PROTECTION MOTIVATION THEORY AND CONSUMER WILLINGNESS-TO-PAY IN THE CASE OF POST-HARVEST PROCESSED GULF OYSTERS

A Thesis

by

EMILY ANN BLUNT

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2012

Major Subject: Agricultural Economics

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Approved by:

Chair of Committee,	Richard Woodward
Committee Members,	Ariun Ishdorj
	Robin Brinkmeyer
Head of Department,	John Nichols

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ABSTRACT

Protection Motivation Theory and Consumer Willingness-to-Pay
in the Case of Post-Harvest Processed Gulf Oysters. (August 2012)
Emily Ann Blunt, B.S., California Polytechnic University, San Luis Obispo
Chair of Advisory Committee: Dr. Richard Woodward

Gulf oysters are harvested and consumed year-round, with more than 90% consumed in a raw, unprocessed state. A chief concern of policymakers in recent years is the incidence of *Vibrio vulnificus* infection following raw seafood consumption. *V.vulnificus* refers to a halophilic bacterium naturally occurring in brackish coastal waters, which concentrates in filter-feeding oysters. Proposed FDA legislation requiring processing of all raw Gulf oysters sold during warmer summer months threatens the Gulf oyster industry, as little to no research regarding demand for post-harvest processing (PHP) has preceded the potential mandate.

This research endeavors to examine the relationship between oyster consumers' fears of *V.vulnificus* infection and their willingness-to-pay (WTP) for processing of an oyster meal. The psychological model of Protection Motivation Theory (PMT) is employed alongside the economic framework of contingent valuation (CV) to result in an analysis of oyster processing demand with respect to threats and efficacy. A survey administered to 2,172 oyster consumers in six oyster producing states elicits projected consumption and PMT data. Principal Component Analysis is used to reduce the number of PMT variables to a smaller size, resulting in five individual principal components representing the PMT elements of source information, threat appraisal, coping appraisal, maladaptive coping, and protection motivation. Using survey data, the marginal willingness-to-pay (MWTP) for PHP per oyster meal is also calculated, and the five created PMT variables are regressed on this calculation using four separate OLS models.

Results indicate significant correlation for four of the five created PMT variables. In addition, a mean MWTP for PHP of $0.31 per oyster meal is determined, contributing to the demand analysis for processing of Gulf oysters. The findings suggest a strong relationship between the fear elements and the demand for processing, and support arguments in favor of further research on specific PHP treatments and the necessity for a valid PMT survey instrument.

DEDICATION

This thesis is dedicated to those who read about a topic, find something interesting, and pursue the heck out of it.

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CHAPTER I

INTRODUCTION

Fear can be a very motivating factor. Whether we are exercising more to prevent cardiovascular disease or building a fence to keep the neighbor's dog from encroaching on our front lawn, anxiety influences us on a daily basis. Recent trends in consumer research have led to linkages between fear and consumer purchases, with specificity to food safety. This research endeavors to explain the linkages between components of consumer fear and the motivation to purchase safer, processed oysters.

In this thesis I plan to incorporate the cognitive psychological model of Protection Motivation Theory to explain differences in the marginal willingness-to-pay for post-harvest processing of gulf oyster meals. By creating variables to explain the various components related to an individual's fears I can determine which factors most greatly affect consumer willingness-to-pay, helping to better determine the marketability of post-harvest treatment of gulf oysters.

First, questions will be selected from the survey based on their adherence to the Protection Motivation Theory model. Once selected, these questions will be grouped into protection motivation variables using Principal Component Analysis. The result will be variables that measure the various factors that make up protection motivation. Finally, a willingness-to-pay variable will be created based upon consumer responses related to projected consumption figures. This variable measures willingness-to-pay for

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This thesis follows the style of *American Journal of Agricultural Economics*.

the post-harvest treatment on a gulf oyster meal. The goal is to regress the created protection motivation variables (along with others) on the willingness-to-pay variable to determine the influences of fear elements on willingness-to-pay for safer seafood.

Four models will be used in this analysis. The first is a model regressing the created protection motivation variables on willingness-to-pay. The second model includes both the created protection motivation variables and key demographics regressed on willingness-to-pay. The third is a replica (to the best of our ability) of Huth's original model, including variables chosen by the researcher upon initial analysis (Morgan, Martin, & Huth, 2009). The fourth is a model regressing all previously included variables on willingness-to-pay, referred to as the "kitchen sink" model.

Significance of Study

The U.S. Oyster Industry

Oysters are bivalve molluscan shellfish, identified by their rough exterior and oval shape. The flesh of the oyster consists of an adductor muscle, gills, tentacles, and digestive organs. The strong adductor muscle serves to keep the oyster shells closed in order to protect the sensitive flesh from predation. Oysters feed through their gills, drawing water in and extracting algae and saltwater particulates from the brackish environment (National Geographic, 2012). This serves as a form of "filter-feeding", as the oyster latches on to particles and releases the water back into its habitat (Texas Parks & Wildlife, 2011). Oyster reproduction occurs during warm months through broadcast spawning, a process involving the release of eggs and sperm into the water to be fertilized outside of the oysters. Oysters also typically change gender at least once during their life (Texas Parks & Wildlife, 2011).

The Eastern or Atlantic oyster (*Crassostrea virginica*) is the only oyster species native to the United States east coast and the Gulf of Mexico (Stanley & Sellers, 1986). Four additional oyster species are also cultivated in the United States, including the Olympia oyster (*Ostrea lurida*), native to the west coast, Pacific oysters (*Crassostrea gigas*) imported from Japan in 1903 (Pauley, Van Der Raay, & Troutt, 1988) and introduced during the 1920's into west coast seed beds because of major die-offs of native *O. lurida* (Couch & Hassler, 1989), the European Flats oyster (*Ostrea edulis*) imported strictly for farm cultivation in the 1950's (Davis & Calabrese, 1969), and the Kumamoto oyster (*Crassostrea sikamea*), accidentally imported from Japan with the Pacific Oyster (Andrews, 1980). However, roughly 75% of U.S. oyster harvests are contributed to the Eastern oyster, which is cultivated primarily along the Gulf Coast of Mexico and the Atlantic Coast of the Chesapeake Bay. (Lutz, Sambidi, Harrison, & Huntrods, 2011).

Eastern oysters prefer shallow depths of 8 to 25 feet, and can withstand temperatures ranging from 30 to 90°F. While the predators to Eastern oysters are numerous and include humans, starfish, finfish, aquatic mammals, and birds, the oysters themselves primarily feed on a basic diet of algae and plankton found on the ocean's surface (Texas Parks & Wildlife, 2011).

While oysters have been cultivated for human consumption since the Roman era, little has changed over the centuries in how the shellfish are seeded and harvested

(Andrews, 1980). The oyster industry on the whole is comprised of three separate divisions: harvesters, wholesalers/processors, and retailers (Muth, Karns, Anderson, & Murray, 2002). Harvesters include a varying range of practices, from wild harvesting to acutely managed cultivating operations. Of the average 34 million pounds of oyster meat harvested yearly in the U.S. from 2001 to 2010, roughly 60% was produced by means of cultivation (United States Department of Commerce, National Oceanic Atmospheric Administration, National Marine Fisheries Service, 2011; Wallace, 2001). Cultivating oysters can include methods as simple as planting shells in areas where oyster larvae are likely to settle, to placing larvae on the shells to set, to introducing larvae into containers lines with ground shells to produce single oysters. The larvae itself can also be uprooted and shipped to other hatchery/cultivation locations. Oysters typically mature at 1-3 years (depending on growth rate), allowing smaller immature oysters to be transplanted to different beds as necessary (Wallace, 2001).

While it is not uncommon for oyster harvesters to sell directly to restaurants and retailers, most harvesters sell to wholesalers and processers. Wholesalers repackage the oysters into sacks or boxes before selling them to chefs and retailers. Processers add further value to the oysters by shucking them, cooking (or canning) them, or treating them by other means (Muth, Karns, Anderson, & Murray, 2002). These processed oysters are then sold to retailers to be purchased by consumers, or to restaurants for use in menu items.

Oysters are primarily sold in the following forms: raw in-shell, raw half-shell, raw shucked, processed half-shell, processed shucked, or as a value-added product in fresh, canned, or frozen form (Lutz, Sambidi, Harrison, & Huntrods, 2011). While the percentage of oyster consumers who prefer to eat the mollusks raw (verses cooked) varies from study to study, it is the raw consumption that has been the source of recent food-safety related media attention.

The Gulf Coast

The coastal environs along the Gulf of Mexico provide excellent conditions for the Eastern oyster to thrive. Due to the sensitive nature of oyster propagation, temperature is the most important physical factor in oyster production (Schlesselman, 1955). Temperatures above 20ºC (68ºF) are best, making the Gulf Coast functional for oyster production year round (Wallace, 2001). In addition to temperature, the Gulf region is home to the shallow coastal harbors perfect for oysters to flourish. The brackish water, due largely to the merging of freshwater rivers and marshes with the saltwater of the Gulf of Mexico, provides sufficient salinity for oyster production, with levels of 5 to 30ppt (parts per thousand) (Schlesselman, 1955).

Eastern oysters, native to the New England area, have been harvested since the first settlers arrived on American soil. In the 1800s immigrant fishermen from Dalmatia brought the oyster seed from small beds along the Mississippi River Delta to the Gulf of Mexico, hoping to establish the industry in an area promising lower costs of production. While this habitat was inadequate for natural oyster growth due to high predation of oyster seed and larvae, it was well suited for transplanting of young seed oysters. The higher salinity of the Gulf waters proved to result in a fattier oyster, with an accelerated growth rate (Perret & Chatry, 1988). The warmer southern waters can shorten the harvest time from upwards of 6 years (for northern-grown oysters) down to a mere 2 years (Florida Department of Agriculture and Consumer Services, 2011; Kibbe, 1901)

Various advances to production have been employed over the past century to help to prevent the spread of foodborne illness and to ensure the safety, freshness, and quality of the oysters during transportation. Over 90% of Gulf oysters are sold raw, with very few being canned or frozen. Most of the value-added oysters are imported from overseas suppliers, namely Japan and South Korea. Currently the market is dominated by China (Wirth & Minton, 2004). While the United States accounted for 80% of the world oyster supply in 1950, U.S. landings dropped to only 6% in 2000 (Food and Agricultural Organization of the United Nations, 2011).

Vibrio vulnificus *Prevalence*

Oysters are commonly deemed "filter-feeders," as they take in ocean water, filtering out the edible components and releasing the cleansed water back into the environment. This filtering results in the oyster's consumption of not only detritus (dead organic matter), but other compounds present in the water. The filtration of these compounds from the water causes them to be stored in concentrated levels within the oysters, which can prove toxic when ingested by predators. This process is essential to the survival of the aquatic ecosystem in which the oyster thrives. The cleansing of the shallow water allows for less fresh seawater to be needed to keep the coastal areas at proper plankton and oxygen levels. This form of natural purification also protects delicate reefs from the buildup of excess organic matter and algae (Shpigel & Blaylock, 1991).

This filtration process not only provides advantages to the natural estuarine ecosystem, but is relevant also to oyster consumers. Due to the consumption of oysters in their raw state, a number of food safety issues have arisen with respect to bacteria present within oyster meat. The most noteworthy of these is *Vibrio vulnificus*, a bacterium related to *Vibrio cholerae,* the causative agent of cholera. Similar to *V. cholerea*, *V. vulnificus* is a highly virulent and invasive human pathogen (Calif, Kaufman, & Stahl, 2003). This gram negative bacterium is unique in its halophilic nature, or that it requires salt to survive. *V. vulnificus* naturally occurs in brackish, estuarine/coastal waters with optimum growth occurring at temperatures between 20 and 24 °C and salinities from 7 to 16 ppt (Pfeffer, Hite, & Oliver, 2003; Borenstein & Kerdel, 2003).

While it is possible to contract *V. vulnificus* through an open wound coming in contact with ocean water (resulting in wound infection), the consumption of raw oysters allows for the bacteria to enter the body in a more highly concentrated form, often resulting in gastroenteritis and similar forms of intestinal distress (Borenstein & Kerdel, 2003). This bacterium is extremely dangerous, as the presence of *V. vulnificus* does not alter the smell, taste, or the appearance of oysters (Weisbecker, 2010). Warmer water causes elevated levels of the bacteria, and is often associated with higher incidence of infection (Centers for Disease Control and Prevention, 2011). Although many factors like turbidity and dissolved oxygen levels may contribute to *V.vulnificus* levels, a recent study indicates that water temperature accounts for most of the variability (Pfeffer, Hite, & Oliver, 2003). It should be noted that although higher water temperatures may serve to predict incidence of *V.vulnificus*, a causal relationship cannot be established as the rise in temperature may be an effect of another cause. Fluctuating water temperatures may be indicative of other environmental shifts, meaning that a temperature rise could be the result of another instigating factor (Shapiro, et al., 1998). For example, climate change or increases in use of local waters may cause temperatures to elevate, causing an increase in *V.vulnificus* levels.

Upon entering the body *V.vulnificus* can cause an array of distresses, including gastrointestinal problems including severe abdominal pain, diarrhea, and vomiting. The condition covering these symptoms is commonly known as gastroenteritis. Should the illness progress to include symptoms of fever and shock, then the diagnosis is labeled as primary septicemia (Shapiro, et al., 1998).

