Risk Perceptions, Food Quality, and the Demand for Seafood

A Study from Eastern North Carolina

Josh Olinick
Department of Economics
East Carolina University

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Introduction

In recent years, the popularity of seafood has increased, however food borne illnesses have also been on the rise. Knowledge about certain types of diseases or the risks involved with eating seafood is expected to have effects on the demand for seafood. It is then safe to say that the demand for seafood is most likely related to the risks involved with consumption (Lin and Milon). Inspection codes are one method of lowering the risk of getting sick from eating seafood, however they would also tend to increase the price of seafood meals. As far as policy is concerned, the inspection codes should be implemented if the benefits outweigh the costs.

Food safety is a major concern for both consumers and policy makers. Such concerns have given birth to organizations like the Food and Drug Administration (FDA), whose purpose is to evaluate certain products and help reduce the risks involved with using them. In the arena of seafood markets, it has become possible to reduce risks of eating seafood through inspection programs. Since people are becoming more concerned with what they eat these days, it only stands to reason that a rational consumer would choose to eat seafood that has a reduced probability of causing sickness. A monetary value can be placed on decreases in perceived health risk for a product by observing consumer willingness to pay for seafood with reduced risk involved (Buzby et al.). Knowing consumer willingness to pay allows for estimation of consumer surplus (benefit) from inspection programs that are designed to reduce the risks involved with eating seafood.

This paper looks at how changes in perceived and absolute risk affect the demand for seafood meals in eastern North Carolina. By using contingent behavior methods to estimate demand models, we are able to estimate the benefits of programs designed to reduce probability of sickness from consumption. First we will look at studies that provide relevance to this specific topic. Next we develop some models for demand estimation. A description of the data set used follows. Finally, our results and possible policy implications are stated.

Literature Review

The primary method used to value the effects of changes in risk on demand is the contingent behavior method. The contingent behavior method uses surveys designed to place a value on non-market goods.

Buzby, Skees, and Ready (1991 & 1995) used this method to observe the effects of risk reduction from the elimination of certain pesticides use in the production of grapefruit. In two separate studies they find that the age of and the attitude (belief about the safety of foods) of survey respondents had significant effects on the demand for pesticide-reduced grapefruit. They also show that the contingent behavior method provides highly valid responses when the hypothetical scenarios (given in the surveys) were similar to market situations. Finally they conclude that consumers are willing to pay a significant amount above original market prices to avoid certain risks.

Eom and Smith (1993) perform a similar analysis to estimate the demand for "organic" (pesticide free) produce. Their study use "joint estimation" techniques to estimate values for non-market goods. The phrase joint estimation refers to looking at both the revealed and stated preferences of respondents. Revealed preference is how consumers behave in actual situations as reported by answers to survey questions. Stated preference questions ask consumers how they would respond in hypothetical situations.

Eom and Smith show that "revealed and stated preference data is constrained by two factors" one being the definition of the characteristic being evaluated, and two the theoretical rational for which it should appear in the individual utility function.

Halbrendt, Sterling, and Santoro (1991) use the contingent valuation method to estimate both the willingness to consume and the willingness to pay for pork products that have reduced levels of saturated fats. Their analysis leads to the conclusion that as the negative characteristics involved with consumption of a particular good were decreased, the average consumption increased, and as a result the willingness to pay for the good increased as well.

In the same arena of study is a paper by Lin and Milon (1991) on how health risks can influence the demand for shellfish products. Their findings made four major points. One, the "value of risk reduction does not increase with the magnitude of risk reduction"(p.96). Second, they find that the value amount reported by respondents is not responsive to the method in which the information about risk was presented. A third finding s that willingness to pay responses are influenced by personal experiences with risk. An example from their study is that a person, who has been sick from eating oysters, will have influenced decisions regarding value of oysters. Therefore their responses may be biased because of past experiences. Finally, they show that other characteristics of a food are taken into consideration when asked to put a value on the food (ex. taste).

Most recently and most closely related to this particular study, Huang, Haab, and Whitehead show that changes in quantity of seafood meals are affected by the perceived absolute and relative risk involved with consumption. In their study absolute risk is the stated number of times a person is likely to become sick from eating a seafood meal.

Relative risk is the probability of becoming sick from a seafood meal relative to the probability of becoming sick from consuming poultry or meat. They combine revealed and stated preferences towards seafood consumption, and show that gender, sex, age, marital status, and education are all significant factors in determining the demand for seafood meals among groups of people that think poultry and meat are safer than seafood. They conclude that perceived risks involved with seafood have a significant effect on its demand.

