remained the same), where the price changes were varied randomly across respondents.[21]

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[20] Respondents were prompted to choose from a five-level Likert scale of "Not very likely at all; Somewhat unlikely; I don't know; Somewhat likely; Very likely."

[21] Each respondent received a price increase of $1, $3, $5, or $7, or a price decrease of either $1, $2, $3, $4.

Respondents were then randomly assigned and presented with either a *V. vulnificus* brochure or a *V. vulnificus* informational video, the source of which was varied randomly between no source, the FDA, the ISSC, or a not-for-profit American Shellfish Foundation.[22] The source is clearly identified to the respondent before reading/viewing the treatment, plus the source is also clearly labeled on the brochure and in the bottom-right corner of the screen for the video treatment. Further, respondents were also informed of the source's mission. For example, if a respondent was presented with a brochure or video sourced to the ISSC they were then informed:

> "The mission of the ISSC is to foster and promote shellfish sanitation through the cooperation of state and federal control agencies and the shellfish industry to seek to insure the safety of shellfish products consumed in the United States. The ISSC is partially funded by the U.S. government."

Respondents were then asked a follow-up SP question as to the number of annual oyster meals they expect to consume having read/viewed the *V. vulnificus*

[22] Recall, there are two different video treatments that vary by threat severity. Respondents could therefore receive one of three informational treatments; a brochure, a standard video, or an alternative video.

informational material, again followed by a question regarding their expected chance of getting sick from consuming those meals.

Next, respondents read a fictitious newspaper article regarding a recent consumer illness and death associated with eating raw oysters. The article was based on actual media reports of *V. vulnificus*-related human illnesses and fatalities. Again, follow-up SP annual oyster meal and expected sickness questions followed.

The final stage of the survey investigated respondents' behavioral response to treating oysters to reduce the actual risk of *V. vulnificus* contamination. Prior to the SP expected oyster meal count question, respondents were presented textual material on PHP treated oysters. The material informed respondents that there are currently four FDA-approved PHP methods, all of which reduce *V. vulnificus* to non-detectable levels. An SP question then elicited respondents' annual oyster meal count having read about PHP and assuming that the only oysters available are those that have been Post-Harvest Processed. To further examine whether respondents would pay a premium for PHP oysters that eliminate the risk of death from consuming raw oysters, we asked the same SP question on expected annual oyster meals consumed but with an increase in price.[23] Table 1 summarizes the seven SP questions.

Insert Table 1 Here

[23] Price premiums were varied randomly across respondents as $1, $3, $5, or $7.

In total, there were 1,849 completed responses from oyster consumers across the seven states. Table 2 provides sample definitions and descriptive statistics for variables used in the analysis for the sample. On average, respondents eat 16 oyster meals per year. The average respondent in the sample is 44 years of age, Caucasian, and earning a household income of $69,000. Just over half of the sample was female. In terms of the behavioral and health variables, over 62 percent of the sample consumed raw oysters with 18 percent classified in the at-risk category for potential illness from consuming raw oysters.

Insert Table 2 Here

The Conceptual Framework

The online survey instrument collects RP and SP data for analysis in a basic oyster demand model. The RP data is based on actual annual number of oyster meals consumed and the SP data is used to stimulate a change in oyster meals consumed resulting from price changes and the provision of different information treatments. SP meal questions are asked about future meals consumed: (1) under status quo conditions, (2) with a price increase and decrease scenario, (3) with the provision of a brochure or video, (4) with news of a *V. vulnificus*-related death, (5) with a mandatory PHP policy, and (6) with a mandatory PHP policy and associated price premium.

As the dependent variable is a nonnegative integer with a high frequency of low meals consumed, a linear count panel data specification is estimated. A basic count model is assumed and is written as

$$\Pr(x_{it}) = \frac{e^{-\lambda_{it}}\lambda_{it}^{x_{it}}}{x_{it}!}, x_{it} = 0,1,2,... \quad (1)$$

The natural log of the mean number of meals is assumed to be a linear function of prices, the perceived chance of becoming ill from consuming oysters, income, and scenario dummy variables. To allow for variation across oyster consumers that cannot be explained by the independent variables, we assume that the mean number of meals also depends on a random error, u_{it}. The pooled RP/SP Poisson demand model is:

$$ln\lambda_{it} = \beta_0 + \beta_1 P_i + \beta_2 c_i + \beta_3 y_i + \beta_4 \boldsymbol{s}_i + \beta_5 I + \beta_6 N + \beta_7 PHP + \beta_8 PHP_{prem} + \beta_9 SP + \mu_{it} \quad (2)$$

where P is the price of an oyster meal; y is income; $\boldsymbol{s}$ is a vector of socio demographic variables; individuals are indexed i = 1, …, 1,849; and t = 1, …,8 denotes annual oyster meal demand under RP status quo, SP status quo, SP price increase, SP price decrease, SP information treatment, SP news treatment, SP PHP treatment, and SP PHP treatment with price premium, respectively, in the pseudo-panel data. Dummy variables I (I = 1 when t = 5), N (N = 1 then t = 6), PHP (PHP = 1 then t = 7), and PHP_{prem} (PHP_{prem} = 1 then t = 8) are demand shift variables for the information, news, and PHP treatment scenarios. The *SP* dummy variable is included to test for hypothetical bias. *SP* = 1 for hypothetical meal data (t = 2, …, 8) and 0 for revealed meal data (t = 1). $\beta_0 - \beta_9$ are coefficients to be estimated in the model. Pooling the data suggests that panel data methods be used to account for differences in variance across sample individuals, i, and scenarios, t. The distribution of meals conditioned on u_{it} is Poisson with conditional mean and variance, λ_{it}. If $\exp(\lambda_{it})$ is assumed to follow a gamma distribution, then the unconditional meals, x_{it}, follow a negative binomial distribution (Hausman, Hall, and Griliches 1984).