In a study involving the association between gulf oysters and *Vibrio vulnificus* infections from 1988 to 1996, *V.vulnificus* was the leading *Vibrio* species reported in the Gulf Coast region. Nearly half of the 422 infections reported followed the ingestion of seafood, resulting in either gastroenteritis or primary septicemia. Another 45% occurred following wound exposure to either seawater or seafood drippings. Of those whose outcomes were reported, 39% (143) were fatal (Shapiro, et al., 1998). This coincides with CDC findings that bloodstream infections of *V.vulnificus* prove fatal approximately 50% of the time (2011). Similar studies indicate that seafood consumption during the week before onset of the illness is quite common (Hlady & Klontz, 1996). It is suspected that in many cases not associated with raw seafood consumption, individuals infected with *V.vulnificus* may have consumed cooked seafood that had been cross-contaminated with raw seafood drippings.

In such extreme cases where the pathogen enters the bloodstream, septicemia evidenced by decreased blood pressure and fever/chills often occurs. Infection is particularly severe for persons with already compromised immune systems, as with persons suffering from liver disease, diabetes, cancer, AIDS/HIV, and iron overload disease (Centers for Disease Control and Prevention, 2011; Morgan, Martin, & Huth, 2009; Pfeffer, Hite, & Oliver, 2003). In fact, studies indicate that infections from *V. vulnificus* are more common in patients with liver disease or who are immuno-compromised (Borenstein & Kerdel, 2003), further suggesting that liver disease is a strong predictor of fatality in *V.vulnificus* infections. While the number of *V.vulnificus* cases reported has been steadily increasing over the past several decades, it is not known whether the rise is due to an increase in incidence of the disease or an increase in reporting (Shapiro, et al., 1998). This also may be due in part to the lack of national surveillance of the disease until 2007, when Alabama, Florida, Texas, Mississippi, and Louisiana collaborated with the CDC to monitor the incidence of the disease in the Gulf Coast region (2011).

Oyster Consumers

Examining the typical oyster consumer helps researchers to understand the risks and behavioral profile associated with oyster consumption in the United States. Specific demographic characteristics are also attributed to oyster eaters. Several studies have indicated that males over females prefer oysters, demonstrating that males are nearly twice as likely to eat raw oysters as women (Klontz, et al., 1991) (Shapiro, et al., 1998). Research conducted by Posadas and Posadas found that while respondents who consumed oysters were split evenly, with half being male and half female, 28% of males consumed raw oysters as compared with only 13% of females (2011).

Ethnicity is another distinguishing characteristic for oyster consumers. One report stated that 86% of oyster consumers were white (Hanson, House, Sureshwaran, Posadas, & Liu, 2003). Another examination of food handling and consumption practices revealed that self-reported risky behavior was higher for whites than blacks, but that with specificity to raw oyster consumption Asians/Pacific Islanders revealed higher figures, with whites following second (Altekruse, Yang, Timbo, & Angulo, 1999).

Education levels of oyster consumers vary on a much larger scale. One study found that 28% of oyster consumers surveyed had completed at least some college (Posadas & Posadas, 2011), while another boasted 81% (Hanson, House, Sureshwaran, Posadas, & Liu, 2003). While some studies reported an increase in raw oyster consumption with education (and income), some pose that perhaps an explanation for this is that safe food preparation techniques are developed through e*xperience*, rather than through intellectual awareness of foodborne pathogens (Altekruse, Yang, Timbo, & Angulo, 1999).

Several studies also indicate that a preference for raw oysters lies with younger consumers. One study indicated that oyster consumption decreased with age, with respondents aged 59 and younger responding more than those over 60 (Altekruse, Yang, Timbo, & Angulo, 1999). Another investigation cited that most raw product consumers surveyed were under the age of 50 (Klontz, et al., 1991).

In addition to a general focus on younger, white, male consumers with moderate to higher socio-economic status, it is important to note related behaviors as potential influences on consumption choices. For example, there seems to be a correlation between raw oyster consumption and other adverse health behaviors, such as cigarette smoking and alcohol consumption (Altekruse, Yang, Timbo, & Angulo, 1999). A Florida study found such high markers that it reports that persons who indulge in several risk-taking behaviors are more likely to be raw oyster consumers (Klontz, et al., 1991). This research also notes that often oysters are sold in “raw bars” where alcohol is available and cigarette smoking is common.

Post-Harvest Processing

Advances in processing technologies have greatly reduced the incidence of foodborne illness in oysters sold at the retail level. Over the last few decades several Post-Harvest Processing (PHP) methods have been developed which either eliminate completely or reduce to undetectable levels the *Vibrio vulnificus* bacteria present in the harvested raw oysters. Part of the variation in processes may be due to the fact that the infective dose of *V.vulnificus* resulting in human illness has not yet been officially determined (Shapiro, et al., 1998). This has led to differing opinions in what are deemed “safe levels”, though most industry and government officials agree that undetectable levels provide a suitable goal. Treatment via PHP also assists in prolonging the shelf life of raw oysters, thereby reducing the concern for foodborne illness (Posadas & Posadas, 2011).

The most promising of the PHP methods include individual quick freezing (IQF), heat-cool pasteurization, high-hydrostatic pressurization, gamma irradiation, and depuration (Morgan, Martin, & Huth, 2009) (Muth, Karns, Anderson, & Murray, 2002). Four of these processes are currently approved by the U.S. Food & Drug Administration (FDA), while depuration is still being tested for use in *V.vulnificus* elimination. Currently Auburn University is working conjointly with the USDA to complete this research (United States Department of Agriculture, 2010).

The four FDA approved PHP methods differ greatly in application of technology, intensity of treatment, and resulting alteration of the final oyster product. One uniting factor is that each process was developed to reduce the presence of *V. vulnificus* in oysters to undetectable levels (Morgan, Martin, & Huth, 2009). The most prominent method involves individual quick freezing (IQF), a process by which raw oysters are opened and put on the halfshell before being passed through a freezer tunnel that uses liquid CO_2 to rapidly lower the temperature of the oysters to -120ºC. The oysters can then be thawed and sold as “raw” product (Peterson, 2009). Cool pasteurization has been employed in the U.S. since 1997 as a method of bacteria reduction in oysters. This process involves quickly submerging the live product in a vat of temperature-regulated warm water, followed immediately by plunging the oysters into cold water (Muth, Karns, Anderson, & Murray, 2002). Some offer that this method does not conform to defined pasteurization processes, and so have deemed it a “temperature treatment” process copyrighted as the AmeriPure Process. Actual pasteurization can be used, but the product is no longer considered “raw”, as the steam heats the oysters sufficiently to produce a “cooked” result (Peterson, 2009).

High-hydrostatic pressurization is one of the most recent developments to oyster processing treatments, first used commercially in the U.S. in 1999. The action entails applying pressures of up to 40,000psi (pounds per square inch) to oysters using an electric pump applied to a pressure chamber filled with water (Muth, Karns, Anderson, & Murray, 2002). The low-dose gamma irradiation method has been employed in the U.S. food industry for decades, namely in instances of pork in the elimination of *Trichinella spiralis* (a roundworm mammalian parasite) (Brake, et al., 1985). In August of 2005 the FDA approved the use of irradiation as a fourth means to post-harvest process oysters (Posadas B. , 2010). This approach involves exposing oysters to light energy in the form of gamma radiation (Hanson, House, Sureshwaran, Posadas, & Liu, 2003).

The depuration process has not yet been approved by the FDA for use in reducing bacteria in live oysters. This method requires flushing the oysters with purified water to remove harmful pathogens (Hanson, House, Sureshwaran, Posadas, & Liu, 2003). Depuration is unique in that it appears to leave the organoleptic, or aspects of food experienced by the senses, unaltered. Other methods requiring temperature or pressure alterations can cause changes to the oyster texture, taste, and smell. Since depuration involves purified salt water (and oysters are grown in saltwater), there is no significant observed change (Lewis, Rikard, & Arias, 2010).

As of April 2010 there are sixteen plants in operation in the United States that employ PHP technologies. Twelve of these are located in states bordering the Gulf of Mexico, compared to a mere four plants in 2004 (Posadas & Posadas, 2011) (Posadas B. , 2010). Of these twelve, eight employ the IQF process (Posadas B. , 2010). This may be due to the longer history attributed to the IQF process, as compared with other PHP methods.

Consumer preferences elicited for various PHP treatments are as follows. As mentioned previously, oyster consumers are concerned with any process that may change the organoleptic qualities of raw oysters. Pasteurization can alter the texture of the product, as the process essentially cooks the oyster as the temperature increases. Historically consumers have been wary of the concept of radiation, encouraging some researchers to avoid potential bias derived from the word "irradiation" by instead describing the processes being studied (Peterson, 2009). One such study found 43.6% of all oyster consumers surveyed to be most supportive of the depuration process (Hanson, House, Sureshwaran, Posadas, & Liu, 2003). A similar study found that 43% of oyster consumers indicated that they would increase consumption of oysters if depuration was employed to increase the product's safety (Berry, Allen, & Hanson, 2002; Texas Parks & Wildlife, 2011). Regardless of method, it is evident that oyster consumers are becoming more aware of the abilities of processors to treat raw oysters to make them safer to eat.

While not all oyster consumers are aware of the various technologies employable to treat oysters to reduce bacterial infection, there is evidence that general awareness does exist among oyster lovers. One study of consumers in Mississippi denoted that 47% of respondents believed that methods existed to make raw oysters safer for consumption (Posadas & Posadas, 2011). This suggests that consumers are hopeful of future attempts to decrease the incidence of foodborne illness in their beloved oysters.

Motivation for Research

Proposed Gulf Oyster Policy

In 1998 the Center for Science in the Public Interest (CSPI) petitioned the FDA to take action to protect consumers of raw oysters from deadly bacterial infection. The citizen petition called for the setting and adoption of a "performance standard" intended to encourage the development of burgeoning technologies as cost-effective methods of treating shellfish to protect consumers (Mitchell & Smith DeWaal, 2000). As director of food safety for CSPI Caroline Smith DeWaal stated, "With new technology available that can make raw oysters free of dangerous bacteria, it's time for FDA to require that oysters be made as safe as they can be (Center for Science in the Public Interest, 1998)." Specific attention was attributed to harvesting regions linked to incidence of *Vibrio vulnificus* known for harvesting oysters during warmer summer months.

The CSPI petition arose after numerous attempts by the FDA and the Interstate Shellfish Sanitation Conference (ISSC) to reduce illness incidence through consumer awareness. The ISSC in a regulatory agency made up of the FDA, individual states, and shellfish industry representatives (United States Food & Drug Administration, 1999). Since the early 1990s the ISSC has struggled to improve labeling efforts and to ask harvesters to comply with suggested time and temperature controls (Mitchell & Smith

DeWaal, 2000). A joint effort of the FDA and the ISSC in the late 1990s resulted in the development of post-harvest refrigeration standards for reduction of *V. vulnificus* in oysters (United States Food & Drug Administration, 1999). These regulations called for the reduction of time allowable between oyster harvesting and refrigeration during months where harvest site water temperatures exceeded 84ºF (29ºC) to a 6 hour maximum. Unfortunately these requirements affected only oysters harvested in the warmest of summer months (Shapiro, et al., 1998). In addition, an attempt by the ISSC to educate at-risk oyster consumers through a campaign launched addressing the dangers of eating raw oysters proved ineffective in achieving long-term reduction of *V. vulnificus* illness (Goetz, 2011).

The initially proposed FDA legislation was slated for implementation during the summer of 2011, but was postponed for various reasons. The principal cause for the temporary hiatus of the oyster legislation comes in response to an outcry from the oyster industry itself. Industry members have been quick to point out that without the approval of Congress, the FDA measure could not proceed. The legislation has obvious potential economic ramifications to the industry which have also not yet been measured, resulting in a call for analysis of the costs and benefits of PHP treatments across the board. One recent FDA commissioned study predicts the shutting down of 14% of Gulf seafood operations during the summer should the legislation pass (Goetz, 2011).

On a related note the Gulf seafood industry has suffered a recent decline due largely to the Deepwater Horizon oil spill on April 20th of 2010, which occurred off the coast of Florida. Over 200 million gallons of oil was released over the subsequent b4 days, and by June of 2010 approximately 37% of federal waters in the Gulf of Mexico were closed to fishing (Upton, 2011). The closing of fisheries along the coast, in addition to increases in consumer fears of clean and safe seafood, contributed to both immediate and potential long-term harm to the industry. The loss of habitat along the Gulf and the revenue damages to the seafood industry may never be fully measured, as the nature and magnitude of the spill make the effects difficult to quantify.