In this analysis we use a contingent behavior survey to look at how perceptions of seafood "risk" affect the quantity demanded of seafood. To do this we must first examine how present perceptions of food safety influence decisions of consumption between three different "groups". These groups are those that think seafood, poultry, or meat is the safest to consume. Next we introduce hypothetical situations where the risk and/or price of a seafood meal is changed. To look at whether or not the same change in risk causes the quantity of seafood meals demanded to change at different rates across groups. More specifically we are testing for structural differences across groups with respect to changes in risk. From here it is possible to estimate changes in consumer surplus due to changes in risk, which is relevant for the purpose of looking at policies that are designed to lower the risk involved with consumption.

Descriptives

The data used in this study are taken from the Eighth Annual Survey of Eastern North Carolina. The survey had no specific theme, but covered a large area of topics that were the subjects of concern in the eastern part of North Carolina. The survey itself was taken in 42 counties in eastern North Carolina by telephone using random digit dialing.

This is estimated to be about 86% of the households in eastern North Carolina, because only those who had a telephone or a listed telephone number could be questioned. This is a potential cause for bias because a portion of the population has been excluded from the sample.

Approximately 1010 out of the 1282 questioned completed the survey, of which a subset was used for this study. Ninety-one percent of the sample were seafood eaters and therefore were presented with seafood questions. Twenty percent of these respondents could not place a rank on the probability of sickness from consumption of meat, poultry, or seafood and were excluded from the sample. After elimination of missing values the remaining sample consists of 548 respondents.

Questions concerning the consumption of seafood (all types), poultry (chicken and turkey) and meat (pork and beef) under three different situations along with the current "state of the world" were asked. The result was four price/quantity observations from each respondent. For ease of discussion these will be referred to as "scenarios", where scenario 1 will be under current conditions, and scenarios 2-4 will be hypothetical situations imposed on those being questioned. Table 1 provides a visual representation of the scenarios that each group faced.

Respondents were first asked their present consumption of seafood, and the average price they would expect to pay for a seafood meal under current conditions. Price is to be defined as the average cost of a fresh seafood meal whether purchased in a restaurant or in a store. Hypothetical price increases were randomly drawn from one of five amounts: one dollar, 3$, 4$, 5$, 7$. After these prices were presented, respondents were asked how their consumption of seafood would change (per month) with these higher prices. These figures allow for the estimation of the "current condition " demand curve.

Table 2 shows the descriptive statistics from the sample. Those who think seafood is the safest (column 1) consume on average 6.54 seafood meals per month. As the price increases, the law of demand tells us that there should be a decrease in the number of seafood meals consumed. Scenario two introduces a hypothetical price increase, from which we see that the average number of seafood meals decreases to 5.43 meals per month. Scenario three takes us back to the original price level, but a hypothetical increase in the risk involved with eating seafood is introduced. Increasing the risk of eating seafood also caused consumption to decrease, but this time to a level of 4.22 meals per month. In the fourth scenario, we examine the effect of lowering the higher risk at a small price increase. The result is that the average seafood meals consumed per month moves to 5.22.

Looking at those who thought poultry or meat is the safest (columns 2 and 3), we see a similar type of pattern. When the price of seafood increases, the average quantity of seafood meals eaten decreases. The second hypothetical scenario, for groups two and three provides different circumstances; in this case we decrease the risk of seafood consumption (this makes all three groups relatively worse off in this scenario). This is done because these groups already believe seafood is less safe than their preferred food. Increasing the risk of getting sick from it is not going to change their perception of risk involved with eating it. In this scenario, when the risk of consumption is decreased, consumption increases. Here the increase in meals/month eaten is around 2 (as opposed to a drop of just over 1 for group 1). Moving back to the original starting point, the third (hypothetical) scenario for those who believed that meat or poultry is the safest decreases the risk of eating seafood (to that of their preferred food), but this comes with a price increase. We would expect an increase in the average quantity of seafood meals eaten, relative to poultry or meat meals. Here we see that the average quantity of seafood meals consumed per month increases above that of the current state of the world situation for group two, but for group three this number dropped. This implies that on average, a decrease in the risk of consumption is not worth the price increase for group three.

Model development

To begin our analysis, we develop a simple model of demand for seafood meals. In 3 of the four scenarios, the consumer is being faced with a change either in price or the risk involved with consumption. However, other factors that have influence on demand are held constant. The demand for seafood is assumed to take the form:

$$\ln Q_{ij} = \alpha_j + \beta Z_{ij} + \delta X_i$$

where Q is the quantity of seafood meals for individual i, in scenario j. Z_{ij} are explanatory variables that vary by individual and scenario. X_i are individual characteristics that are held constant for the "j" scenarios, but differ for the across individuals. α_j are scenario specific constants, and β and δ are parameters.