With the semi-log functional form the baseline economic benefit per annual oyster meals consumed for the representative consumer as measured by average annual per-person consumer surplus (CS) is:

$$\frac{CS}{\hat{x}_{SP=1}} = \frac{\hat{x}}{-(\beta_1)} \tag{3}$$

where $\hat{x}_{SP=1}$ is the annual number of predicted meals for the representative oyster consumer without controlling for potential hypothetical bias (uncorrected model) and all independent variables are set at sample means (Bockstael and Strand 1987).

In the uncorrected model, the change in annual per-person CS as a result of new *V. vulnificus* information is:

$$\frac{CS \mid SP}{\hat{x}_{SP=1}} = \frac{(\hat{x} \mid I=1)-(\hat{x} \mid I=0)}{-(\beta_1)} \tag{4}$$

The CS effects of the news treatment and PHP scenarios are estimated in a similar fashion with the respective dummies. The corresponding annual per-person CS and changes in annual per-person CS estimates when controlling for potential hypothetical bias (corrected model) are:

$$\frac{CS}{\hat{x}_{SP=0}} = \frac{\hat{x}}{-\beta_1} \tag{5}$$

$$\frac{CS \mid RP}{\hat{x}_{SP=0}} = \frac{(\hat{x} \mid I=1)-(\hat{x} \mid I=0)}{-\beta_1} \tag{6}$$

We also conduct a latent class analysis that allows behavioral responses to the information treatments to be examined across subgroup populations. Latent class models are used to estimate separate parameter estimates for survey respondents who possess similar preferences (McLachlan and Peel, 2000). Boxall and Adamowicz (2002) introduce the latent class model in the environmental economics literature with an application to recreation site selection. Scarpa, Thiene and Tempesta (2007) extend the latent class model to continuous data models of recreation demand. Both applications find that willingness-to-pay estimates differ significantly over different classes of respondents. The latent class model is an extension of the panel data model where separate coefficient vectors arise for each class of respondent. The model sorts respondents into c = 1, …, n latent classes probabilistically, $\pi(i,t|c)$, where the probabilities interact non-parametrically with the coefficient estimates. The latent class model is useful for identifying unobserved preference heterogeneity and identifying the potential for outliers in the data.

Estimation Results

Before presenting and discussing the results from the LCA, Table 3 presents the regression results from a random effects Poisson oyster demand model.

Insert Table 3 Here

This is a standard pooled RP/SP model that examines the effect of different information and PHP treatments on oyster demand for the average consumer. Table 4 presents changes in annual per-person consumer surplus estimates for an uncorrected (SP=1) and corrected (SP=0) version of the model, together with 95% confidence intervals constructed using a bootstrapping procedure (Krinsky and Robb 1986). The procedure generates 1,000 random variables from the distribution of the estimated parameters and generates 1,000 consumer surplus estimates. The estimates are sorted in ascending order and the 95% confidence intervals are found by dropping the bottom and top 2.5% of the estimates.

Insert Table 4 Here

Before looking at the information and PHP treatments, some other findings are worthy of note. First, the price coefficient is negative and statistically significant so respondents behave in line with economic theory. This represents an annual average per-person consumer surplus of approximately $438. Income is positive so oysters are normal goods. The negative sick coefficient indicates that respondents who believe they are more likely to get sick from eating oysters consume fewer meals.

In the standard pooled model, the result of particular interest concerns the average consumer's response to a policy mandate that all oysters must be treated by one of the four PHP methods. Results from the *PHP* parameter provide the first feedback to the FDA and interested stakeholders regarding consumer acceptance of a treated oyster. The *PHP* coefficient is negative and statistically significant at the 1 percent level indicating that if only PHP oysters are available at market then this will induce a decrease in demand. The welfare changes are also large relative to the other information treatments, with a PHP-only policy reducing annual individual welfare by $10.45.[24] In assessing individuals' acceptance of the use of technology in food production, the literature has identified the role of the perceived benefits from the new

[24] We acknowledge that this is an upper-bound estimate on lost annual welfare as the proposed FDA policy would only preclude traditional (non-PHP) oysters from market during warmer months (currently set at April through October); therefore consumers could still purchase and consume traditional oysters outside of this window.

technology as a determining factor in driving acceptance. We hypothesized that the benefits of PHP oysters are a function of both the change in perceived taste and the decrease in actual risk. For the average consumer, the change in actual risk is negligible, so the decrease in demand appears to be driven by the perception that post-harvest processing reduces the taste/texture quality of the product and this effect overwhelms any positive change from the decrease in risk. Further, as processing oysters will increase producers' production costs, we consider consumer responses to PHP-only oysters with an associated price premium. As expected given the previous finding, *PHP_prem* is negative and significant so demand decreases following the introduction of a PHP oyster with a price premium. As Muth et al. (2011) indicate that the PHP process will likely increase the price of a dozen raw half-shell oysters by between $0.48 to $0.84 to the consumer, our results provide strong empirical evidence that restricting the sale of oysters in the summer months to only PHP oysters will have significant negative effects on the oyster industry as consumers decrease their oyster demand for the processed product.