CHAPTER II

REVIEW OF LITERATURE

The study of human behavior is nothing new. For centuries scientists have inquired as to what drives people to make specific choices, and to keep them from making others. Often this decision -making involves weighing the potential outcomes, or consequences, of adopting a certain specified behavior. In this respect, a cost-benefit analysis of sorts is undertaken by individuals posed with the opportunity to adopt a preventative behavior. For example, if a cigarette smoker is offered the chance to purchase and use a nicotine patch, he or she may weigh the potential good outcomes (i.e. improved cardiovascular health, lowered chance of lung disease, and money saved by not purchasing cigarettes), against the potential negative outcomes (i.e. potential relapse to smoking, loss of comfort in the daily smoking ritual, or difficulty adapting to the change of a patch). The individual will then weigh these potential outcomes to decide a course of action, whether it be continued smoking (a form of maladaptive behavior) or adaptation of a nicotine patch (adaptive behavior). The same holds true for seafood consumption, as consumers may decide to purchase safer, processed product (adaptive behavior) over continued consumption of raw, unadulterated oysters (maladaptive behavior).

The study of fear as a motivator is emerging as researchers seek to explain the stimulus behind an individual's decision to change. This chapter will give an overview of recent research into the psychology behind motivational fear, as well as presenting the economics behind measuring consumer behavior. These topics provide the background for the analysis performed in this study.

Protection Motivation Theory

To better explain why some people choose adaptive behavior while others do not, a model derived from the field of psychology is often used. Cognitive psychology involves the study of mental processes internal to an individual, including the acquisition, storage, and recall of information. This differs from behavioral psychology, which focuses on observable behavior of an individual. In short, cognition deals with internal processes, rather than external stimuli and outcomes (Neisser, 1976). As the focus of psychological research turned to mental factors internal to the individual, studies evolved to attempt to explain the connections between cognition and behavioral change.

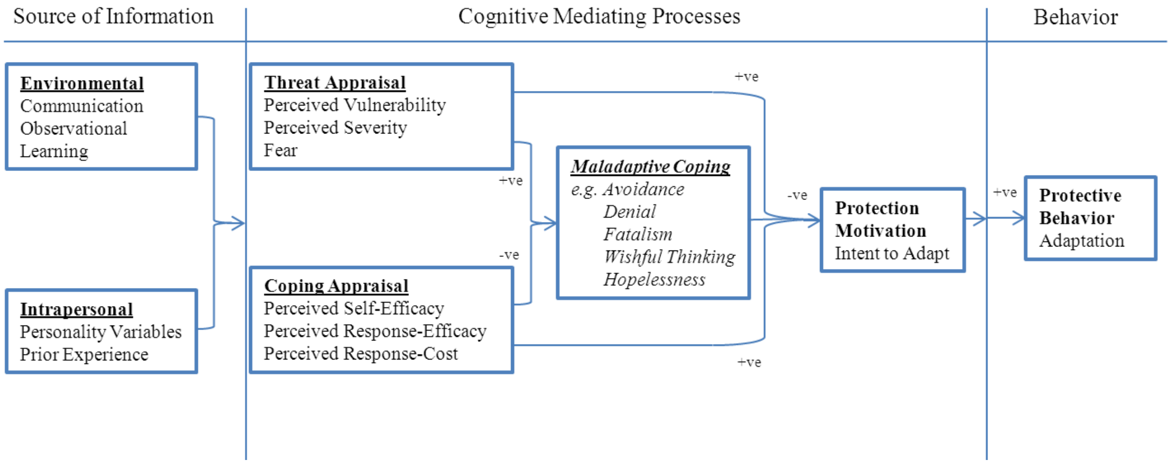
In the 1970s Ronald W. Rogers developed a model titled Protection Motivation Theory (PMT) to help social psychologists explain individual tendencies towards adaptive and maladaptive behavior. Protection Motivation addresses how the components of an individual's fears concerning a specific event or outcome could facilitate a change in the individual's behavior to protect him or herself from that event (Rogers, 1975; Prentice-Dunn, McMath, & Cramer, 2009; Maddux & Rogers, 1983). The ultimate goal of the model is to curtail the effects of fear appeals as predictors of health-related behavioral change. A proposed protective behavior is built into the model, and the participants' aim to adopt the recommended preventative measure is quantified as the amount of "protection motivation" aroused (Rogers, 1975).

Currently PMT is a popular model used with researching the psychological aspects of health-related behavior (Grothmann & Patt, 2005). Often the applications of PMT have proven successful in the adaptation of preventative treatments to ward off negative outcomes, as with damage prevention in flood-prone areas (Grothman & Reusswig, 2004). Other historical applications of PMT include sun protection, exercise and cardiovascular health, and self-breast examinations (Hodgkins & Orbell, 1998; Prentice-Dunn, McMath, & Cramer, 2009; Wurtele & Maddux, 1987; Rippetoe & Rogers, 1987; Maddux & Rogers, 1983).

In PMT, Rogers describes fear as a “relational construct”, with an adherence to both a stimulus and a response (1975). In other words, fear may be seen as a bridge between the perception of danger and the protective action needed to cope with the situation. The term “fear appeal” is used to describe this link, or the act of using an individual’s apprehension of an event or topic to provoke a preventative response. A similar definition suggests that a fear appeal attempts to communicate a potential threat to an individual’s well-being by both describing the threat in detail and suggesting steps to avoid or reduce the impact of the threat (Milne, Sheeran, & Orbell, 2000).

One significant feature adherent to PMT is the breakdown of the fear appeal into two main perceptual processes. The first of these is the *threat appraisal*, wherein a person evaluates the risk and probability associated with a threat if the person were to continue without a change in behavior. The second is the *coping appraisal*, in which the person then evaluates his or her ability to handle and survive the threat unharmed

(Grothmann & Patt, 2005). These processes are then further segmented into distinct variable categories.



Adapted from: (Milne, Sheeran, & Orbell, 2000)

Figure 1: Protection Motivation Theory Model

Figure 1 above represents the elements inherent to the PMT model, as well as the flow of constructs leading to a decision towards adaptive behavior. The threat appraisal evaluates the fear appeal elements that relate to how threatened an individual perceives oneself to be. The factors affecting the threat appraisal include those of perceived vulnerability, perceived severity, and fear. First, *perceived vulnerability* is defined as his or her susceptibility to emotional or physical harm. One example would be a person's expectancy of his or her home being struck by a hurricane during the appropriate season. In fear related studies, perceived vulnerability can be associated with demographic factors (location, race, etc.) in addition to those related to prior health knowledge (individual health history and family risk). The term "perceived vulnerability" is used, as individuals are reporting on their own perception of susceptibility to an event or communicated threat (Milne, Sheeran, & Orbell, 2000). The literature often uses the term "probability" in lieu of "vulnerability," as the two are assumed to be interchangeable. *Perceived severity*, or magnitude, of the noxious event is the second element of the threat appraisal. Perceived severity is described as a measure of how serious an individual perceives a threat would be to him or herself personally (Milne, Sheeran, & Orbell, 2000). For example, an individual who smokes cigarettes may perceive the potential for developing emphysema as high, which adds to the individual's threat appraisal (Rippetoe & Rogers, 1987). The elements of perceived vulnerability and perceived severity are linked by a third variable of *fear*, seen as an intervening variable. For example, the more vulnerable an individual feels to an event, the more elevated the fear level and the higher the likelihood of motivation towards protective behavior from that event. In addition, the greater the magnitude of the noxious event, the more likely the individual will be motivated to protect him or herself from the threat of the event (Milne, Sheeran, & Orbell, 2000). Questions connected to fear are often posed in relation to salient feelings, as with inquiries about how a specific threat makes an individual feel. The statement, "The thought of breast cancer makes me feel (very anxious – not at all anxious)" was used in a study measuring the linkages between PMT and breast self-examination, with anxiety serving as a proxy for fear (Hodgkins & Orbell, 1998).

Coping appraisal, often referred to as perceived adaptive capacity, evaluates an individual’s ability to manage and avert the threatened event (Floyd, Prentice-Dunn, & Rogers, 2000). The coping appraisal must be evaluated after the threat appraisal, as a threat must be identified before it can be fully evaluated (Floyd, Prentice-Dunn, & Rogers, 2000). In his original theory, Rogers recognized *perceived response efficacy* as the primary criterion of the coping determinant (1975). Response efficacy measures the belief that a recommended response will be successful in reducing the apparent threat to an individual. Prentice-Dunn, McMath, & Cramer (2009) measured response efficacy related to sun protective behavior by posing questions related to the perceived success of sunscreen in the prevention of premature aging. The second component of *perceived self-efficacy* relates to an individual’s perceived ability to carry out the recommended response to achieve the desired outcome. Rather than measuring the effectiveness of the treatment itself, self-efficacy measures the individual’s capability of adapting to the treatment. For example, participants in a study on the prediction of exercise behavior and intention were asked questions related to their capability of sticking with a regular exercise regimen, as well as the difficulty associated with doing so (Wurtele & Maddux, 1987). The third tenet to the coping appraisal is the *response cost* (or adaptation cost). While several studies chose not to include this component in the PMT model, some reviews suggest that the component plays a significant role in deterring individuals from pursuing coping mechanisms. Response costs describe beliefs about how costly performing the recommended behavior would be to an individual, and can include both monetary and non-monetary values such as embarrassment or timeliness related to pursuit of the treatment (Milne, Sheeran, & Orbell, 2000). While it is true that self-efficacy and adaptation costs may be related, conceptually the belief's about one's own ability are treated independently of the cost of responding. One study explained that an individual may believe that as a tenant he or she is not permitted to install electronic appliances on the second floor of the home, however as an electrician is would not cost much to do so (Grothmann & Patt, 2005).

The mediator between the threat and coping appraisals is *protection motivation*. As Maddux and Rogers explain, "These cognitive processes mediate the persuasive effects of a fear appeal by arousing protection motivation, an intervening variable that arouses, sustains, and directs activity to protect the self from danger" (1983, p. 470). This variable tells researchers of the probability of change in an individual's behavior. In other words, the protection motivation variable measures the *intent* of a person to alter behavior, as with the intent to reduce alcohol consumption to promote liver health. This mediator effectually measures an individual's predisposition to change, and provides the ultimate goal of PMT in understanding the components that motivate protective conduct.

The PMT model deals with the evaluation of fear appeals in motivating protection against a negative outcome. While factors like the degree of exposure to danger and self-efficacy with respect to a preventative measure provoke fear, it is the introduction of a change option containing a threat component that provides the additional stimulation needed to result in behavioral change. An example would be the difference between talking about the risks of sun damage to skin verses talking about the risks and how sunscreen can diminish such risks. In other words, a "recommended opinion" raises a question and poses a new answer (Hovland, Janis, & Kelley, 1953). Here it is important to note the difference between this protection motivation and actual behavior. Protection motivation measures intent to change rather than actual change and these may differ given that individuals may face barriers like lack of resources, time, knowledge, or money (Grothman & Reusswig, 2004).

Based on the outcomes of both the threat and coping appraisals, a person will respond in either of two ways. An adaptive (or protective) response is one that will diminish or prevent damage to the individual if the noxious event occurs. A maladaptive (or non-protective) response does not prevent such damage, but instead only prevents negative emotions by ways of fatalism, wishful thinking, and hopelessness, and avoidance (Grothmann & Patt, 2005). For example, a frightened individual may avoid walking the streets of a city at night, but the decision to act in avoidance does not alleviate the problem of facing the streets at night in the long run. Maladaptive behavior serves as non-productive in that it acts in opposition to dealing with the reality of the situation at hand (Rippetoe & Rogers, 1987). Studies indicate that respondents are more apt to choose adaptive behavior when threat and coping appraisals are high and maladaptive behavior when the appraisals are low (Grothman & Reusswig, 2004).

Protection motivation responses to each of the two appraisals differ. Studies indicate that high threat appraisal leads to some sort of response, either adaptive or maladaptive (Milne, Sheeran, & Orbell, 2000). This suggests that high threat appraisal motivates a response, whether protective or non-protective (Grothman & Reusswig, 2004). In several studies high coping appraisal components of efficacy and self-efficacy both see negative correlation with maladaptive responses and positive correlation with adaptation (Rippetoe & Rogers, 1987; Milne, Sheeran, & Orbell, 2000).

Related Cognitive Psychological Models

Protection Motivation Theory pulls largely from Expectancy-Value Theory (EVT), wherein the propensity towards one behavior is explained as a function of the expectancy of that behavior to result in a specified consequence, related also to the value of said consequence (Rogers, 1975). In addition, this allows for the hypothesis that if one's perceptions of an outcome can be changed, so also can his or her intent. With favorable outcomes comes heightened intent, resulting in an increase in motivation to change the behavior in order to produce more (larger quantity of) favorable outcomes (Hovland, Janis, & Kelley, 1953). In using this well-established model as a basis, Rogers attempted to yield what he describes as "a fuller understanding of psychological phenomena" (Rogers, 1975).

As explained above, the development of PMT was based primarily on EVT and revised later to include the self-efficacy element (Floyd, Prentice-Dunn, & Rogers, 2000). Self-Efficacy Theory (SET) studies the extent to which individuals perceive themselves to be capable of carrying out a task links directly to their sense of control over their own environment and behavior. Measures of self-efficacy can also be used to determine whether or not an individual will undergo a change in behavior, the amount of effort an individual is willing to expend, and the duration of persistance of an individual in the face of obstacles (Bandura, 1982). When measured quantitatively, self-efficacy can be used to determine the scope of effort an individual will exert in the face of a predetermined obstacle. Previous research in self-efficacy theory has indicated that those respondents with stronger measures of self-efficacy are more determined to overcome challenges, while those with greater self-doubt often give up. It should be noted that Bandura also attributes good performance of a desired outcome to both a high measure of self-efficacy and some degree of uncertainty about the task in question, which leads to further gathering of informationand honing of skills on the part of the individual (1982, p. 123).