To examine the effects of changes in price and (or) risk independently we can separate the vector of variables Z_{ij} into two separate variables, ΔP_{ij} and ΔR_{ij} (ΔP_{ij} represents the change in price from the current price to scenario "j"). Here the effects of price and risk changes are captured entirely by these two variables. The base price and risk variables are constant and thus added to X_{ij}. The resulting analytical model takes the form:

$$\ln Q_{ij} = \alpha_j + \beta_p \Delta P_{ij} + \beta_r \Delta R_{ij} + \delta X_i$$

and has the change in price and change in risk variables in scenario j for the i^{th} individual.

This model assumes that Q_{ij} is known with certainty. However, we do not observe all of the factors that affect the demand for seafood. As a result, we consider Q_{ij} to be the expected demand for a person with the characteristics $\Delta P_{ij,}$ ΔR_{ij}, and X_i.

Another assumption made is that there are fixed effects across scenarios. This means that the intercepts in at least 2 of the scenarios are different. The point of interest in this case would be if there were sufficient evidence to suggest that different scenarios do not have different intercepts ($\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha$). If this were the case then respondents are behaving the same in the revealed and stated situations.

Because seafood meals are measured as a discrete quantity, two things must be considered in estimating the demand for seafood. First, the functional form of the demand for seafood meals per month has to be non-negative. Using a semi-log specification of Q is one way of addressing this in a standard OLS model. Second, these quantities have to be non-fraction values. A count data model is used to account for the discrete nature of the data. The Poisson regression assumes non-negative integral valued dependant variables. This is more representative of the data in this study since the individual quantity of seafood meals per month are in integers.

For a Poisson regression, the probability density function of Q_{ij} (number of seafood meals eaten by individual "i" in scenario "j") is:

$$P(Qij) = \frac{e^{-\lambda ij} \lambda^{yij}}{Q_{ij}} \qquad y_i = 0,1,2,3\ldots$$

Two important assumptions of the Poisson are that it has an expected value of λ_{ij} [$E(Q_{ij}) = \lambda_i$] and a variance of λ_{ij} [$V(Q_{ij}) = \lambda_i$]. Where λ_i is assumed to take the functional form:

$$\lambda_{ij} = e^{\,Xij\ \beta}$$

The Poisson distribution restricts the variance of the dependant variable (Q_{ij}) to be equal to the mean, however the data and subject matter imply that this is not the case. For example, we might expect to see higher dispersion of the number of seafood meals consumed at higher income levels.

A negative binomial model is introduced to allow for the over-dispersion of the data. This is an extension of the Poisson in that it allows a non-constant variance. If our assumption about the over-dispersion is false, it can be shown that the negative binomial model "breaks down" into the Poisson regression model. Therefore by using the negative binomial we are doing no worse in our estimation than what the Poisson could do. However, if our assumption about the over-dispersion is correct then the negative binomial model will provide a better fit.

Panel Data

Up to this point we have assumed that there are no random effects. More plainly put, the error terms across observation from the same individual are not correlated. However, since there are four responses from each individual, each individual response is related to the previous response, making each scenario response highly correlated within individuals, giving error terms that are correlated with individual responses.

To correct for the problem of breaking the assumption of no auto correlation, a panel model will be used. There are five benefits from paneling the data that deserve mentioning. One, by paneling the data we are controlling for individual heterogeneity. An individual's responses are affected by factors that are unique to that individual, but unobservable to the researcher. By controlling for this we are reducing the risk of obtaining inconsistent standard error estimates. Two, panel data allow for more variability, and less co-linearity, which result in more informative data. This allows for more accurate parameter estimates. Three, we are able to look at the "dynamics of adjustment" using panel data. This allows for examining the choices or characteristics of a group over scenarios. For example, cross sectional data can estimate percentage change in quantity of seafood meals consumed from one scenario to the next. But panel data will provide a more efficient estimate of the percentage change in quantity, due to the fact that the standard errors will be more accurate. Fourth, the ability to identify and measure effects that are not detectable in cross-sections or time series data is better. It is possible to hold certain individual characteristics constant, which allows for the isolation of the variables being examined. Finally, panels allow us to construct more complicated behavioral models.

The benefits of panel models do not walk without limitations. The limitations most directly related to this study come in the form of problems in the data itself. The first deals with data collection problems. Problems may arise from having a sample that is non-representative, the population being tested or respondents may not remember how previous questions were answered. To elaborate, a respondent must remember how he/she answered price/quantity questions for the current "state of the world" situation before answering hypothetical price/quantity questions. A second limitation comes in the form of distortions of measurement error. These may arise because of unclear questions (mis-understanding of what is being asked), mis-recording of responses by interviewer, or memory errors by respondents (Baltagi 1995). Neither of these possible problems are not ruled out when examining these data.