Other notable results from the pooled model are that the majority of the brochure and source combination treatments cause the average consumer to reduce their demand for oysters. Even though the information is designed to reassure most consumers that oysters are safe to eat, while also highlighting the necessary health characteristics that may put a consumer in the at-risk category, it seems these treatments cause individuals to act defensively and reduce their demand for oysters, decreasing annual per-person CS by between $0.26 and $1.52. While other research has demonstrated that providing information based on experts' judgments carries little weight in altering individuals' perceptions, our results are stronger and perhaps suggest that the brochure highlighted the issue of *V. vulnificus* that oyster consumers hadn't previously considered. Comparing results from the brochure and standard video treatments, there is partial evidence of treatment and source effects. In general, information presented in brochures has a greater negative effect on demand than the same information presented in a video format. While all but one brochure treatment (*BrocFDA*) causes a statistically significant decrease in oyster demand, only one video treatment significantly reduces oyster demand (*VidASF*). In terms of source effects, in contrast to other research in the psychology literature, oyster consumers seem more trusting of the government agency (FDA) than the not-for-profit American Shellfish Foundation. While both the brochure and video sourced to the ASF reduce demand, decreasing CS by $1.05 and $0.94 (in the corrected model), respectively, the FDA video actually increases demand, raising annual consumer welfare by $4.51.

By further comparing the responses between the standard and alternative videos, in line with the PMT literature, the severity of the threat does seem to influence behavior. Recall, the standard video treatment disseminates the same information as the brochure, mentioning the potential risk of both death and illness from consuming raw oysters while the alternative video only mentions the risk of potential illness. All else equal, reducing the severity of the threat does appear to reduce the perceived risk for the average consumer with a resulting increase in demand.

In terms of the negative media treatment effects, in line with other literature on consumer responses to food-borne health risk announcements, the coefficient on *news_loc* is negative and significant (see Anderson and Anderson, 1991; Ahluwalia et al., 2000; Parsons et al., 2006). News of a local illness and death reduces annual consumer surplus by $5.27. Interestingly, *news_Chi* is only marginally significant (at the 6 percent level) and lower in magnitude compared to *news_loc*. This supports findings from the PMT literature by suggesting that news of a local event incurs a greater individual behavioral change than an identical non-local event.

Next, we consider the results from a LCA that allows behavioral responses to the information treatments to be examined across subgroup populations.

Insert Table 5 Here

Table 5 presents the results from a latent class panel Poisson model with random effects where we focus on the same specification as the standard model. Table 6 then provides the consumer surplus for the corrected (SP=0) models with 95% confidence intervals.

Insert Table 6 Here

We tried different class models but the Akaike Information Criterion (AIC) scores indicated that the four class model performed the best. As expected, the price coefficient is negative and statistically significant across all groups. The positive coefficient on the income parameters indicates that all classes of consumer treat oysters as a normal good. In contrast to the average consumer results, the SP coefficient is positive and statistically significant so correcting for hypothetical bias will decrease consumer surplus estimates. Also, the perceived likelihood of becoming sick from consuming oysters influences all classes of consumers in the same manner. The greater perceived likelihood of sickness from oyster meals, the fewer meals they consume. Finally, all classes of consumer have strong preferences to avoid PHP oysters if there is an associated price premium.

The class membership probability parameters suggest that Group 1 membership is comprised of respondents that are likely to consume raw oysters and to be a member of the at-risk consumer population. Certainly from a policy perspective, it's the behavioral responses from raw, at-risk oyster consumers that are of particular interest to the industry. Based on the prior class probabilities, there is a 9 percent chance that a member of the sample is in Group 1. Price coefficients indicate that at-risk raw consumers derive the greatest benefit from consuming oyster meals across all classes with an average annual consumer surplus of over $1,350. Results also provide an interesting perspective of how this subgroup responds to the different information treatments. In contrast to the findings from the pooled Poisson model on the average consumer, results from the Group 1 membership suggest that at-risk raw oyster consumers exhibit risk seeking behavior as they increase their demand for oysters having read or viewed the brochure or standard video treatments. This provides strong empirical evidence why the brochures have had no effect on reducing *V. vulnificus*-related deaths as the group that these brochures are specifically directed towards, in hope that they will alter their risk-seeking behavior, actually increase their demand for oysters after reading the health-risk information. Perhaps, this is a function of optimism bias, in which at-risk consumers realize the potential health effects of consuming raw oysters but consider others in this group as more likely to become seriously ill or die from their behavior. This finding is supported by research that indicates information conveying the risks of certain health hazards can exaggerate optimism bias, causing vulnerable individuals to increase their consumption (Weinstein and Klein 1995). However, the negative and statistically significant coefficients on *News_loc* and *News_Chi* provide evidence that news of an actual *V. vulnificus* death tempers optimism bias in this group. Perhaps, this news of an actual death highlights the risky behavior to an extent that readdresses their perceived risks, causing a decrease in oyster demand.

The raw, at-risk consumers also exhibit strong preferences for a traditional oyster product. A policy making only PHP oysters available significantly decreases demand at the 1% confidence level, reducing per-person annual consumer surplus by $33. Across the four classes of consumer, this is the only group with a clear preference for a traditional rather than a PHP oyster. Even though there are defined benefits to this group from consuming PHP oysters, we again posit that the benefit (reduction in risk) is overwhelmed by the perceived change in taste, causing a significant decrease in oyster demand.

Class membership probability parameters indicate that non at-risk consumers that cook their oysters are more likely to fall into Groups 2 and 3 with prior class probabilities indicating that consumers have the highest probability of falling into one of these two groups. The most interesting finding for both groups is that these individuals do not have a strong preference for traditional oysters over PHP oysters. That is, consumers that cook their oysters are more accepting of PHP oysters. This marries with the explanation that raw consumers dislike PHP oysters because of the perceived change in taste. For Class 2 and Class 3 consumers, it is likely that any difference in perceived taste between a PHP and traditional oyster is insignificant if the oysters are cooked. However, with the coefficients on *PHP_prem* negative at the 1 percent level, even consumers that are more accepting of a PHP oyster are not willing to pay a premium for them. This is contrary to the findings of Shogren et al. (1999) and Fox et al. (2002) who found that consumers were willing to pay a premium for cooked irradiated food (chicken and pork sandwiches, respectively).