Willingness-to-Pay

Economics provides several methods with which to quantify the effects of the psychological attributes already discussed. While understanding the behavioral changes is important, determining market effects for such changes is of high value to researchers. In order to measure the value of a good or service, it must be acknowledged that individuals exhibit preference for certain goods over others (Field & Field, 2006). The economic concept used to quantify consumer preference for a good is Willingness-to-Pay (WTP).

The WTP measure places a value on the trade-offs that individuals are willing to accept in exchange for a good. Specifically, WTP is the maximum amount that an individual is willing to pay for a good or service, thus tying the individual's valuation of the good to his or her purchasing power. In contrast to WTP, Willingness-to-Accept (WTA) is the amount that a person will accept to have a good taken away, or the minimum amount he or she will accept in lieu of the good.

The issue of divergence of the two measures has been studied by many, as studies indicate that often WTP amounts do not match WTA amounts. In other words, what one person is willing to pay for a candy bar may not equal what he or she is willing to accept if asked to give up the same candy bar. The convergence of WTP and WTA has to do with the availability of substitute goods and the income of the respondent. The WTP for a specific person will eventually reach a limit related to expendable income, while the WTA has no comparable limit. To simplify, WTP is tied to *ability*-to-pay. It has been found, however, that divergence is persistent when the good in question has few substitutes, as with reduced risk to health (Shogren, Shin, Hayes, & Kliebenstein, 1994).

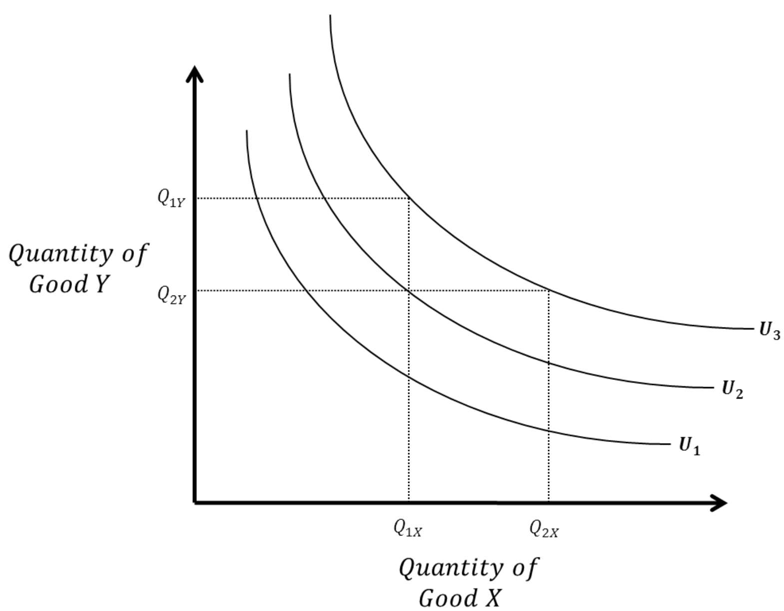


Figure 2: Consumer Indifference Curves and WTP

Figure 2 shows consumer utility with a map of indifference curves. Since WTP measures a trade-off between two goods, *X* and *Y* (one good often being money), the slope of the indifference curve between the two goods is deemed the Marginal Rate of Substitution (MRS). In the case above, the slope between the points (Q_{1X}, Q_{1Y}) and (Q_{2X}, Q_{2Y}) is the MRS between goods *X* and *Y* at those quantities, with utility at U_3. The user is said to have the same satisfaction at point (Q_{1X}, Q_{1Y}) as at point (Q_{2X}, Q_{2Y}), or to be indifferent between these points. Hence, he or she would be willing to give up (WTP) $Q_{1Y} - Q_{2Y}$ in order to increase his or her quantity of Good *X* by $Q_{2X} - Q_{1X}$.

According to the theory of rational behavior, a consumer will choose to increase his or her utility by increasing consumption, moving to higher indifference curves away from the origin, until the consumer is constrained by expendable income. The different curves shown in Figure 2 represent different levels of satisfaction, so that U_3 denotes greater satisfaction, or utility, than U_2.

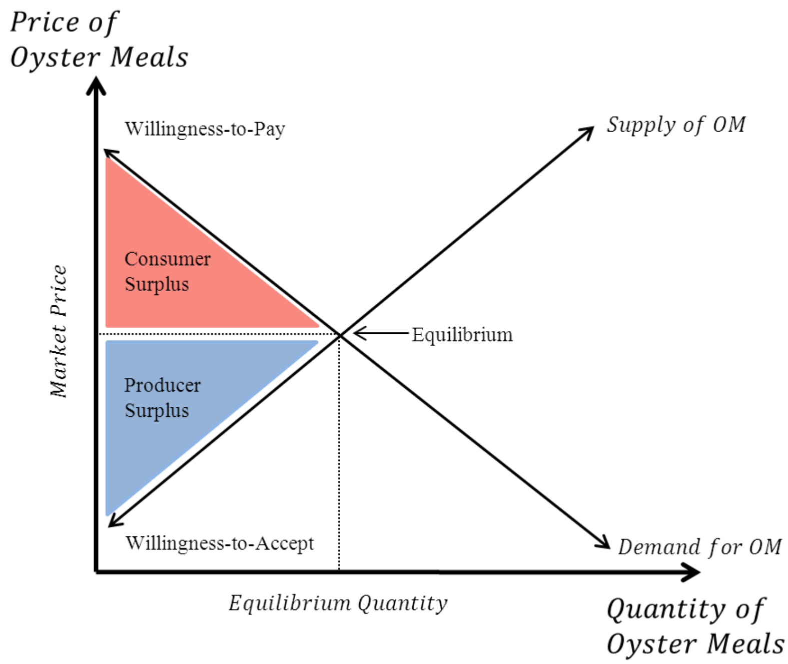


Figure 3: WTP and WTA in a Competitive Market

Since the marginal WTP or marginal WTA can be expressed as prices, it can be said that the benefits of both consumer and producer participation in a competitive market can also be measured monetarily. Figure 3 above depicts consumer surplus as the amount that consumers benefit by being able to purchase a good at a price less than or equal to the amount they are willing to pay for it. Producer surplus is the amount that producers benefit from being able to sell a good a price higher than the minimum amount they are willing to accept for the good. This figure assumes a competitive market where the producer is a price taker.

Non-Market Valuation

In cases where the good in question is new to the market or no market for the product exists, a variety of techniques exist that can be used to measure WTP. These techniques are either designed to reveal consumer preferences through actual purchase experiments, or to elicit attitudes through stated preference modeling. Revealed preference methods can involve the analysis of real market data, or can elicit responses through experimental procedure. One fault of real market data is that it can lack the price variation necessary for accurate WTP study. Historical sales data, for example, often reflects the economy of the chosen time period and may not include reasonable WTP figures for a current market. In addition it is not possible to calculate WTP for a product for which there exists no market, so new goods will not work with market data studies (Breidert, Hahsler, & Reutterer, 2006).

Revealed preference experiments can range from real-world market experiments to research conducted in auction-type settings. Laboratory experimentation can pose hypothetical bias because respondents are not only aware of the experiment, but they do not actually spend their own money, causing them to artificially direct the experiment as it proceeds. While auctions can prove to be good indicators of consumer behavior, applied research using auction experiments is limited (Breidert, Hahsler, & Reutterer, 2006). In addition auctions can be subject to starting-point bias, wherein the definition of a specific range may affect the response given, as with price increases by dollar verses price increases of multiple dollar amounts.

Stated preference procedures involve the use of surveys, and pose questions about WTP either indirectly or directly. Conjoint Analysis, also called choice modeling, uses multidimensional choice profiles and asks respondents to rank the profiles according to preference. Conjoint Analysis leads to Discrete Choice Analysis, a method wherein consumers are given varying product profiles and are asked to choose from these.

The most direct way to get consumers to tell their WTP for a product is to simply ask them. This more direct approach to valuation of a good is called the Contingent Valuation Method (CVM). The CVM is used when the value of a good is less identifiable, as with goods that may not yet have a market (new goods) (Field & Field, 2006). Often the data is elicited with a survey that poses hypothetical scenarios regarding consumer WTP for a good. Direct surveys ask specific questions about WTP, as with the question, “Above which price would you definitely not buy this good?” (Field & Field, 2006) More complicated techniques may ask an individual a “yes” or “no” question in a form like, “Would you pay $100 to preserve the park for future use?” (Tietenberg, 2006) Because the data is not derived from actual purchases, it is said to be stated, and the models are referred to as “stated preference” models.

The CVM uses survey techniques to determine the value of a good or service to individuals. These types of models were first used to estimate a market value for a non-market good, such as access to a national park. While utility may be derived from such a good in forms like beauty of landscape or preservation of habitat, it can be difficult to attribute a price to such utility. The basic idea behind CVM is that individuals are directly asked to say how they would act when placed in certain contingent situations (Field & Field, 2006). The inherent assumption underpinning the CVM is that individual responses to hypothetical markets reflect behavior in actual markets (Mitchell & Carson, 1989).

While many of the historical CVM applications have been applied to environmental studies of public goods, several have been linked to health-related issues (Nocera, Bonato, & Tesler, 2002). A study of angina sufferers aimed to determine the value of symptom reduction and relief (Tollley & Babcock, 1986). Others have been used to estimate consumer WTP for reduced risk of foodborne illness (Hammit, 1986).

In addition, specific research related to the consumption of safe seafood has garnered use of the CVM. One study (Wessells & Anderson, 1995) combined elements of Conjoint Analysis and CVM to allow respondents to rate their preferences for seafood attributes via a written survey and to then state their WTP for the highest ranked attribute. Results indicated that consumers who purchase flounder for consumption at home were willing to pay 32 cents more per pound for catch site assurances (information relation to the harvest site of the flounder). The CVM was also successfully used to study the effects of pfiesteria-related fish kills on the demand for seafood, where the fish kills were known to pose no threat to consumer health (Parsons, Morgan, Whitehead, & Haab, 2006). Consumers were asked to report on potential changes to their seafood consumption, should a pfiesteria-related fish kill be reported in the press. This research found that pfiesteria-related fish kills significantly affected seafood demand and that a mandatory seafood inspection program would largely reduce potential welfare loss due to misinformation.

Studies applying the CVM to safe oysters are more limited. One recent study based in Taiwan found consumers to be willing to pay 46% more for HACCP (Hazard Analysis Critical Control Point) on oysters (Jan, Fu, & Liao, 2006). A study by Lin and Milon concluded that consumers were willing to pay an average of 72 to 80 cents more per dozen oysters for a reduction in foodborne risk (1995).[1] These high percentages suggest that food safety with respect to oysters possesses great marketability.

As with any research method, it is important to note the potential for bias in data derived from an elicitation. Tietenberg (2006) explains the potential for four types of bias frequently found in CVM studies. Strategic bias is possible if respondents attempt to alter the outcome of a survey by adjusting their responses away from their true values, as when individuals state higher WTP for a park entry fee if they wish the park to be open year-round. Information bias occurs when individuals have little experience related to the good (or substitutes) in question, and therefore give answers that are biased by the information, or lack thereof, that is provided in the survey. For example, if a person in California states a low WTP for pacific oysters, it may be because he or she believes that gulf oysters may be purchased as a substitute, when in reality California does not import oysters from the gulf. Thus hypothetical bias can often result in the need to both educate and measure value (Lin & Milon, 1995). Starting-point bias, as explained earlier, involves occurrences wherein the specific range definition may affect

[1] Lin and Milon assume a $4.00 per dozen base price.

the individual's response. Perhaps the greatest concern about bias involves hypothetical bias. Hypothetical bias may arise if the survey scenario is perceived as contrived, causing the respondent to give artificial values because he or she will not actually have to pay them. The lack of real-world implications may cause misrepresentation in elicited answers (Field & Field, 2006).

CHAPTER III

DATA & METHODOLOGY

Survey Instrument & Development

This study builds on previous work by Morgan, Martin, and Huth in which contingent valuation techniques were employed to determine how health safety risks are perceived and evaluated by consumers of both raw and cooked oysters in light of an oyster-related mortality (2009). In this initial research a web-based survey was administered which attempted to measure the impacts of consumer education on demand for oyster meals. This was done via source treatments, including a brochure (with a source of random assignment) and PHP treatment and price premium. This research focused on Florida households, with primary attention being given to the markets supporting the Florida oyster industry, courtesy of the Florida Sea Grant Program. Two rounds of the initial survey were administered, the first by telephone and the second via the project website.

That foundational study included 368 oyster consumers participating in the round 1 telephone surveys. Of these, 340 agreed to participate in the internet-based second round, of which 103 actually logged on to complete the instrument. Once incomplete responses were removed there were 79 useable observations left for the initial panel model (Morgan, Martin, & Huth, 2009).