Sample Characteristics

The characteristics of our sample (shown in Table 2) show that approximately 65% of the respondents are white. We also observe a little less than 40% male from this sample. The average age of the respondents is about 42 years, with 90% graduating from high school, and about 16% having graduated from a university. Here, the income of the average person was around $34 thousand a year.

For better analysis a few variables needed to be constructed from the data gathered in the sample. Absolute risk was developed using the stated number of meals out of one million (per month) that would make people sick. This is shown in percentage terms. Panel B of Table 2 shows the means for the three groups. The variable DPRCNTCP is a measure for the percentage difference in the risk of seafood and poultry. Similarly, DPRCNTCM measures the percentage difference in the risk of seafood relative to meat. These show how much more a person is believed to become sick from eating seafood as opposed to other foods. From the bottom of Table 2 we see that on average, people believe that they are 12% more likely to become sick from eating seafood than from eating poultry. They also believe that they are 26% more likely to become sick from eating seafood than from eating meat. In some cases these values were not consistent with their stated "safest" food. By simply dropping these responses we are possibly corrupting our sample. This is because there is possibly some systematic relationship that is causing the respondents to answer questions in this fashion. By eliminating them we could possibly make a random sample non-random.

In order to address the possible problem of discrepancies in the ways respondents answered questions about which of the three types of foods were the most likely to make them sick, a dummy variable was constructed. The variable FUNNY2 is coded one when a respondent states that poultry (or meat) is the least likely to make them sick, but their stated difference in risk (DPRCNTCP & DPRCNTCM) reports differently. This variable is coded zero if this situation did not occur.

Revealed preference is observed by examination of current state of the world consumption decisions. Stated preference is what a respondent "states" their consumption would be under our hypothetical scenarios. Since there is possible measurement error in the stated preference case we include a dummy variable named SP. This variable is coded one for the hypothetical situations (scenarios 2, 3, or 4), and zero for the "actual" state of the world. The significance on this variable allows us to determine whether or not the hypothetical scenarios make a difference in the measurement of the demand curve. Huang, Haab, and Whitehead showed that the structure of the hypothetical situations was the same ($\alpha_2 = \alpha_3 = \alpha_4$).

Results

In the estimation, we want to pay particular attention to the variables PCFOOD, ABSRSK, DPRCNTCP, and DPRCNTCM. These are the price and risk variables. We expect that PCFOOD will have negative coefficient, due to the law of demand. We also expect that ABSRSK will have a negative coefficient, which tells us that as the perceived risk of illness from consumption increases, the quantity demanded will decrease. The relative risk variables DPRCNTCP, and DPRCNTCM show us the likelihood of getting sick from eating seafood as opposed to poultry or meat. We are not sure what type of affect these variables will have on demand, but based off of prior research we expect a few different outcomes. For those who think seafood is the safest, they believe that they are less likely to get sick from seafood. Therefore, we would think that these variables would not have much effect on demand for this group. However, for groups two and three we expect that changes in the relative risk of seafood compared to poultry of meat will have an effect on demand. For example, in group two (poultry) as the risk of sickness is reduced compared to meat, we expect that demand for seafood will increase. These variables show the size of the substitution effect.

The estimation of the demand curve is presented in Table 3. These are the results from a negative binomial, panel data model. Here we are assuming random effects and are controlling for them. Model one includes personal characteristics along with perceptions about risk as regressors. The analysis of this model is run on all three groups individually. Here we see that the price of seafood is insignificant for group one, but it is significant for groups two and three. This actually implies that the demand for those who believe seafood to be the safest is perfectly inelastic. For this group, demand for seafood is not sensitive to changes in price. The likelihood that this is true is not very high, however, this point will be discussed in greater detail below.

The relative risk variables (DPRCNTCP, DPRCNTCM) in groups one and two are insignificant. Telling us that the risk of seafood above that of meat or poultry does not have an effect on the demand for seafood meals in groups one or two. However, for group three the additional risk of seafood relative to poultry is significant, but the additional risk of seafood relative to meat is not. Here we can say that as the risk of seafood increases with respect to poultry, those that believe meat is the safest will demand less seafood.

In group one, we see that the coefficient on the stated preference dummy variable (SP) is significant[*]. This tells us that the hypothetical situations have a measurable effect on demand. For groups two and three this dummy is not significantly different than zero telling us that we can compare the stated and revealed preference choices by consumers in groups two and three.