The final class is the base case. Prior class probabilities indicate that there's a 25 percent chance that a member of the sample falls into this category with an average per-person annual consumer surplus of $505. This is the only group of consumers where the information source seems to be influential, with behavior contrary to previous empirical research. While the brochures sourced to the government entities (the FDA and ISSC) increase demand, raising per-person annual welfare by up to $3, the same media form of information decreases demand, reducing welfare by $1.44 if sourced to the not-for-profit organization. Like individuals in Classes 2 and 3, this group of consumer does not significantly change their purchase behavior if only PHP oysters are available. They are also non-responsive to news of an oyster consumer death, both local and non-local.

Conclusion

This research developed a revealed and stated preference (RP/SP) latent class modeling approach to examine the welfare effects of different health-risk information treatments as well as a recent FDA proposal for the use of food safety technology on oyster consumer behavior. We extend previous RP/SP research by analyzing how homogenous subgroups of the population, based on individual health and behavioral characteristics, respond differently to the treatments. This extension provides both an interesting academic investigation and strong policy input as the FDA and ISSC are committed, under the NSSP, to reduce the annual number of deaths associated with consumption of raw oysters and *V. vulnificus* infection.

As only a specific subgroup of the oyster consuming population is at-risk from *V. vulnificus* infection, the LCA examined the effect of different information and source type treatments on consumer population subgroups. The probabilistic model indicated that at-risk, raw oyster consumers respond differently to the information treatments than the average consumer. Specifically, we found that the brochure and video treatments, designed to highlight the risks of consuming raw oysters to the at-risk group actually increased demand for the traditional product. Perhaps the at-risk consumers were already aware of the health risks and the information merely emphasized the negligible actual risk to them from their behavior. Or perhaps these consumers exhibit optimistic bias, believing that other at-risk consumers are more likely to become seriously ill from raw oyster consumption, and the information exaggerates this effect.

The FDA recently proposed a ban on traditional Gulf of Mexico oysters intended for the half-shell market during the months of April through October. Instead, only PHP oysters will be available. The proposed ban received a backlash of criticism from the oyster industry and interested stakeholders, with clear concerns over consumer acceptance of a treated oyster and the potential negative impacts on oyster demand. From a policy perspective, findings from both a standard pooled RP/SP Poisson model and a LCA suggest that the proposed FDA ban will have a detrimental effect on the industry. With only PHP oysters available, the average oyster consumer will reduce demand for oysters even without an increase in price to reflect additional producer costs of production. Based on other literature into consumer acceptance of technology in food production, we surmise that the actual benefits of reduced risk are outweighed by the perceived change in taste from treating the oyster. As such, the net benefits of PHP oysters are negative. This argument is further supported by the finding that the not-at-risk consumer group that cook their oysters are accepting of a PHP oyster. If consumers are cooking their oysters then the change in taste will be negligible, so they do not alter their purchase behavior. However, even this group reduces quantity demanded for oysters if the PHP product increases the price of their oyster meals. This provides important feedback toward a FDA policy on treated oysters that is currently on hold pending research on consumers' acceptance of the product. Our result indicates that if the policy is put into practice, certain consumer subgroups will not change their demand for oysters; however, all consumers will reduce their demand if only PHP oysters are available at a price premium. As processing oysters will increase production costs, which will invariably be passed on to the consumer, the oyster industry will suffer from the negative economic effects of reduced consumer demand under the new FDA mandate.

References

Abraham SCS, Sheeran P, Abrams D, Spears R (1994) Exploring teenagers' adaptive and maladaptive thinking in relation to the threat of HIV infection. Psychology and Health 9:253-272

Adamowicz W, Louviere J, Williams M (1994) Combining revealed and stated preference methods for valuing environmental amenities. Journal of Environmental Economics and Management 26: 271-292

Ahluwalia R, Burnkrant RE, Unnava HR (2000) Consumer response to negative publicity: the moderating role of commitment. Journal of Marketing Research 37:203-214

Anderson JG, Anderson JL (1991) Seafood quality: issues for consumer researchers. The Journal of Consumer Affairs 25:144-163

Bockstael NE, Strand IE (1987) The effect of common sources of regression error on benefit estimates. Land Economics 13:11-20

Boxall PA, Adamowicz WL (2002) Understanding heterogeneous preferences in random utility models: a latent class approach. Environmental and Resource Economics 23:421-446.

Brown DJ, Schrader LF (1990) Cholesterol information and shell egg consumption. American Journal of Agricultural Economics 72:548-555

Bruner D, Huth W, McEvoy DM, Morgan OA (2010) Accounting for tastes: A valuation of risk reduction in raw seafood consumption. Appalachian State University working paper

Butry DT, Pattanayak SK (2011) Local impacts of tropical forest logging: joint estimation of revealed and stated preference data from Ruteng, Indonesia. In: Whitehead JC, Haab T, Huang J-C (eds) Preference data for environmental valuation, 1st edn. Routledge, New York

Dumas C, Herstine J, Whitehead JC (2011) Joint estimation of revealed and stated preference trip and willingness-to-pay data to estimate the benefits and impacts of an Atlantic Intracoastal Waterway dredging and maintenance program. In: Whitehead JC, Haab T, Huang J-C (eds) Preference data for environmental valuation, 1st edn. Routledge, New York

Eiser JR, Miles S, Frewer LJ (2003) Trust, perceived risk and attitudes toward food technologies. Journal of Applied Psychology 32(11):2423-2433

Fox JA, Hayes DJ, Shogren JF (2002) Consumer preferences for food irradiation: how favorable and unfavorable descriptions affect preferences for irradiated pork in experimental auctions. Journal of Risk and Uncertainty 24(1):75-95

Frewer LJ, Howard C, Shepherd R (1997) Public concerns about general and specific applications of genetic engineering: Risk, benefit, and ethics. Science, Technology, and Human Values 22:98-124.