The initial Gulf State Oyster Survey (GSOS) instrument was expanded for purposes of further research, as was the territory covered in the study. These are the data being used in this thesis. The revised GSOS was internet-based, and spread over 6 gulf oyster producing states. After a brief series of demographic questions were asked, participants were asked about their current oyster meal consumption, to form a baseline to reference when posed future contingent behavior questions.[2] Respondents then followed the GSOS instrument, answering contingent behavior questions after each presentation of information/source treatment.

Data & Summary Statistics

The descriptive statistics for the demographic variables are included in Table 1. Fifty-two percent of participants were female, and 21 percent of these noted their age to be from 25 to 34 years. In fact, of seven age categories listed the highest category represented was the 25 to 34 year range (22%). The mean age for respondents was 37 years. Over half of participants professed to having a Bachelor's degree or higher, and nearly all stated having received a high school diploma. Nearly 75 percent of participants were white, while 10 percent were either Asian or Pacific Islander. The largest proportion (21%) of those surveyed profess to have an income of $50,000 to $75,000. Half of the respondents are married, and 30 percent are single. The respondents indicated an average of 2 to 3 persons living within their households.

[2] An "oyster meal" was defined as a meal eaten at home or a restaurant, which includes meals where oysters were the main course, meals where oysters were an essential ingredient (like gumbo), or meals where oysters were present in appetizer form.

Table 1: Demographic Descriptive Statistics

Variable	N	Mean	Standard Deviation	Min	Max
gender	1015	1.52	0.50	1.00	2.00
age	1015	4.29	1.61	2.00	7.00
education	1015	5.30	1.52	1.00	9.00
ethnicity	1015	1.70	1.39	1.00	7.00
income	1015	6.05	2.35	1.00	10.00
marital status	1015	2.45	1.06	1.00	5.00
no_inhouse	1015	2.63	1.52	1.00	24.00
WTP	1015	0.31	3.83	-22.25	35.92

WTP Variable

In an ideal situation respondents would have been asked to give the average price paid for an oyster meal. However, since this price can vary depending on factors like season, location, quantity (discounts may be given for oysters ordered by the dozen), and number of oysters per meal, it was decided that the survey would address the changes in price associated with oyster meals and the PHP process. This makes it more difficult to determine the marginal willingness-to-pay (MWTP), i.e. how much more (or less) an individual would be willing to pay for an oyster meal with the treatment process.

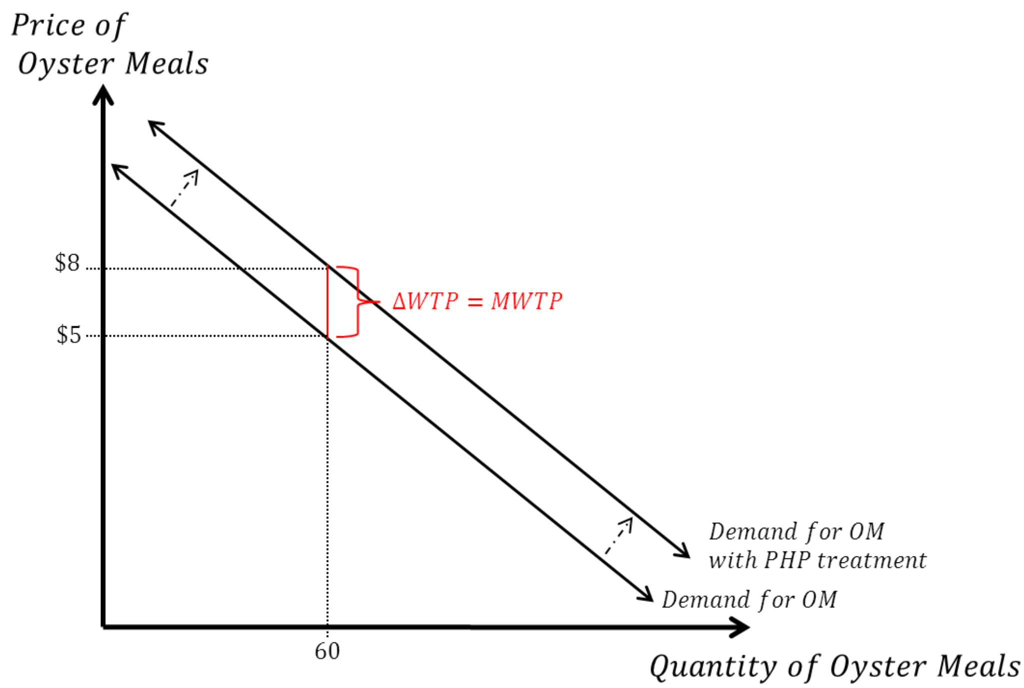


Figure 4: Theoretical MWTP for PHP Treatment of Oyster Meal

Figure 4 above portrays the demand curve for oyster meals (OM) and the demand curve for oyster meals with the PHP treatment. Assuming that the PHP treatment leads to a parallel shift in the demand curve, holding all individual welfare factors constant, the MWTP for the added treatment can be calculated by subtracting the base price per oyster meal ($5) from the price per processed meal ($8) to get a treatment value of $3 per meal.

The three dots on Figure 5 represent the data that are actually contained in the GSOS data. These three points (A, B, and C) illustrate the starting points used to calculate MWTP, and are explained below.

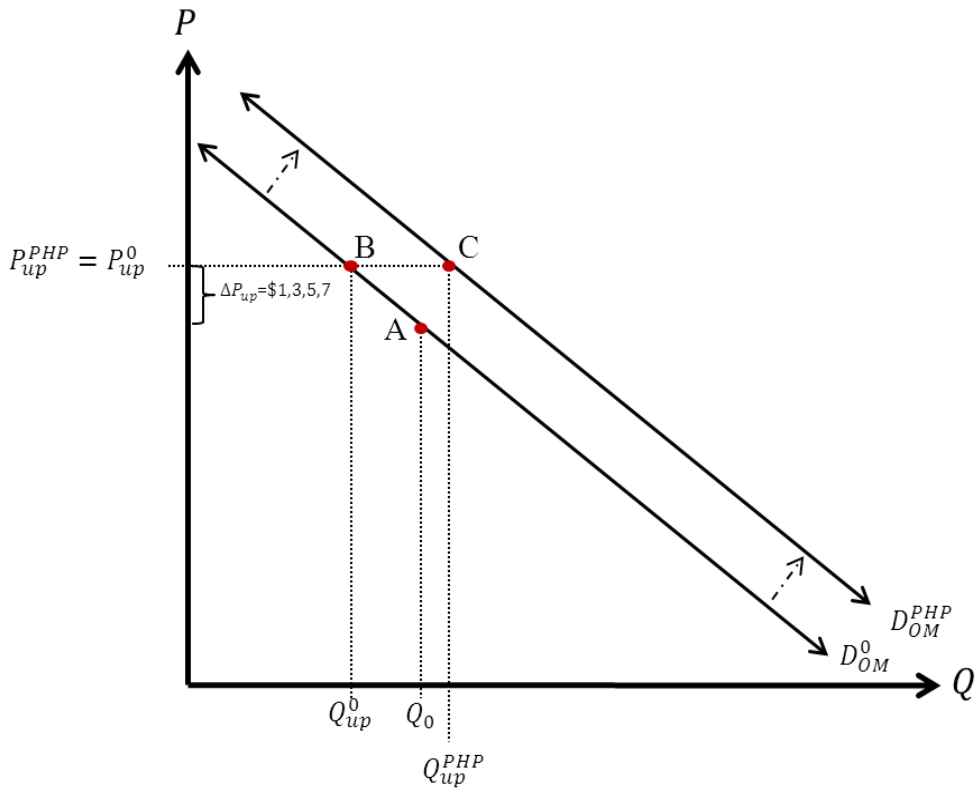


Figure 5: Given GSOS Data for MWTP Calculation

The MWTP for the PHP treatment for this research was estimated for each individual using variables from the GSOS that captured the individual's projected consumption of oyster meals with and without the PHP, along with randomly assigned price increases. Three data points were used to calculate the MWTP for the treatment. While a base price for a typical oyster meal was not included in (A). Subjects were given a randomly assigned hypothetical increase in price, ΔP_{up}, and then asked to report their projected consumption if the price of their meals went up by this amount (Q_{up}^{0})

(B).[3] In addition, subjects were asked to report their projected oyster meal consumption if the oysters were treated with a PHP treatment in combination with the same randomly assigned price increase (Q_{up}^{PHP}) (C). Using basic principles of geometry, these three points were used to determine the slope of the aggregate projected consumer demand for oyster meals without the PHP treatment (S_D^{OM}) using standard slope calculations, shown by:

$$S_D^{OM} = \frac{\Delta P_{up}}{Q_{up}^{0} - Q_0}.$$[4]

With the slope of the individual's oyster demand curve and the change in quantity for PHP, it is possible to calculate the vertical shift in the demand curve that would explain the change in quantity of oysters consumed. This is portrayed graphically in Figure 6.

[3] The PHP price premium was assigned randomly as either $1, $3, $5, or $7.
[4] Data for projected consumption given a price decrease was also collected, but was not used in the MWTP calculations. The explanation for this is that the addition of PHP would ultimately cause an increase in the overall price for oyster meals, not a decrease.

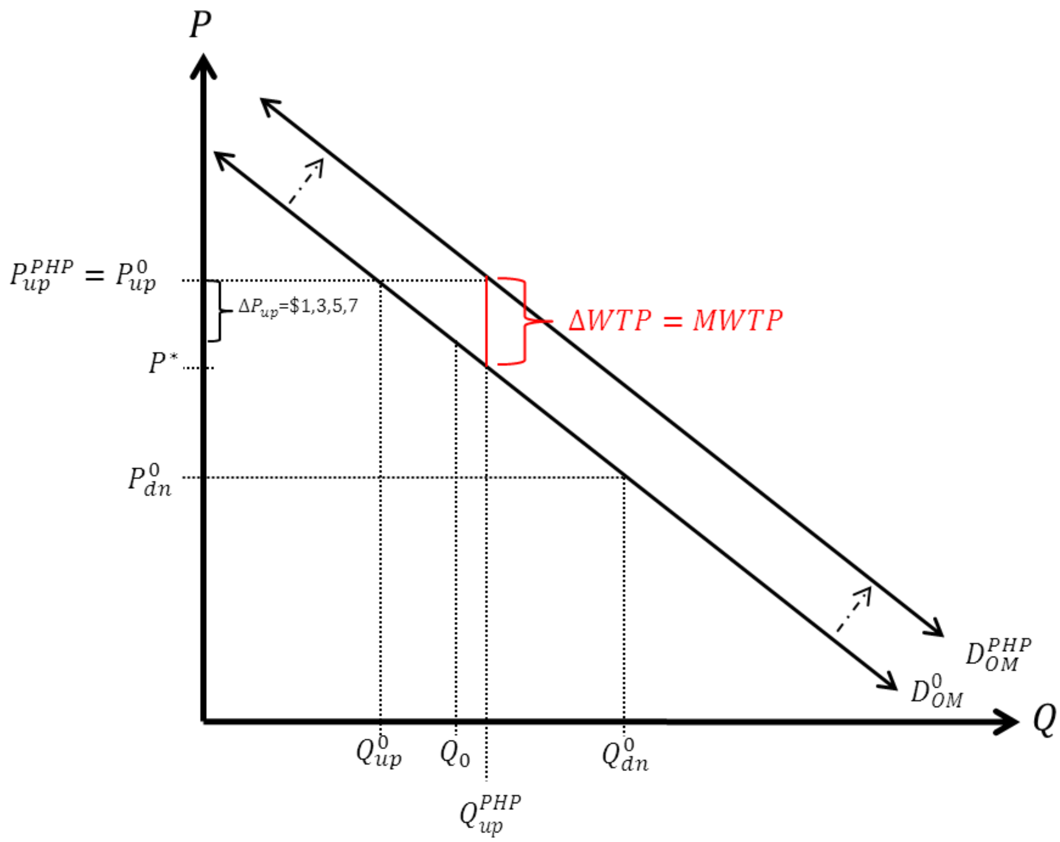


Figure 6: Actual MWTP for PHP Treatment of Oyster Meal

To calculate the change in WTP for PHP treatment, the slope of the demand curve is multiplied by the difference between projected consumption at a price increase and projected consumption at a price increase with the PHP treatment. If we let P^* represent the base price, this equation is written as follows:

$$S_D^{OM} \times \left(Q_{up}^0 - Q_{up}^{PHP}\right) = P_{up}^0 - P^* = \Delta WTP.$$

The calculated change in WTP between the demand curves D_{OM}^0 and D_{OM}^{PHP} is the consumer's marginal willingness-to-pay, or $MWTP$. This of course assumes that the slope of the demand curve for oyster meals is the same as the slope of the demand curve for PHP oyster meals, which is a fairly strong assumption. Assuming this parallel shift allows for the distance between the two demands to be measured at any one quantity amount, resulting in a constant MWTP.