The term "A" is a parameter for determining the variance of the demand for seafood. This method accounts for possible over-dispersion in the data. The variance of the negative binomial dependant variable is equal to $\lambda(1+A\lambda)$. Since this value is positive and significant, our earlier assumptions about over dispersion in the error terms are correct (the variance of Q_{ij} exceeds the mean).

The term "B" is a parameter that picks up random effects in these models. This term is positive and significant for all groups (and combinations therein) meaning that there is correlation across responses for each individual.

Between the groups we see a type of trend in the characteristics of seafood demand. White, males tend to consume more seafood meals. Those that are married also tend to consume more. The coefficients on the variables for these characteristics allow us

[*] The importance of this finding is discussed in more detail below

to make these “inferences”. However, most of these are insignificant, therefore any inferences would not be statistically correct.

Since many parts of the individual models are insignificant, we decided to compare those that believed seafood to be the safest with all others. To do this, the same model was run on all three groups combined, and groups two and three combined, and individually on the seafood safest group. Before any inference could be made we needed to test for structural change among these models.

Our null hypothesis is that there is no difference between groups two and three. While our alternative is that there is sufficient evidence to support that the two groups are different. A simple F-test would not work in this case because of the types of models used (negative binomial). Therefore, we use a Likelihood Ratio test to check for differences in these models. This test takes the form:

$$-2 [\ln (L_R) - \ln (L_{UR})] \sim \chi^2 (k)$$ (Tests are shown in the appendix.)

where L_R is the log likelihood function for the restricted group, and L_{UR} is the log likelihood function for the unrestricted group.

Based on the likelihood ratio test, we find that there is no difference in the behavior of groups two and three, but that those who think seafood is the safest are making different consumption decisions. Because of this we can now compare the models from group one to groups two and three combined.

Attempts at re-classifying the regression analyses were made for each possible combination of groups*. The subset of the sample that believed seafood to be the safest

* All possible combinations of groups were regressed and tested to determine which could be grouped together

could not be grouped with any of the combinations. The estimations for this group implied that they have a perfectly inelastic demand. However, we do not believe this to be the case, and can make a few arguments in this favor. First, the significance on the SP variable (in group 1) shows that there is structural change between the actual and hypothetical scenarios. There is some sort of non-random process that is occurring in this group that is not happening in groups two and three. Since this group is behaving differently than those believe that meat or poultry is the safest, we could argue that this group does not believe that the hypothetical scenarios offered are possible, and therefore are not giving honest responses. This consideration was tested by excluding the scenarios that include changes in risk from a regression on demand for group 1 (i.e. We looked only at scenarios one and two); here we found a negative and insignificant price coefficient. But when the changes in risk were added back in the price effect fell out. The changes in the significance (and sign) of the price variable over scenarios implies that this group does not believe that increasing the risk of seafood makes them worse off.

A second argument is the degree of measurement error in the recording of sample data. The scenarios between groups are of a confusing nature and could easily be mis-recorded. For instance, group one is made worse off when seafood is made more “risky”, but groups two and three are made worse off when seafood is made less “risky”. There is no real way to measure for this type of error in recording, and thus no “real fix”.

A Third argument is that the respondents may be answering off a whim, and not according to their true beliefs. Or, they could possibly have forgotten how previous questions were answered. This is not an unbelievable statement due to the length of the survey. However, we would have to believe that only those who believed seafood to be the safest had this problem.

Looking back at Table 3, we can now compare the differences between those that think seafood is the safest with all others in the sample. Referring to the column labeled groups 2 & 3, we see that the PCFOOD variable is negative and significant. ABSRISK is also negative and significant. This tells us that as the perceived absolute risk of becoming sick from eating seafood increases, the quantity demanded of seafood meals decreases in the combined group. Those that believe seafood to be the safest behave in a similar manner. When the perceived absolute risk of becoming sick from seafood consumption increases, the quantity demanded also decreases, however, the change is more drastic for this group. We see that the relative risk of seafood to poultry (DPRCNTCP) is significant in groups two and three combined, telling us that as the risk of seafood increases compared to poultry, the quantity demanded of seafood will decrease. The risk of seafood relative to that of meat (DPRCNTCM) is still insignificant for both group 1 and the combined group, implying that changes in the risk of seafood compared to meat has no effect on the demand for seafood meals. Because of this we can say that seafood demand is affected by the absolute risk and its risk relative to poultry, but not meat, which implies that poultry is a substitute for seafood when risk increases.