Hamstra AM, Smink C (1996) Consumers and biotechnology in the Netherlands. British Food Journal 98:34-38

Hausman J, Hall BH, Griliches Z (1984) Econometric models for count data with an application to the patents-R&D relationship. Econometrica 52(4):909-938

Hovland CI, Weiss W (1951) The influence of source credibility on communication effectiveness. Public Opinion Quarterly 15:635-650.

Huffman WE, Tegene A (2002) Public acceptance of and benefits from agricultural biotechnology: a key role for verifiable information. In: Santaniello V, Evenson RE, Zilberman D (eds) market development for genetically modified food. CAB International, New York

Huffman WE, Rousu M, Shogren JF, Tegene A (2004) Who do consumers trust for information: the case of genetically modified foods? American Journal of Agricultural Economics 86:1222-1229

Huffman WE, Rousu M, Shogren JF, Tegene, A (2002) The effects of prior beliefs and learning on consumers' acceptance of genetically modified foods. Journal of Economic Behavior and Organization 63:193-206

Johnson H, Steiner I (1968) The effects of source on response to negative information about one's self. Journal of Social Psychology 74:215-224

Johnston RJ, Wessells CR, Donath H, Asche F (2001) Measuring consumer preferences or ecolabeled seafood: an international comparison. Journal of Agriculture and Resource Economics 26:20-39

Krinsky I, Robb A (1986) Estimating the statistical properties of elasticities. Review of Economics and Statistics 68:715-719.

McLachlan G, Peel P, (2000) Finite Mixture Models, Wiley Series in Probability and Statistics

Maddux JE, Rogers RW (1983) Protection motivation theory and self-efficacy: a revised theory of fear appeals and attitude change. Journal of Experimental Social Psychology 19:242-253

Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, Griffin PM, Tauxe RV (1999) Food-related illness and death in the United States. Emerging Infectious Diseases 5(5):607-625

Milgrom P, and Roberts J (1986) Relying on the information of interested parties. RAND Journal of Economics 17:18-32.

Morgan OA, Huth WL (2010) Using revealed and stated preference data to estimate the scope and access benefits associated with cave diving. Resource and Energy Economics 33:107-118

Morgan OA, Martin GS, Huth WL (2009) Oyster demand adjustments to alternative consumer education and post-harvest treatments in response to vibrio vulnificus. Journal of Agricultural and Applied Economics 41(3):683-696.

Muth MK, Arsenault JE, Cajka JC, Cates SC, Coglaiti Mc, Karns SA, O'Neil M, Viator C (2011) Analysis of how post-harvest processing technologies for controlling vibrio vulnificus can be implemented. Prepared for Food and Drug Administration, Center for Food Safety and Applied Nutrition, College Park, MD.

Neuwirth K, Dunwoody S, Griffin RJ (2000) Protection motivation and risk communication. Risk Analysis 20(5):721-734.

Parsons GR, Morgan OA, Whitehead JC, Haab TC (2006) The welfare effects of Pfiesteria-related fish kills in seafood markets: a contingent behavior analysis. Agricultural and Resource Economic Review 35:1-9

Parsons GR, Stefanova S (2011) Gauging the value of short-term site closures in a travel-cost rum model of recreation demand with a little help from stated preference data. In: Whitehead JC, Haab T, Huang J-C (eds) Preference data for environmental valuation, 1st edn. Routledge, New York

Rogers RW (1975) A protection motivation theory of fear appeals and attitude change. Journal of Psychology 91:93-114

Rousu M, Huffman WE, Shogren JF, Tegene A (2004) Estimating the public value of conflicting information: the case of genetically modified foods. Land Economics 80:125-135

Scarpa R, Thiene M, Tiziano T (2007) Latent class count models of total visitation demand: days out hiking in the eastern Alps. Environmental and Resource Economics 38(4):447-460

Smith E, van Ravenswaay EO, Thompson SR (1988) Sales loss determination in food contamination incidents: an application to milk bans in Hawaii. American Journal of Agricultural Economics 70:513-520

Sternthal BP, Lynn W, Dholakia R (1978) The persuasive effect of source credibility: a situational analysis. Public Opinion Quarterly 41:285-314

Swartz DG, Strand IE (1981) Avoidance costs associated with imperfect information: the case of kepone. Land Economics 57:139-150

Weinstein ND, Klein WM (1995) Resistance of personal risk perceptions to debiasing interventions. Health Psychology 14:132-140

Wessells CR, Anderson JG (1995) Consumer willingness to pay for seafood safety assurances. Journal of Consumer Affairs 29:85-107

Whitehead JC, Haab TC, Huang J-C (2000) Measuring recreation benefits of quality improvements with revealed and stated behavior data. Resource and Energy Economics 22:339-354

Whitehead JC, Dumas CF, Herstine J, Hill J, Buerger B (2008) Valuing beach access and width with revealed and stated preference data. Marine Resource Economics 23(2):119-135