Figure 6 also assumes a downward-sloping curve for each demand, in accordance with traditional economic theory that as price decreases, quantity demanded of a product increases, and vice versa and a downward sloping demand curve is required in approach used to estimate MWTP. Any individual whose answers were inconsistent with a downward sloping demand curve was, therefore, excluded from the analysis. For example, respondents are dropped if they were willing to purchase more oyster meals as price increased (indicating an upward-sloping demand). So, if $Q_{up}^{0} \leq Q_0$, then the value was not included. Likewise, if a respondent was willing to purchase fewer oyster meals as price decreased, or $Q_0 \leq Q_{dn}^{0}$, then the value was not included. In addition, WTP values for which there was no change in quantity demanded were rejected, as this indicates a seemingly vertical (completely inelastic) demand at certain intervals. A strikingly large portion of the respondents did not indicate a downward sloping demand curve; 1,026 of the original 2,172 observations were rejected for these reasons. This left 1,146 useable WTP observations. An additional 131 observations were dropped from the analysis due to missing values in other relevant variable categories, resulting in 1,015 total useable observations.

It is important to note that in 421 of the original observations the slope of the demand curve for oyster meals differed from $Q_{up}^{0} - Q_0$ and from $Q_0 - Q_{dn}^{0}$, suggesting a "kink" in the individual's demand for oyster meals. For example, one individual displayed a slope of -.1 for the price increase range and a slope of -.3 for the price decrease range. To account for this the slope from $Q_{up}^{0} - Q_0$ and from $Q_0 - Q_{dn}^{0}$ were averaged, resulting in one slope to be used to calculate MWTP.

While Figure 6 portrays an outward moving shift in demand as PHP is added to the oyster meals, it should be noted that movement in the opposite direction is also possible. Such movement would explain the behavior of consumers with negative $MWTP$ values, i.e. those who would pay less for oysters with the PHP treatment.

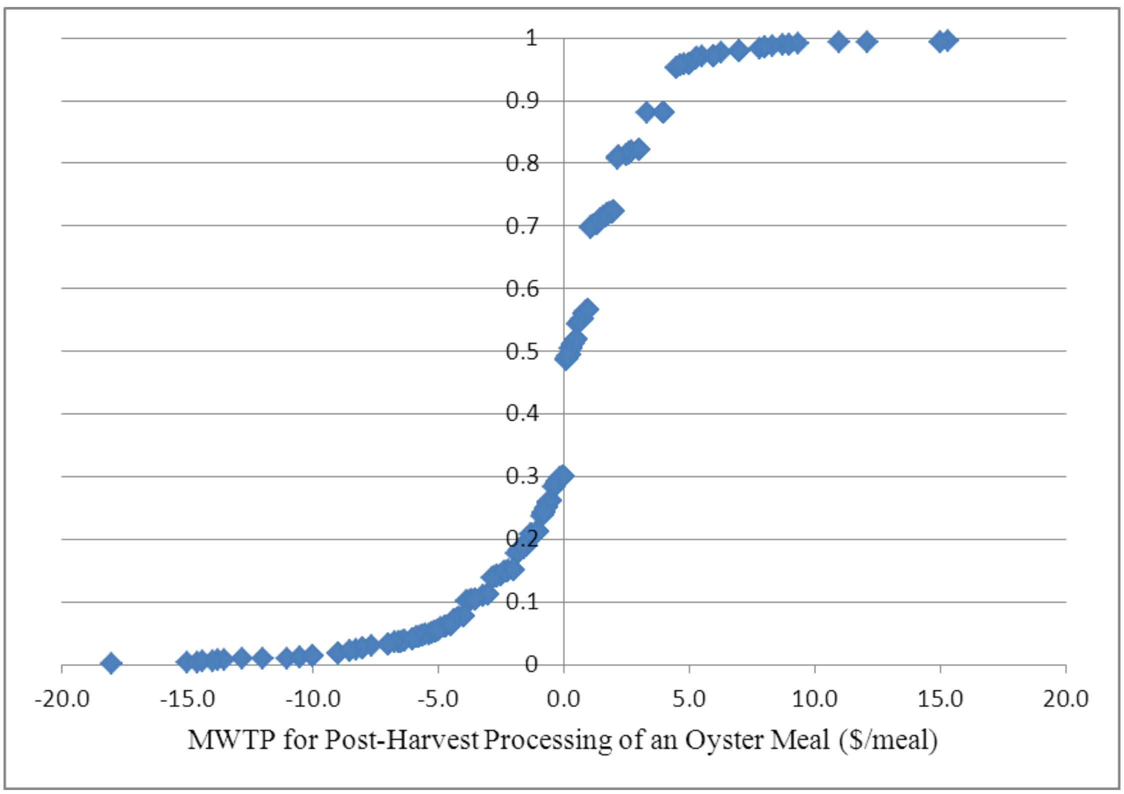


Figure 7: CDF of MWTP Values

Figure 7 shows the cumulative distribution function (CDF) for the MWTP values calculated for the 1,015 individuals with downward sloping demand curves as stated above. This graph indicates a high concentration of values around the 0 MWTP point, with the actual number at 188 observations. The mean MWTP for the PHP treatment is \$0.31 per oyster meal, with a standard deviation of \$3.83. The smallest value calculated is -\$22.25, and the largest value is \$35.92.

Created PMT Variables

The next step in the research was to create PMT variables from selected original GSOS questions. As mentioned previously, PMT differentiates between two perceptual processes, the threat appraisal and the coping appraisal. Each of these processes is further sorted into subcategories. These subcategories include perceived vulnerability, perceived severity, and fear (threat appraisal), and self-efficacy, efficacy of the treatment, and treatment cost (coping appraisal), with the intent to change behavior listed as PMT (protection motivation).

In order to choose questions from the survey that represented these components, a list of reference questions was formed from reviews of the PMT literature. Examples of survey questions used in previous analyses are listed in Table 2.

Table 2: Sample Survey Questions from PMT Literature

Category	Sub Category	Sample Question
Threat Appraisal	Perceived Vulnerability (V)	"Considering all of the different factors that may contribute to AIDS, including your own past and present behavior, what would you say your chances are of getting AIDS?" (Aspinwall, Kemeny, Taylor, Schneider, & Dudley, 1991, p. 436) "My chances of developing breast cancer in the future are (very low-very high)." (Hodgkins & Orbell, 1998, p. 241) "Even though I do not exercise regularly, my chances of having a heart attack or stroke are slight." (Wurtele & Maddux, 1987, p. 457) "Because I do not exercise regularly, my cardiovascular system is deteriorating." (Wurtele & Maddux, 1987, p. 457)
	Perceived Severity (S)	"How serious a health problem is AIDS?" (Abraham, Sheeran, Abrams, & Spears, 1994, p. 436) "Developing breast cancer would force me to change my goals in life." (Hodgkins & Orbell, 1998, p. 241) "Most people who survive heart attack and strokes are seriously affected for the rest of their lives." (Wurtele & Maddux, 1987, p. 457) "Due to recent medical advances, if a person has a heart attack or stroke, the chances of surviving and leading a normal life are excellent." (Wurtele & Maddux, 1987, p. 457)
	(Rewards-Maladaptive)	"Sex would be more exciting without a condom." (Abraham, Sheeran, Abrams, & Spears, 1994)
	(Avoidance-Maladaptive)	"I try not to let the thought of breast cancer enter my mind." (Hodgkins & Orbell, 1998, p. 241)
	Fear	"The thought of breast cancer makes me feel (very scared-not at all scared)." (Hodgkins & Orbell, 1998, p. 241)
Coping Appraisal	Response Efficacy (E)	"If I quit smoking I will greatly increase my chances of living a longer life." (Maddux & Rogers, 1983, p. 473) "If I were to carry out BSE, I would ensure early detection of any abnormalities." (Hodgkins & Orbell, 1998, p. 241) "Exercising regularly is more effective than changing one's diet or quitting smoking in preventing heart attacks and strokes." (Wurtele & Maddux, 1987, p. 457) "Exercising stimulates the growth of new blood vessels." (Wurtele & Maddux, 1987, p. 457)
	Self-Efficacy (SE)	"Sticking with a regular program of exercise would be very difficult for me to do." (Wurtele & Maddux, 1987, p. 457) "I am discouraged from performing BSE as I feel I do not know how." (Hodgkins & Orbell, 1998, p. 241) "I am capable of starting and continuing a regular program of exercise." (Wurtele & Maddux, 1987, p. 457) "Sticking with a regular program of exercise would be very difficult for me to do." (Wurtele & Maddux, 1987, p. 457)
	Response Costs (C)	"I would feel awkward examining my breasts." (Hodgkins & Orbell, 1998, p. 241)
PMT		"I intend to carry out a breast self-examination in the next month." (Hodgkins & Orbell, 1998, p. 241) "Within the next two weeks, I will begin a regular program of exercise." (Wurtele & Maddux, 1987, p. 457)

After carefully considering the phrasing and design of the questions listed in Table 2 above, questions were selected from the GSOS in order to represent the different PMT categories. To aid in consolidation, the sub-categories of perceived vulnerability and perceived severity were combined into the threat category. In addition, a source category was created to measure previous knowledge of and exposure to the topics of oyster processing and oyster-related illness, and a maladaptive category was created (in accordance with literature). The selected questions are listed in Table 3.

Most of the questions used in the PMT analysis are answered with either *yes* or *no* responses or a five point Likert scale. The variable *m1* was created to combine the follow-up questions that were linked to the initial *vv_worry* question. In other words, those who answered *no* to *vv_worry* were then asked four follow-up questions pertaining to why they answered *no*. Since these questions all concerned worry, they were summed (and a 1 was subtracted to account for the dummy variable) in order to create a new variable (*m1*) to cover the entire topic, allowing for the variable to measure a scale of worry from (1) *none* to (5) *high*.

Table 3: Survey Questions for PMT Modeling

Category Variable	+,-	GSOS Survey Question
Source ***(sourcePC1)***		
s1	+	"Do you recall seeing or hearing any news or information about safety or health issues concerning eating oysters in recent months?" (*yes* or *no*)
s2	+	"Have you ever had an illness caused by eating oysters?" (*yes* or *no*)
s3	+	"Have you ever eaten a post-harvest processed oyster" (*yes*, *no*, or *I don't know*)[5]
s4	-	"I know at least one person who has been infected with Vibrio vulnificus from eating raw oysters." (Likert scale with endpoints *strongly agree* to *strongly disagree*)
Threat Appraisal ***(threatPC1)***		
t1	-	"In general, thinking of risks to your personal health, do you consider eating oysters to be…" (Likert scale with endpoints *very unsafe* to *very safe*)
t2	+	"Now considering the _____ oyster meals you expect to eat over the next year, what do you think your chances are of getting sick from eating these meals? Do you think your chances of getting sick are…?" (Likert scale with endpoints *not likely at all* to *very likely*)[6]
t3	+	"I feel frightened about the subject of *Vibrio vulnificus*." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
t4	+	"*Vibrio vulnificus* is threatening to my personal safety and health." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
Coping Appraisal ***(copingPC1)***		
c1	+	"Oysters still in their shells can be processed by the producer to remove the risk of illness from eating them." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
c2	+	"Oysters take out of their shells can be processed by the producer to remove the risk of illness from eating them." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
c3	+	"Thorough cooking of oysters removes the risk of illness from eating them." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
c4	+	"I am capable of eating more cooked or PHP oysters to prevent illness caused by *Vibrio vulnificus*." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
c5	-	"Eating more cooked or PHP oysters will require a significant amount of effort." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
c6	+	"Eating post-harvest processed (PHP) oysters is an effective way to prevent illness caused by *Vibrio vulnificus*." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
Maladaptive Behavior ***(maladPC1)***		
m1	-	"*Vibrio vulnificus* is something to worry about when consuming oysters." (*yes* or *no*) "If I worry about getting *Vibrio vulnificus*, it will bother me too much." (dummy variable) "There's nothing I can really do about it." (dummy variable) "If I get *Vibrio vulnificus*, I can be cured." (dummy variable) "If I get *Vibrio vulnificus*, God will take care of me." (dummy variable)
m2	+	"If you eat raw oysters , you will get *Vibrio vulnificus* sooner or later." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
m3	-	"I try not to think about things like *Vibrio vulnificus*." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
m4	+	"I think the government should ban raw oysters when the risk of *Vibrio vulnificus* is high." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
PMT ***(PMTPC1)***		
p1	+	"I intend to reduce my alcohol consumption in order to make better decisions about preventing *Vibrio vulnificus*." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
p2	+	"I intend to eat more post-harvest processed (PHP) oysters in order to prevent *Vibrio vulnificus* in the future." (Likert scale with endpoints *strongly disagree* to *strongly agree*)
p3	+	"I intend to eat more cooked oysters in order to prevent Vibrio vulnificus in the future." (Likert scale with endpoints *strongly disagree* to *strongly agree*)

[5] *I don't know* responses were recoded as *no* to keep treat PHP awareness conservatively.
[6] Responses indicating (5) *I don't know* were dropped from the analysis.

Principal Component Analysis (PCA) was the method employed to assist in the creation of larger PMT variables in order to capture the individual elements of each PMT category into one variable. Principal Component Analysis assigns a weight to each observed variable and forms a linear combination of the variables, resulting in a principal component. This is done by combining a set of observed variables into a smaller set of artificial (or created) variables, therefore compensating for redundancy in the original set of variables and reducing the total number of variables to a more manageable quantity (SAS Corporation, 2011). The first principal component created computes the greatest variance in the data, and the second principal component captures the second largest amount, and so forth. Each principal component is uncorrelated with the previous one, by way of orthogonality (Jolliffe, 2002). Lastly, using PCA created variables facilitates the comparison of variables with differing response ranges and response directions. The variables are manipulated so that each resulting factor has a mean of zero and a standard deviation of one (SAS Corporation, 2011).