Consumer Surplus

Consumer surplus can be loosely defined as the area under the demand curve but above the price. A change in consumer surplus is measured through the difference in the original demand curve and the demand curve that results from a change in the state of the world. In this case we use the original demand curve and the demand curve that results from a decrease in risk. These estimates were computed using the formula:

$$\Delta CS = \frac{-[\ X_1(\pi_2) - X_1(\pi_1)\ ]}{\beta}$$

Where $X_1(\pi_1)$ is the seafood consumption under current risk, $X_1(\pi_2)$ is the seafood consumption under with a reduction in risk, and β is the price coefficient in the original demand models [the price remains constant under this reduction in risk; moving from current state of the world to risk reduced situations]. This shows us the area between demand curves divided by the average number of seafood meals. Graph 1 gives a visual representation of the change in demand due to these risk reductions. This is a visual representation of the resulting shift in the demand curve from a change in risk. Notice that even at a higher price, with reduced risk, consumers are better off. The change in benefits to the consumer from a reduction in risk are shown in areas B and C.

Knowledge about changes in consumer surplus from policy improvement is essential for determining the net benefits of implementing programs that affect the public. In this specific case, changes in consumer surplus could be calculated for any estimated change in risk that comes from policy improvement. We use four hypothetical reductions in risk to examine the changes in surplus that results. The reductions are of 10, 20, 30, and 50 percent.

Table 4 shows the change in consumer surplus for the combined group. Here we see that when seafood is made safer, the total consumer surplus for the combined group increases for each reduction. With the 10% reduction, surplus increases by about 30 cents. With a 50% reduction, surplus increases by about $1.56.

Conclusions

We have shown that, perceived risk of seafood consumption for those who think that seafood is not the safest has a significant affect on seafood demand. The significance of the risk of poultry relative to seafood has shown that poultry and seafood have a higher compatibility of substitution than that of meat of seafood. This may be because those that are concerned with possibilities of sickness may also be concerned with other health issues involved with the broad classifications of these foods. For instance, a person that is concerned with sickness from seafood may also avoid pork because of its higher fat content. In this case if seafood risk decreases they would substitute away from pork and toward seafood. This same person may think that beef is perfectly safe, but including pork in the "meat" grouping, would affect their responses for the entire category.

The data used does not provide price information for poultry of meat. This would cause the estimations of our demand models to be slightly overstated. By not including the possibility of cross price elasticities, we are estimating a demand curve with a slope that may be too large. This leaves a space for future research. Using more valid pricing information (along with a larger sample), would allow better demand estimations. However, the underlying premise of the study can be shown in that there are increases to consumer benefit from reductions in the possibility of sickness from seafood consumption.

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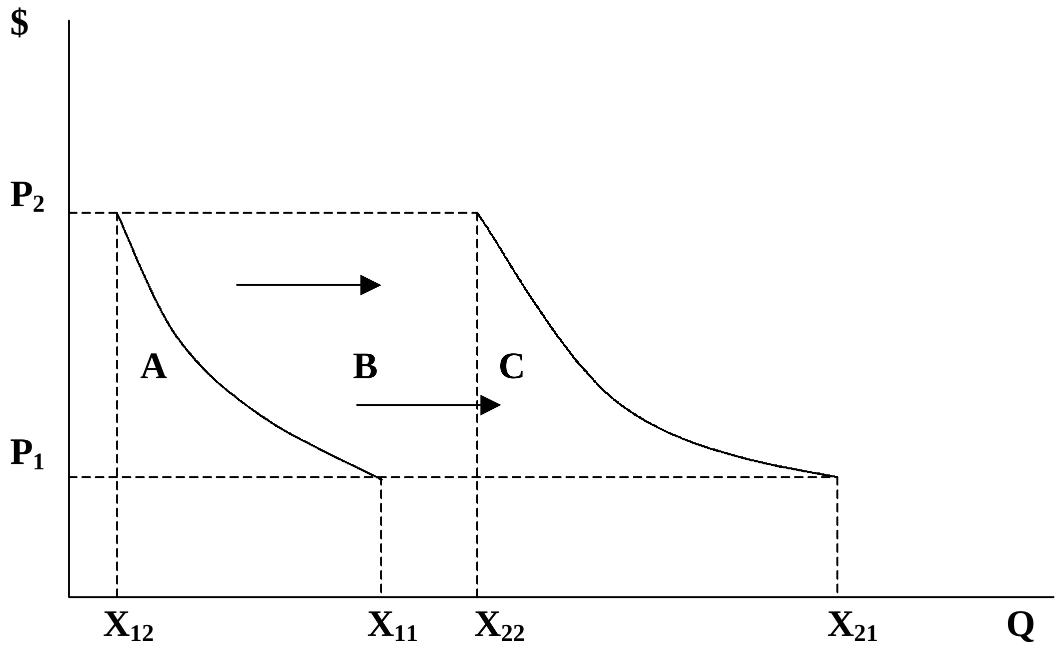
Graph 1. Seafood Demand



X_{11} refers to original risk, original price.
X_{12} refers to original risk, increased price.
X_{21} refers to lowered risk, original price.
X_{22} refers to lowered risk, increased price.