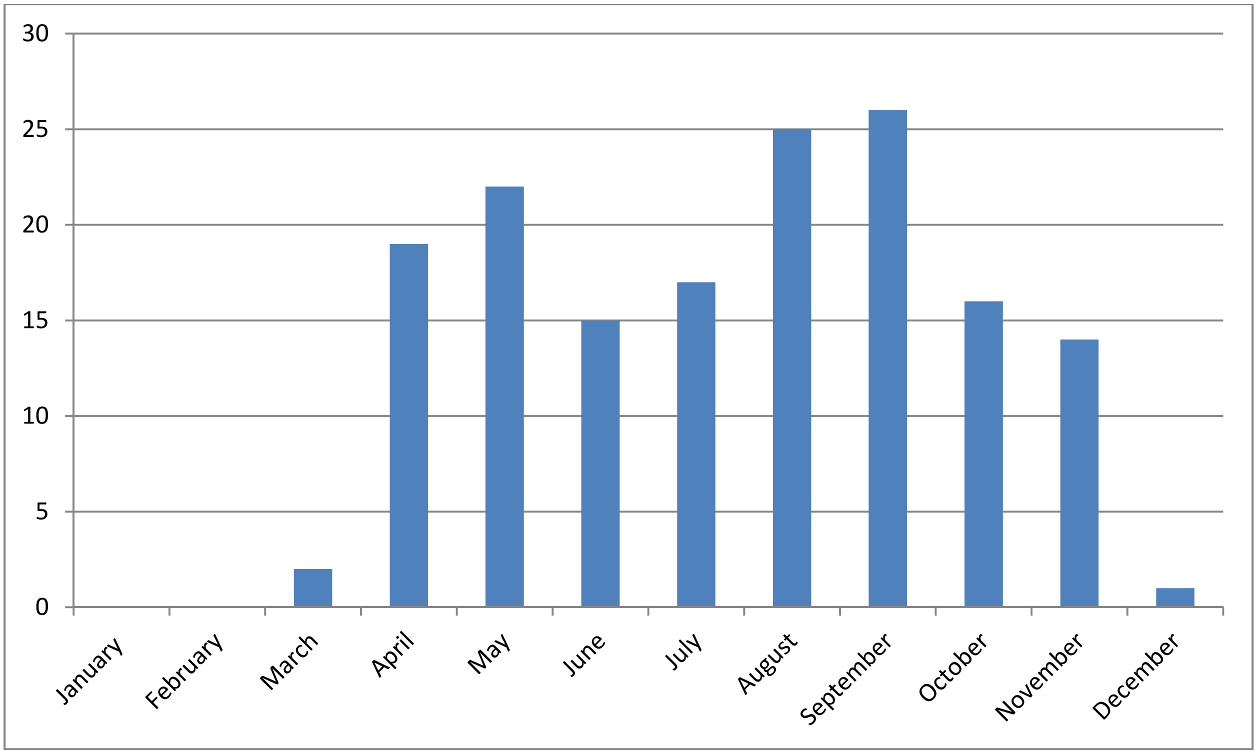

Figure 1 Monthly Average Core State *V. Vulnificus* Cases

Table 1 Five SP Questions with Varying Informational Treatments

SP Question	Text
SP1: Expected meals consumed next year	Now we'd like to ask about the number of oyster meals you expect to eat **over the next 12 months**, starting from today. Thinking of the [NUMBER] oyster meals you told us that you typically eat in a year, if the average price of your oyster meals **stays the same**, do you think you will eat more, less, or the same number of oyster meals over the next year? *Then*, About how many more or less oyster meals do you expect to eat over the next year?
SP2 and SP3: Expected meals consumed next year with a price increase (decrease)	Oyster prices change over time. For example, if oyster harvests are large, prices go down. When oyster harvests are smaller, prices go up. Suppose the price of your portion of your typical oyster meal goes up (down) by [DOLLAR_UP] [(DOLLAR_DOWN)] but the prices of all other food products stay the same. Compared to the [NUMBER_SP1] oyster meals you said that you expect to eat over the next year, do you think you would eat more, less, or the same number of oyster meals over the next year with the higher (lower) price for each meal? *Then*, About how many more or less oyster meals do you expect to eat over the next year?
SP4: With brochure/video	Thinking about oyster meals again, suppose that the average price of your oyster meals stays the same. Compared to the [NUMBER_SP1] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals in the next year, having read or watched the information from [INSERT SOURCE] on how you can reduce the risk from eating oysters? *Then*, About how many more or less oyster meals do you expect to eat over the next year?
SP5: News of illness and death	Thinking about oyster meals again, suppose that the average price of your oyster meals stays the same. Compared to the [NUMBER_SP4] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals next year after learning about the recent illness and death reported in the article you just read? *Then*, About how many more or less oyster meals do you expect to eat over the next year?
SP6: PHP oysters	Suppose that the average price of your oyster meals stays the same. Compared to the [NUMBER_SP5] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals next year **assuming that the only oysters available are those that have been Post-Harvest Processed**? *Then*, About how many more or less oyster meals do you expect to eat over the next year?
SP7: PHP Oysters with price premium	Continue to assume that the **only** oysters available are those that have been Post-Harvest Processed. Now suppose that the price of your portion of your average oyster meal using PHP oysters goes up by [DOLLAR_UP], but the prices of all other food products stay the same. Compared to the [NUMBER_SP6] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals next year assuming that the only oysters available are those that have been Post-Harvest Processed? *Then*, About how many more or less oyster meals do you expect to eat over the next year?