For example, using PCA the threat appraisal questions of *t1, t2, t3,* and *t4* were combined to form one threat appraisal variable, labeled *threatPC1.* This allowed the creation of a single variable for each of the five behavioral categories listed in Table 3. In this way we can directly evaluate each of the PMT categories and also compare them.

Because a single index for each category is desired, only the first principal component for each set of variables in a PMT category was used. The variables attributed to a particular principal component are also listed in Table 3. The column marked "+,-" indicates whether the variable contributed positively or negatively to the corresponding PMT variable that was created using PCA. Once these positive and negative relations were found, each one was compared to the literature to ensure that the resulting contribution was logical. For example, for the Threat Appraisal component, *t1* contributed negatively, while *t2* through *t4* contributed positively. This makes sense because participants who rate oysters to be highly safe would also believe that there chances of getting sick are lower, and would perhaps feel less threatened by *Vibrio vulnificus*. Descriptive statistics for the PMT categories are displayed below in Table 4.

Table 4: Descriptive Statistics for PMT Categories

Variable	N	Mean	Standard Deviation	Min	Max
sourcePC1	1015	0	1.15	-6.44	0.94
threatPC1	1015	0	1.38	-2.75	4.09
copingPC1	1015	0	1.31	-4.85	3.47
maladPC1	1015	0	1.26	-5.20	2.92
PMTPC1	1015	0	1.27	-3.38	3.47

Most of the variables included in the PCA procedure were Likert-scaled variables, as mentioned previously, and several were dummy variables. The descriptive statistics for these variables are listed in Table 5 (refer to Table 5 for a description of the questions). For all variables reported, there were 1015 usable observations. Respondents reported high mean scores for the source category variables *s1* through *s3*, indicating that the individuals had very little previous knowledge of oyster-related deaths or PHP methods. The mean of 1.86 for *s4* indicated that less than half of respondents know a person who has been infected with *Vibrio vulnificus*. The higher mean for threat appraisal variable, *t1*, is in accordance with the lower means for *t2* through *t4*, as the scale on the question was reversed. These *t*-variable means indicate that most respondents felt that oysters were safe to eat and that illness chances and fears were low. The average to above average means for the coping appraisal variables show that most individuals surveyed believe that oysters can be treated to remove illness risks, and that they are capable of eating more cooked or PHP treated oysters. The lower mean of 2.70 for *c5* corresponds with the response scale again being reversed, and indicates that respondents feel that a below average level of effort is required to eat more cooked or PHP oysters.

Each of the means for the maladaptive coping responses (*m1* through *m4*) hovered around the 3.00 mark, except for *m1* which had a mean of 0.18. This variable was the created worry variable, and indicates that respondents do not worry much about becoming infected with *Vibrio vulnificus*. The PMT variables are interesting, as they measured the intent of the respondents to change their behavior. If the means are ranked in ascending order, it could be said that survey participants would rather plan to eat more cooked oysters (*p3* mean of 3.41) than to plan to eat more PHP oysters (*p2* mean of 3.07) or plan to reduce their alcohol intake (*p1* mean of 2.28). This could imply that while the GSOS served to educate oyster consumers about PHP and *Vibrio vulnificus* risk, consumers are still more inclined to choose a cooked oyster meal over a PHP oyster meal.

Table 5: Descriptive Statistics for PMT Variables

Variable (see Table 3)	Survey Placement (of 170)	Mean	Standard Deviation	Min	Max
s1	39	1.76	0.42	1.00	2.00
s2	31	1.96	0.19	1.00	2.00
s3	111	1.92	0.28	1.00	2.00
s4	137	1.86	1.03	1.00	5.00
t1	30	3.78	1.01	1.00	5.00
t2	69	1.56	0.65	1.00	4.00
t3	134	2.82	1.10	1.00	5.00
t4	136	2.91	1.15	1.00	5.00
c1	36	3.00	1.02	1.00	5.00
c2	37	3.53	1.01	1.00	5.00
c3	38	4.09	0.89	1.00	5.00
c4	141	3.54	0.90	1.00	5.00
c5	142	2.70	1.00	1.00	5.00
c6	167	3.58	0.83	1.00	5.00
m1	121,124,125,126,127	0.18	0.56	0.00	4.00
m2	135	2.76	1.02	1.00	5.00
m3	138	3.12	1.01	1.00	5.00
m4	144	2.74	1.31	1.00	5.00
p1	139	2.28	1.03	1.00	5.00
p2	143	3.07	0.92	1.00	5.00
p3	168	3.41	1.08	1.00	5.00

The correlation matrix for the variables is presented in Table 6. As will be discussed in the Results & Discussion to follow, it would be useful to establish that the PMT modeling variables are exogenous, i.e., essentially fixed personal characteristics rather than evolving during the survey. In order to look for endogeneity of variables (i.e., a lack of correlation with variables that are provided during the survey) a correlation matrix of the principal components and the source treatments was procured. The correlation matrix also provides some insights into the relationships between variables and allows for us to check for problems of multicollinearity.

The source treatments were randomly assigned information treatments that were either in brochure or video form. Each treatment either had no source, had the ISSC (Interstate Shellfish Sanitation Conference) listed as the source, had the ASF (American

Shellfish Foundation, a fictitious source created for the GSOS) listed as the source, or had the FDA (Food & Drug Administration) as the source. Here is significant correlation between the different source types, which makes sense because the sources represent different origins for the information, yet each is a source of information. Since each individual received a treatment from one source, this correlation is to be expected. Nonetheless, there is no indication that the correlation is so great that it will create serious problems of multicollinearity.

All of the PC variables are correlated with *PMTPC1*. This also makes sense, as *PMTPC1* measures the intent of the individual to change behavior, and (per literature) is affected by the other PC variables. The *maladPC1* variable is correlated with both *sourcePC1* and *threatPC1*. This indicates that the less information a participant had about Vibrio-related deaths and PHP prior to the survey, the less likely he or she was to provide maladaptive responses (i.e., inevitability, worry). It also shows a high relationship between maladaptive coping and threat appraisal, meaning that the more threatened participants felt, the more likely they were to respond in avoidance (also in accordance with the literature). While several variables were shown to be correlated with WTP, each was correlated at less than the 0.05 level.

The correlation matrix of the key variables with the demographic variables is presented in Appendix B, Table 8. Overall, there are no correlations that are particularly noteworthy.

Table 6: Correlation Matrix for Source Treatments, PCs, & WTP

	brochure	*video*	*alt_video*[7]	*no_source*	*FDA*	*ISSC*	*ASF*	*sourcePC1*	*threatPC1*	*copingPC1*	*maladPC1*	*PMTPC1*	***WTP***
brochure	1.00	-0.67****	-0.40****	-0.06*	-0.02	0.12***	-0.02	-0.02	0.02	-0.02	0.03	-0.05	-0.05*
video		1.00	-0.41****	-0.01	-0.05	0.08**	-0.02	0.05	0.02	-0.03	-0.00	-0.04	-0.01
alt_video			1.00	0.08**	0.08**	-0.25****	0.05*	-0.04	-0.02	0.06*	-0.04	-0.00	0.08**
no_source				1.00	-0.38****	-0.31****	-0.35****	-0.02	0.10**	-0.04	0.07**	0.03	0.01
FDA					1.00	-0.31****	-0.36****	0.00	-0.02	0.00	-0.02	0.00	0.01
ISSC						1.00	-0.29****	-0.00	-0.03	-0.01	0.00	0.00	-0.02
ASF							1.00	0.02	-0.06*	0.05	-0.06*	-0.03	0.00
sourcePC1								1.00	-0.23****	-0.02	-0.13****	-0.17****	-0.08**
threatPC1									1.00	-0.05*	0.57****	0.38****	-0.09**
copingPC1										1.00	0.01	0.27****	0.09**
maladPC1											1.00	0.42****	-0.04
PMTPC1												1.00	0.06*
WTP													1.00

**** denotes significance of p-value≤.0001.
*** denotes significance of p-value≤.001.
** denotes significance of p-value≤.05.
* denotes significance of p-value≤.10.

[7] *alt_video* represents an alternate video used as a source treatment.

CHAPTER IV

RESULTS & DISCUSSION

This chapter contains the description and results for the four regression models used in the analysis. First the models are explained and results displayed for the analysis. Second, the relationship between the created PMT variables and the WTP variable are discussed, with specific attention given to the potential for endogeneity between variables. Lastly, and overall interpretation of the PMT variable results is given and further research possibilities are discussed.

Four separate Ordinary Least Squares (OLS) regression models were run to analyze the variables of interest in varying combinations. The first model, Model 1, includes the created PMT variables only. Model 2 includes the created PMT variables and all demographic variables sequestered from the GSOS instrument. The third model employs variables that are also used in the original research done prior to completion of the GSOS, and is labeled Model 3 (Morgan, Martin, & Huth, 2009). Essentially Model 3 attempts to replicate the original research as best as possible. Model 4 includes all variables used in each of the three previous models, and is aptly referred to as the "kitchen sink" model. The results of the OLS regression for each model are listed in Table 7.

Table 7: OLS Regression Results

	Model 1			Model 2			Model 3			Model 4		
	Coefficient		Std. Error	Coefficient		Std. Error	Coefficient		Std. Error	Coefficient		Std. Error
INTERCEPT	0.32	**	0.12	0.87		1.62	-0.02		0.74	1.39		1.64
source PC1	-0.32	**	0.11	-0.28	**	0.11				-0.25	**	0.11
threatPC1	-0.37	***	0.11	-0.32	**	0.11				-0.32	**	0.11
copingPC1	0.17	*	0.10	0.17	*	0.10				0.16		0.10
maladPC1	-0.05		0.12	-0.04		0.12				-0.02		0.12
PMTPC1	0.25	**	0.11	0.26	**	0.11				0.25	**	0.12
edu_lths				-0.86		0.50				-1.09		1.18
edu_hs				-0.96	**	0.34				-0.98	**	0.50
edu_c				-0.50		1.18				-0.46		0.34
age18to24				-0.30		0.56				-0.29		0.56
age25to34				0.04		0.45				0.09		0.45
age35to44				0.09		0.44				0.09		0.44
age45to54				0.61		0.44				0.62		0.44
age55to64				0.04		0.49				0.09		0.49
single				-0.86		1.66				-0.87		1.66
livpart				-1.10		1.70				-1.13		1.70
married				-1.20		1.64				-1.18		1.64
sep_div_wid				-0.97		1.68				-0.95		1.68
male				0.58	**	0.25	0.75	**	0.25	0.57	**	0.25
white				0.58		0.64	0.57		0.63	0.64		0.64
hispanic				0.79		0.80	0.67		0.80	0.82		0.81
black				0.63		0.79	0.74		0.78	0.70		0.80
asianpc				0.22		0.74	0.1		0.72	0.24		0.74
under10k				0.36		0.84	0.23		0.82	0.43		0.85
prevto19k				-0.38		0.71	-0.22		0.69	-0.24		0.71
prevto29k				0.18		0.55	0.15		0.54	0.20		0.55
prevto39k				0.04		0.56	-0.03		0.55	0.06		0.56
prevto49k				0.32		0.56	0.22		0.56	0.29		0.56
prevto74k				-0.13		0.48	-0.13		0.47	-0.10		0.48
prevto99k				-0.34		0.51	-0.33		0.50	-0.40		0.51
prevto149k				0.16		0.53	0.24		0.51	0.16		0.53
over150k				-0.47		0.68	-0.41		0.67	-0.48		0.68
no_inhouse				0.04		0.09	0.02		0.08	0.03		0.09
o_peryear							0.01	**	0.00	0.00		0.00
brochure							-0.91	**	0.34	-0.83	**	0.34
video							-0.72	**	0.34	-0.61	*	0.34
FDA							-0.01		0.32	-0.12		0.32
ISSC							0.04		0.36	-0.11		0.36
ASF							-0.07		0.33	-0.20		0.33

*** denotes significance of p-value≤.001.
** denotes significance of p-value≤.05.
* denotes significance of p-value≤.10.

For the most part, the regression results for each variable are consistent across all four OLS models. In Models 2 and 4 the *edu_hs* (high school education) variable is significant at the 0.05 level. In Models 2, 3, and 4 the *male* dummy variable is significant at the 0.05 level. The *brochure* and *video* variables are significant at the 0.05 level for Models 3, but the *video* variable is only significant at the 0.10 level in Model 4 (*brochure* remains significant at 0.05). The *o_peryear* variable, which is a continuous variable measuring the number of oyster meals consumed per year, is significant in the Huth Model (Model 3), but not in the Kitchen Sink Model (Model 4).

Huth's (2009) original model attempted to determine quantities of oysters consumed, while this research measures WTP. Still many of the independent variables included are similar, and so it is important to note similarities and differences in the results. The Huth research found significance with demographic variables including income, gender, race, and number in household. This study found significant results with only gender of those four variables. The Huth model also had a significant price variable and PHP premium variable, while this analysis did not include those variables. Of the source treatment variables the Huth model found significance with the brochure for the fictitious not-for-profit American Shellfish Foundation, while this study found significance with the brochure and video variables, but not with any specific origin of the information.