Appendix

Sample Question (related to Absolute Risk):

To get a better idea how likely you think it is that you will get sick from eating fresh seafood, consider the following situation. Suppose 1 million fresh seafood meals are prepared and eaten in a typical month in eastern NC. How many of these 1 million meals do you think will result in someone getting sick?

Log Likelihood Ratio Computations:

The Log Likelihood Statistic is computed using the formula

$$\ln L = -2\,[\ln(L_R) - \ln(L_{UR})] \sim \chi^2\,(k)$$

Test #1

Restriction: All groups are the same.

H_O: group1 = group2 = group3

H_A: at least one of these groups does not equal the others.

$\ln L = -2\,[\,(-3919.66) - (-1337.75 + -910.43 + -1631.50)]$

$\ln L = 79.96$

$\chi^2\,(38) = 55.785 \Rightarrow$ Reject the null of group1 = group2 = group3

Test #2

Restriction: Groups 1 and 2 are the same.

H_O: group1 = group2

H_A: group1 $\neq$ group2.

$\ln L = -2\,[(-2267.91) - (-1337.75 + -910.43)]$

$\ln L = 39.46$

$\chi^2\,(19) = 30.143 \Rightarrow$ Reject the null of group1 = group2

Test #3

Restriction: Groups 1 and 3 are the same.

H_O: group1 = group3

H_A: group1 $\neq$ group3.

$\ln L = -2\,[(-3000.52) - (-1337.75 + -1631.50)]$

$\ln L = 62.54$

$\chi^2\,(19) = 30.143 \Rightarrow$ Reject the null of group1 = group3

Test #4

Restriction: Groups 2 and 3 are the same.

H_O: group2 = group3

H_A: group2 $\neq$ group3.

$\ln L = -2 [(-2550.39) - (-910.43 + -1631.50)]$

$\ln L = 16.92$

$\chi^2 (19) = 30.143 \Rightarrow$ Fail to reject the null of group3 = group2

Table 1. Scenario Description

	Scenario							
	Current Seafood Consumption		Hypothetical Situations					
	1		2		3		4	
Group	Price	Seafood Risk	Price	Seafood Risk	Price	Seafood Risk	Price	Seafood Risk
#1. Seafood Safest	Revealed	Current Seafood Risk	Hypothetical Increase	Current Seafood Risk	Revealed	(Seafood) Increased Risk to that of Poultry	Hypothetical Increase	Seafood Risk Reduced to normal level
#2. Poultry Safest	Revealed	Current Seafood Risk	Hypothetical Increase	Current Seafood Risk	Revealed	(Seafood) Decreased Risk to that of Poultry	Hypothetical Increase	(Seafood) Decreased Risk to that of Poultry
#3. Meat Safest	Revealed	Current Seafood Risk	Hypothetical Increase	Current Seafood Risk	Revealed	(Seafood) Decreased Risk to that of Meat	Hypothetical Increase	(Seafood) Decreased Risk to that of Meat

Table 2. Variable Names and Sample Means

Variable	EXPLANATION	Those Who Thought Seafood to be the Safest (Group 1)	Those Who Thought Poultry to be the Safest (Group 2)	Those Who Thought Meat to be the Safest (Group 3)
QCFOOD1	Current seafood consumption (meals/month)	6.54	4.56	5.04
QCFOOD2	Seafood meals at higher price (current risk)	5.43	4.02	4.03
QCFOOD3	Seafood meals with changed risk	4.22	5.66	6.08
QCFOOD4	Seafood meals with risk returned to the current levels and a price increase (decreased risk in groups 2 and 3)	5.22	4.85	4.93
PCFOOD0	Average price of seafood meal (to the nearest $)	10	9.38	9.98
PCFOOD1	Hypothetically increased price of seafood	13.75	15.64	13.93
CFNUM	Perceived number of people that will get sick from eating seafood out of 1,000,000	0.041	0.067	0.035
CHNUM	Perceived number of people that will get sick from eating poultry out of 1,000,000	0.045	0.059	0.044
MENUM	Perceived number of people that will get sick from eating meat out of 1,000,000	0.056	0.089	0.033
RACE	Percent White	61%	64%	77%
MALE		43%	31%	43%
AGE		41.36	46.18	44.6
HSGRAD	Percent of High School Graduates	91%	89%	94%
UNIVGRAD	Percent University Graduates	18%	14%	16%
INCOME	mid-point of income category/1000	34.24	33.1	38.91
EFFECT	Categories defined as: effective; somewhat effective; not very effective; ineffective	1.93	1.89	1.85
PFIESTER	Percent that have heard of Pfiesteria	59%	61%	63%
DPRCNTCP	Percent change in relative risk of seafood to poultry*	12.35%		
DPRCNTCM	Percent change in relative risk of seafood to meat*	26.24%		