Table 2 Descriptive Statistics

Variable	Description	Mean	Std. Dev.	Min	Max
Price	Price of oyster meal	0.80	2.11	-5.00	7.00
Quantity	Average annual oyster meals consumed	16.18	28.16	0.00	200.00
Age	Age of respondent	44.41	16.31	18.00	87.00
Gender	Respondent is male (=1)	0.49	0.50	0.00	1.00
Race	Respondent is Caucasian (=1)	0.77	0.42	0.00	1.00
Inc	Household income of respondent ($thousands)	69.04	38.38	8.00	150.00
SP	Stated preference question (=1)	0.88	0.33	0.00	1.00
Sick	Chance of getting sick	1.57	1.14	0.00	5.00
Missick	Inputed missing chance of getting sick	0.03	0.16	0.00	1.00
Broc	Brochure with no source (=1)	0.05	0.21	0.00	1.00
BrocFDA	Brochure sourced to FDA (=1)	0.05	0.21	0.00	1.00
BrocISSC	Brochure sourced to ISSC (=1)	0.05	0.21	0.00	1.00
BrocASF	Brochure sourced to ASF (=1)	0.05	0.22	0.00	1.00
Vid	Video with no source (=1)	0.05	0.22	0.00	1.00
VidFDA	Video sourced to FDA (=1)	0.05	0.22	0.00	1.00
VidISSC	Video sourced to ISSC (=1)	0.05	0.22	0.00	1.00
VidASF	Video sourced to ASF (=1)	0.05	0.22	0.00	1.00
Alt	Alternative video with no source (=1)	0.03	0.18	0.00	1.00
AltFDA	Alternative video sourced to FDA (=1)	0.04	0.19	0.00	1.00
AltASF	Alternative video sourced to ASF (=1)	0.03	0.18	0.00	1.00
News_loc	News of local illness and death	0.18	0.39	0.00	1.00
News_Chi	News of non-local illness and death	0.12	0.32	0.00	1.00
PHP	Post-harvest processed oysters	0.25	0.43	0.00	1.00
PHP_Prem	Post-harvest processed oysters with price increase	0.50	1.54	0.00	7.00
Raw	Raw oyster consumers	0.62	0.49	0.00	1.00
At-Risk	At-risk oyster consumers	0.18	0.39	0.00	1.00

Sample size = 1,849 respondents

Table 3 Random Effects Poisson Demand Model

Variable	Coefficient	Standard Error	*p*-value
Constant	2.8035	0.0406	0.0000
Price	-0.0379	0.0005	0.0000
Inc	0.0018	0.0005	0.0000
SP	-0.0195	0.0026	0.0000
Sick	-0.0528	0.0010	0.0109
Missick	-0.0479	0.0188	0.0000
Broc	-0.0764	0.0094	0.0000
BrocFDA	-0.0126	0.0083	0.1299
BrocISSC	-0.0680	0.0087	0.0000
BrocASF	-0.0532	0.0089	0.0000
Vid	-0.0056	0.0085	0.5066
VidFDA	0.1844	0.0090	0.0423
VidISSC	-0.0141	0.0092	0.1286
VidASF	-0.0444	0.0080	0.0000
Alt	0.0217	0.0104	0.0380
AltFDA	-0.0115	0.0111	0.2982
AltASF	0.0252	0.0098	0.0100
News_loc	-0.0626	0.0132	0.0000
News_Chi	-0.0252	0.0137	0.0620
PHP	-0.0393	0.0083	0.0000
PHP_Prem	-0.0346	0.0011	0.0000
Obs	14,792		
Log likelihood	-48578.86		

Table 4 Consumer Surplus Estimates

	Mean Per-Person Annual Average Consumer Surplus	
	Uncorrected (SP = 1)	Corrected (SP = 0)
Baseline	$430.69	$438.01
	($419.97, $440.48)	($427.25, $449.39)
Broc	-$1.49	-$1.52
	(-$1.53, -$1.45)	(-$1.55, -$1.48)
BrocFDA	-$0.25	-$0.26
	(-$0.26, -$0.26)	(-$0.26, -$0.25)
BrocISSC	-$1.36	-$1.39
	(-$1.39, -$1.33)	(-$1.42, -$1.35)
BrocASF	-$1.03	-$1.05
	(-$1.06, -$1.00)	(-$1.08, -$1.02)
Vid	-$0.12	-$0.13
	(-$0.13, -$0.12)	(-$0.13, -$0.12)
VidFDA	$4.42	$4.51
	($4.31, $4.53)	($4.39, $4.62)
VidISSC	-$0.30	-$0.30
	(-$0.30, -$0.28)	(-$0.30, -$0.29)
VidASF	-$0.92	-$0.94
	(-$0.94, -$0.90)	(-$0.96, -$0.91)
Alt	$0.29	$0.30
	($0.29, $0.30)	($0.29, $0.31)
AltFDA	-$0.17	-$0.17
	(-$0.17, -$0.16)	(-$0.18, -$0.17)
AltASF	$0.35	$0.35
	($0.34, $0.36)	($0.35, $0.36)
News_loc	-$5.17	-$5.27
	(-$5.29, -$5.04)	(-$5.41, -$5.14)
News_Chi	-$1.78	-$1.81
	(-$1.83, -$1.73)	(-$1.86, -$1.77)
PHP	-$10.25	-$10.45
	(-$10.51, -$10.00)	(-$10.71, -$10.20)
PHP_Prem	-$12.72	-$12.98
	(-$13.06, -$12.41)	(-$13.30, -$12.68)