Created PMT Variables Analysis

The key focus of this study was to analyze the relationships between the created PMT variables and the created WTP variable, to determine the relationship between an individual's fear and his or her willingness-to-pay for safer oyster meals. Ideally, we would like to identify a causal relationship in which we could say that the PMT variables cause WTP. Unfortunately, the nature of the created PMT variables and the behavioral aspects of the relationship pose concerns about endogeneity. Since the variables used to form the PMT created variables are asked at differing times during the survey (See Table 5 from Chapter III), the concern is that some of the variables may be codetermined. One test of this would be to look again at the correlation matrices presented in Chapter III and Appendix B (Tables 6 and 8). If we found that the PMT variables were uncorrelated with treatment while our WTP variable is correlated, this would be strong evidence of exogeneity.

As seen in Tables 6 and 8, for some variables there is significant correlation between the created PMT variables. Arguably the most notable of these correlations is with the *PMTPC1* variable and the other created PMT variables. This correlation is understandable, as the *PMTPC1* variable explains the intent of the individual to change behavior, and can be a factor of the other variables (*sourcePC1*, *threatPC1*, *copingPC1*, and *maladPC1*). In addition, the *sourcePC1* variable shows correlation with several other PMT variables due to the fact that the information individuals have before participating in the GSOS may affect their perceptions of fear, ability to cope, and efficacy of treatment (PHP).

On the other hand, the source treatments administered to respondents during the survey in the form of videos and brochures showed weak, if any, correlation with the created PMT variables. Treatments with no source showed weak correlation with the *threatPC1* and the *maladPC1* variables. These results indicate that the source treatments overall had a very weak impact on the created PMT variables. The WTP variable is also weakly affected by the source treatments, as only 2 of the 6 source treatment factors show significance at 0.05 or less. These variables are *brochure* and *alt_video*, which represent methods of delivery of information and not actual agency sources. These results indicate that overall there is no strong support that the source treatments have an effect on any of the other factors, providing some evidence that the endogeneity may not be very severe.

In addition, we also see that the WTP variable exhibits only weak correlation with two of the seven treatments. This poses two obvious conclusions. The first is that the lack of correlation between treatment variables and the PMT variables might suggest that these are exogenous. The second is that WTP is also largely uncorrelated suggests that the treatments are generally ineffective in changing any attitudes towards oyster consumption as indicated in the psychologically-based PMT variables or the economically-based WTP measure. We cannot, therefore, reject the hypothesis that the PMT variables and the WTP variable are jointly determined; a causal relationship between the created PMT variables and WTP cannot be established.

The regression results exhibited in Table 7 indicate significant coefficients for several of the created PMT variables. Our prior hypothesis regarding *sourcePC1* was that it would be positively correlated with WTP – respondents with more information prior to the GSOS would tend to be willing to pay more for treatment. It turned out however that he *sourcePC1* variable coefficient ranges from -0.32 to -0.25, depending on the model. This means that an increase in the source information that an individual has prior to participating in the GSOS by one standard deviation would result in a decrease in WTP of roughly $0.32. This may seem surprising, but perhaps this can be attributed to those with higher initial information having a “cap” on what they are willing to pay for PHP, and since they already know about PHP or *Vibrio vulnificus*, they do not want to pay more for processing while those who initially do not have much information are more easily convinced to pay more for the PHP treatment.

The *threatPC1* variable coefficient is also significant, ranging from -0.37 to -0.32. In other words, an increase in the perceived severity and perceived magnitude of a noxious event (in this case, becoming infected with *Vibrio vulnificus*) by one standard deviation would correlate with a corresponding decrease in WTP for the PHP treatment by roughly $0.35 per oyster meal. The more threatened an individual feels, the less they are willing to pay for PHP and vice versa (again referring to correlation, not causation). Again, this is inconsistent with our prior hypothesis – one would expect that greater perceived risk would translate into greater WTP. This might be attributable to the fact that the risks that an individual faces when consuming oysters are self-determined. Individuals who make risky choices are to some extent revealing in their behavior a lack of WTP for safety.

The *copingPC1* variable is significant at the 0.10 level in Models 1 and 2, with coefficients ranging from 0.16 to 0.17. The *copingPC1* variable measures the individual’s perceived ability to adopt coping mechanisms like eating more cooked or PHP oyster meals and the individual’s confidence in the ability of cooking or processing to remove *Vibrio vulnificus*. A one standard deviation in this variable correlates with a $0.17 increase in consumer willingness-to-pay for the PHP treatment. Intuitively this makes sense, as those who believe both in the efficacy of the treatment and in their own self-efficacy are willing to pay more for the process.

In contrast, the *maladPC1* variable measures the maladaptive coping tendencies of the respondents. Interestingly, while evidence of positive coping attitudes is correlated with WTP, there is no significant correlation with *maladPC1* in any of the regressions. This is puzzling, but perhaps suggests that maladaptive behaviors are not as predictable as adaptive ones. It also explains why, as stated previously in Chapter II, many PMT researchers have chosen to omit the maladaptive response category from their studies.

The coefficients for the final created PMT variable, *PMTPC1*, are statistically significant at the 0.05 level, and range from 0.25 to 0.26. This shows that if individuals increase their intent to change behavior to protect themselves from *Vibrio vulnificus* infection by one standard deviation, their willingness-to-pay also increases by $0.25. Again, this is logical because those who want to protect themselves more are usually willing to pay for such protection.

Implications

Because of the potential for endogeneity we cannot draw causal implications, the results of the regressions still tell an interesting story. Overall, the PMT variables tend to be statistically significant. In Model 4, of the six variables that are significant, three are PMT variables. Lower initial information correlates with higher WTP. Lower perceived vulnerability and severity of becoming infected with *Vibrio vulnificus* correlates with higher WTP. This begs the question, "Why?" Perhaps other factors are influencing WTP. Perhaps consumers are looking for the process to be available for other friends and family with higher risk of *V.vulnificus* infection. It could be that, relative to individuals who partake in other "risky" behaviors, oyster consumers are ill advised of the risks and consequences of eating raw oysters.

The analysis also showed a correlation between high perceived efficacy and self-efficacy of the treatment with higher WTP. Higher intent to perform more adaptive (preventative) behaviors (like eating more processed or cooked oysters) also correlates with higher WTP. This could indicate an overall belief in the effectiveness of the PHP treatment, or that those who are willing to pay more for PHP are more risk averse. Either way, regardless of a substantial argument in favor of causality, the marketing and policy implications of these correlations are present. The protection against *V.vulnificus* and the efficacy and self-efficacy pertaining to oyster processing are valuable to oyster consumers.

Overall, we find significant correlation between some PMT variables and WTP. One interpretation of this result would be that the psychological and economic variables are essentially two measures of the same phenomenon. It might be argued that WTP for risk-reducing practices is a single measure that can be broken down into a variety of attitudinal and informational foundations. The individual's perceptions of threat, their willingness to adopt coping mechanisms, and their willingness to take protective measures all are significantly correlated with WTP. On the other hand, their maladaptive tendencies are not correlated with WTP. While our analysis is only a first attempt to relate the PMT approach to risk behavior and economic measures of WTP, we feel that it is definitely deserving of further analysis.

CHAPTER V

SUMMARY & CONCLUSION

This research has endeavored to combine the economic models of willingness-to-pay and contingent valuation with the psychological framework of the protection motivation theory model. This chapter will give a summary of the research presented, with specific attention given to concluding remarks and potential for further study.

Oyster consumers are commonly viewed as "risk takers." However, recent press highlights the bacteria *Vibrio vulnificus* as a previously little-known threat to raw seafood consumers. While the bacteria occurs naturally in estuarine waters, elevated levels of *V.vulnificus* during warmer months can prove fatal in nearly half of all of those infected, Those with serious liver diseases and immune-compromised systems are at a particular high risk of infection. Several post-harvest processing treatments, including cooking, can reduce the levels of *V. vulnificus* to undetectable levels, Proposed legislation by the United States FDA attempts to curtail the effects of the bacteria on raw seafood consumers by requiring the processing of all Gulf oysters sold raw during summer months.

Protection motivation theory encompasses the psychological study of how individuals' fears regarding a harmful event affect their intent to adopt behavior to protect themselves from such an event. The main components of PMT include the source component, the threat appraisal, the coping appraisal, maladaptive behavior, and protection motivation. This theory was applied to the concept of processing oysters to remove *Vibrio vulnificus* bacteria in raw oysters. Survey questions from an instrument implemented to 2,172 oysters consumers from 6 oyster producing states were selected to create aggregated PMT variables. Principal Component Analysis was used with these initial survey questions to result in the sourcePC1, threatPC1, copingPC1, maladPC1, and PMTPC1 variables. In addition, projected consumption information and randomly assigned price fluctuations were used to empirically calculate consumers' marginal willingness-to-pay for the processing of an oyster meal.

The next step in the analysis of the data was to regress the created PMT variables, along with specified demographic variables and randomly assigned source treatments, on the calculated MWTP for post-harvest processing. While the results from the four OLS models run indicate some potential for endogeneity between the created variables, this is to be expected, and is inherent to the psychological PMT framework. The results do indicate significant correlations between four of the five created PMT variables and MWTP, suggesting that there is a definable relationship between elements of an individual's fear of *V. vulnificus* infection and his or her willingness-to-pay for oyster processing. This tells an interesting story from a marketing standpoint, and further illustrates the need for research assessing the demand for PHP treatments and the cost-effectiveness of federally mandated processing-related changes to the Gulf oyster industry.

Further Research

It would be interesting to analyze if it is possible to identify the PMT variables in a fashion that makes them exogenous to the MWTP variable. To do this, a survey would need to be constructed with emphasis placed on the order of questions, so that the initial PMT components inherent to an individual (fear, vulnerability, self-efficacy) could be measured in advance of any manipulation via survey or information. In addition, a base price question could be added to the survey, to help to determine a suitable average oyster meal price among the surveyed respondents. This restructuring of the survey could prove to better measure the effects of PMT on consumer WTP for oyster processing. Such findings could support the education of at-risk raw seafood consumers to the dangers of such behavior. In the long run such research could also contribute to policy concerning the awareness of coastal water pollution reduction as a means of controlling levels of *V.vulnificus* in the water, to reduce risk of both consumption and wound-related infection.

In addition, further research involving the various types of PHP treatments is necessary to determine both the cost-effectiveness and the demand for each treatment. Choice modeling could offer a proven approach to assessing demand for individual treatments by creating profiles with assigned treatments and pricing. The results of such a study could assist the Gulf oyster industry in deciding which treatment process to employ, based on projected consumer demand.

Before policy is drafted requiring the processing of oysters, it is important to assess the effects of such legislature on oyster consumers and the oyster industry. Such a study would reduce the potential for wasted investment while assisting in the rebuilding of the recently weakened Gulf Coast oyster industry.

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APPENDIX A

NOMENCLATURE

ASF	American Shellfish Foundation
EVT	Expectancy-Value Theory
FDA	Food & Drug Administration
GSOS	Gulf State Oyster Survey
ISSC	Interstate Shellfish Sanitation Conference
NMFS	National Marine Fisheries Service
OLS	Ordinary Least Squares
PC	Principal Component
PCA	Principal Component Analysis
PHP	Post-Harvest Process
PMT	Protection Motivation Theory
USDA	United States Department of Agriculture
WTP	Willingness-to-Pay

APPENDIX B

Table 8: Correlation Matrix for Source Treatments, Demographic Variables, & WTP

	sourcePC1	*threatPC1*	*copingPC1*	*maladPC1*	*PMTPC1*	*gender*	*agecat*	*education*	*ethnicity*	*income*	*marital status*	*no_inhouse*	***WTP***
sourcePC1	1.00	-0.23****	-0.02	-0.13****	-0.17****	0.07**	-0.01	-0.05	-0.03	0.00	-0.01	-0.02	-0.08**
threatPC1		1.00	-0.05*	0.57****	0.38****	0.11***	-0.10***	-0.12****	0.13****	-0.03	-0.08**	0.06**	-0.09**
copingPC1			1.00	0.01	0.27****	0.01	-0.04	0.00	-0.01	0.00	-0.02	0.09**	0.09**
maladPC1				1.00	0.42****	0.12****	0.04	-0.11***	0.15****	-0.05	0.02	0.06**	-0.04
PMTPC1					1.00	0.04	-0.05*	-0.14****	0.13****	-0.11***	-0.05	0.13****	0.06*
gender						1.00	-0.05*	-0.16****	0.00	-0.05	0.03	0.04	-0.10**
agecat							1.00	0.02	-0.22****	0.08**	0.52****	-0.22****	0.02
education								1.00	0.02	0.29****	-0.02	-0.12****	0.08**
ethnicity									1.00	0.05	-0.18****	0.11***	-0.03
income										1.00	0.11***	0.09**	-0.01
marital status											1.00	0.01	0.00
no_inhouse												1.00	0.00
WTP													1.00

**** denotes significance of p-value≤.0001.
*** denotes significance of p-value≤.001.
** denotes significance of p-value≤.05.
* denotes significance of p-value≤.10

VITA

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