Panel B (see appendix for Question)

		Scenario	Group1	Group2	Group3
ABSRSK	Stated "absolute risk" of consumption/ 1,000,000	1	4.15%	6.75%	3.57%
		2	*	*	*
		3	4.58%	5.99%	3.34%
(see appendix for sample of question)		4	4.15%	5.99%	3.34%

*average values across groups

Table 3. Negative Binomial Regression--Random Effects

VARIABLE	Group 1 (seafood safest)	Group 2 (poultry safest)	Group 3 (meat safest)	Groups 2&3	Groups 1,2&3
CONSTANT	3.28073*	3.84654*	3.59027*	3.66859*	3.36421*
	(0.585)	(0.641)	(0.545)	(0.364)	(0.285)
SP	-0.317428*	0.1027	0.0755	0.0752	-0.0701
	(0.080)	(0.126)	(0.081)	(0.061)	(0.038)
PCFOOD	0.0174	-0.0380448*	-0.0427561*	-0.0393564*	-0.0217064*
	(0.009)	(0.015)	(0.006)	(0.005)	(0.004)
ABSRSK	-1.2278	-1.22481*	-0.8370	-1.09646*	-1.01739*
	(0.647)	(0.591)	(0.526)	(0.364)	(0.286)
DPRCNTCP	0.0274	0.0215	-0.0896701*	-0.0536214*	-0.0331
	(0.066)	(0.079)	(0.025)	(0.021)	(0.019)
DPRCNTCM	-0.0269	-0.0518	0.0007	-0.0089	-0.0236
	(0.031)	(0.107)	(0.020)	(0.018)	(0.015)
PFIESTER	0.0840	-0.1206	-0.1010	-0.0932	-0.0392
	(0.171)	(0.229)	(0.158)	(0.113)	(0.089)
EFFECT	0.183931*	-0.0918	-0.0310	-0.0307	0.0683
	(0.102)	(0.161)	(0.096)	(0.076)	(0.054)
COASTAL	-0.1968	-0.0298	-0.1235	-0.1456	-0.1305
	(0.183)	(0.214)	(0.167)	(0.113)	(0.090)
WHITE	-0.557169*	-0.534689*	0.0122	-0.261042*	-0.38451*
	(0.172)	(0.206)	(0.170)	(0.115)	(0.086)
FEMALE	-0.0146	-0.3239	-0.1082	-0.1767	-0.1561
	(.167)	(0.202)	(0.140)	(0.105)	(0.083)
MARRIED	0.2853	0.0457	-0.2961	-0.1330	-0.0158
	(0.199)	(0.201)	(0.159)	(0.114)	(0.090)
AGE	-0.0043	0.0026	0.0060	0.0045	0.0025
	(0.005)	(0.006)	(0.004)	(0.003)	(0.002)
HSGRAD	-0.1634	0.1788	0.2061	0.1417	-0.0213
	(0.327)	(0.452)	(0.377)	(0.229)	(0.159)
UNIVGRAD	0.4160	0.1676	0.0856	0.1961	0.2062
	(0.235)	(0.267)	(0.182)	(0.140)	(0.116)
INCOME3	-0.0030	0.0019	0.0064	0.0051	0.0037
	(0.005)	(0.005)	(0.003)	(0.002)	(0.002)
FUNNY2	0.0188	-0.7611	-0.3025	-0.392544*	-0.304886*
	(0.360)	(0.542)	(0.240)	(0.193)	(0.162)
A	7.63892*	9.25326*	10.9587*	9.74596*	7.82417*
	(1.501)	(1.999)	(1.703)	(1.151)	(0.713)
B	1.76983*	1.97992*	1.7368*	1.84177*	1.85734*
	(0.306)	(0.428)	(0.297)	(0.225)	(0.171)
n	144	103	180	283	427
ln L	-1337.75	-910.43	-1631.5	-2550.39	-3919.66

Numbers in parantheses are the standard errors.
The symbol *, refers to significant at the .05 level or better.

Table 4. Consumer Surplus

Total Consumer Surplus (average number of seafood meals)	57.61
Change in Consumer Surplus Per Meal	Groups 2 & 3 (meat/poultry safest)
10% Reduction in Risk	0.308 (.345)
20% Reduction in Risk	0.582 (.652)
30% Reduction in Risk	0.931 (1.04)
50% Reduction in Risk	1.56 (1.76)

Graph 1. Results of Risk Reduction