Table 5 Latent Class Demand Model

	Group 1		Group 2		Group 3		Group 4	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Constant	3.4663	0.0000	1.3617	0.0000	0.3770	0.0000	2.3487	0.0000
Price	-0.0245	0.0000	-0.0548	0.0000	-0.0471	0.0000	-0.0339	0.0000
Inc	0.0056	0.0000	0.0099	0.0000	0.0082	0.0000	0.0084	0.0000
SP	0.1087	0.0000	0.1683	0.0000	0.2076	0.0000	0.0677	0.0000
Sick	-0.0327	0.0000	-0.1578	0.0000	-0.02283	0.0000	-0.0544	0.0000
Missick	-0.0319	0.4785	0.0448	0.5759	-0.2190	0.3050	-0.0087	0.8682
Broc	-0.0700	0.0000	0.0443	0.3232	0.2015	0.0180	0.0339	0.1596
BrocFDA	0.1115	0.0000	-0.0372	0.4147	0.0054	0.9481	0.1206	0.0000
BrocISSC	0.4697	0.0000	-0.0823	0.0616	-0.0618	0.4644	0.0553	0.0249
BrocASF	0.0828	0.0000	-0.0310	0.4967	0.0335	0.6973	-0.0698	0.0031
Vid	0.2221	0.0000	-0.1322	0.0024	-0.1067	0.1923	-0.0487	0.0282
VidFDA	0.0586	0.0000	-0.0231	0.6021	0.0353	0.6720	0.1526	0.0000
VidISSC	0.0181	0.1415	-0.0033	0.9399	0.1354	0.1168	0.0097	0.6844
VidASF	0.0767	0.0000	0.0237	0.5859	-0.0293	0.7220	0.0035	0.8909
Alt	0.0595	0.0000	-0.1531	0.0005	-0.2266	0.0238	-0.1085	0.0000
AltFDA	-0.2944	0.0000	-0.0277	0.5111	0.1160	0.2313	-0.0653	0.0055
AltASF	-0.2052	0.7229	-0.3386	0.0000	-0.3428	0.0009	-0.0659	0.0073
News_loc	-0.0069	0.0000	0.0574	0.3652	-0.2418	0.0664	-0.0420	0.2219
News_Chi	-0.1042	0.0000	-0.0576	0.3737	-0.2473	0.0620	-0.0236	0.5001
PHP	-0.1050	0.0000	-0.0407	0.3767	0.0303	0.7882	-0.0362	0.1162
PHP_Prem	-0.0254	0.0000	-0.0528	0.0000	-0.0556	0.0004	-0.0364	0.0000
Constant	-6.4123	0.0000	-6.9299	0.0000	-3.1094	0.0000	-5.0766	0.0000
Prob Raw	0.5594	0.0059	-0.6003	0.0000	-0.8945	0.0000		
Prob At-Risk	0.5404	0.0210	0.1575	0.3625	0.1202	0.4743		
Class Prob	0.0919		0.3490		0.3069		0.2530	

Table 6 Consumer Surplus Estimates for Latent Class Model (Corrected, SP=0)

	Mean Per-Person Annual Average Consumer Surplus			
	Class 1	Class 2	Class 3	Class 4
Baseline	$1,352.43	$112.00	$0.51	$504.91
	($1,262.20, $1,442.67)	($101.32, $122.69)	($0.38, $0.65)	($462.84, $544.97)
Broc	-$4.36	$0.23	$0.54	$0.82
	(-$4.65, -$4.07)	($0.21, $0.25)	($0.40, $0.69)	($0.75, $0.87)
BrocFDA	$7.51	-$0.18	$0.01	$2.99
	($7.01, $8.01)	(-$0.20, -$0.16)	($0.01, $0.02)	($2.75, $3.24)
BrocISSC	$39.15	-$0.39	-$0.15	$1.36
	($36.53, $41.75)	(-$0.43, -$0.36)	(-$0.19, -$0.11)	($1.25, $1.47)
BrocASF	$5.20	-$0.14	$0.08	-$1.44
	($4.85, $5.55)	(-$0.15, -$0.12)	($0.06, $0.10)	(-$1.56, -$1.32)
Vid	$17.73	-$0.69	-$0.27	-$1.25
	($16.55, $18.92)	(-$0.76, -$0.63)	(-$0.35, -$0.20)	(-$1.35, -$1.15)
VidFDA	$4.28	-$0.13	$0.10	$4.37
	($4.00, $4.57)	(-$0.14, -$0.12)	($0.07, $0.12)	($4.01, $4.73)
VidISSC	$1.23	-$0.02	$0.38	$0.25
	($1.15, $1.32)	(-$0.02, -$0.02)	($0.28, $0.48)	($0.23, $0.27)
VidASF	$5.46	$0.13	-$0.08	$0.09
	($5.10, $5.83)	($0.12, $0.15)	(-$0.10, -$0.06)	($0.08, $0.10)
Alt	$2.57	-$0.48	-$0.31	-$1.59
	($2.40, $2.75)	(-$0.52, -$0.43)	(-$0.39, -$0.22)	(-$1.72, -$1.46)
AltFDA	-$12.28	-$0.11	$0.22	-$1.16
	(-$13.10, -$11.46)	(-$0.10, -$0.12)	($0.16, $0.28)	(-$1.25, -$1.06)
AltASF	-$7.90	-$0.99	-$0.44	-$1.00
	(-$8.43, -$7.38)	(-$1.09, -$0.90)	(-$0.56, -$0.32)	(-1.08, -$0.92)
News_loc	-$1.68	$0.97	-$1.99	-$3.71
	(-$1.79, -$1.56)	($0.87, $1.06)	(-$2.52, -$1.46)	(-$4.01, -$3.40)
News_Chi	-$15.35	-$0.67	-$1.28	-$1.33
	(-$16.37, -$14.32)	(-$0.74, -$0.61)	(-$1.63, -$0.94)	(-$1.43, -$1.22)
PHP	-$33.16	-$1.04	$0.39	-$4.36
	(-$35.37, -$30.95)	(-$1.14, -$0.94)	($0.28, $0.49)	(-$4.72, -$4.01)
PHP_Prem	-$15.78	-$2.40	-$1.21	-$8.10
	(-$16.83, -$14.73)	(-$2.63, -$2.17)	(-$1.54, -$0.89)	(-$8.76, -$7.44)

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