2016

Characteristics of United States Seafood Consumers

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Digital Object Identifier: http://dx.doi.org/10.13023/ETD.2016.084

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CHARACTERISTICS OF UNITED STATES SEAFOOD CONSUMERS

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
College of Agriculture, Food and Environment at the
University of Kentucky

By

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2016

ABSTRACT OF THESIS

CHARACTERISTICS OF UNITED STATES SEAFOOD CONSUMERS

In this thesis, I conducted an analysis of the consumption patterns associated with demographic and socio-economic characteristics, using Tobit and double-hurdle models. Data were collected for 11,574 households from the US Bureau of Labor Statistics for the year of 2014. Specific determinants included household size, age, income, gender, education, race, region, marital status, and whether the household lived in a coastal state. The results reveal that seafood expenditures are sequential decisions. Asian racial groups, households headed by married couples, a large number of members in households, higher income households, and households residing in the Atlantic and Gulf Coasts were variables that significantly impacted seafood expenditures.

KEYWORDS: Expenditure, Consumption, Fish and seafood, a Tobit model, a double-hurdle model

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April 26, 2016

CHARACTERISTICS OF UNITED STATES SEAFOOD CONSUMERS

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Dedicated to my mother --
Norah Mohammad Alhumaidan

ACKNOWLEDGMENTS

My sincere gratitude goes to my research advisor, Dr. Yuqing Zheng, for his valuable insights and suggestions. Special thanks to my advisory committee members, Dr. Michael Reed and Dr. Wuyang Hu, for their guidance and support during my thesis endeavor. Finally, my gratitude goes to my family, who has been praying for me and supporting me from the very beginning of my studies.

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CHAPTER 1 – INTRODUCTION

1.1. Context

In 1776, Adam Smith (2007) stated that all production was due to the role of consumption. He also argued that consumption is the mechanism which drives the producer to create goods and services. Thus, consumer research can be of great importance for producers by providing valuable information and tools for promotion of the product, with the ultimate goal being the eventual sale of the product. In general, demand for consumption is the largest component of a country's gross domestic product (GDP). Hence, consumption can be divided into three categories: durable, non-durable, and service goods. These categories primarily depend on the durability of the products satisfying the needs (e.g., cars are durable goods, food or clothing are non-durable goods, and entertainment is a service good) (Arnold, 2007, p. 125). Therefore, the consumption expenditures are major economic concepts that have been extensively studied by many other human sciences (e.g., business, political science, psychology, sociology, and geography) (Ivbulis et al., 2008). Mainly, a consumption function expresses consumer spending based on independent variables (e.g., income, wealth and socio-demographics) that affect the consumer's decision of whether or not to purchase an item, and then, the quantity to purchase (Friedman, 1957).

To contextualize, the Engel curve of expenditure states that a key determinant of consumption is the availability of income to purchase goods and services. In this way, when income increases, consumption also increases, although not proportionately. There are also non-income determinants of consumption. These include interest rates, consumer

confidence, wealth, taxes, and expectations concerning the future (Engel, 1857; Wessels, 2000, p. 130).

In the United States, as in most countries, the consumption of seafood products is considered to be an important part of food expenditures. By definition, seafood is any type of sea life consumed directly as food by humans, including, but not limited to, fish. In recent years, seafood has been found by numerous studies to be a healthy protein source. Seafood is also a good source of necessary fats, and Vitamins A and D (Crawford et al., 1989). Furthermore, it has been shown that a small amount of seafood has a positive influence on nutrition in the lower middle class when their diet consists primarily of animal protein (Delgado, 2003, p. 16). From a health perspective, seafood may lower the risk of heart disease, and seafood containing omega-3 fatty acids may improve the quality of life (Foran et al., 2003). Overall, it can be argued that seafood consumption contributes to good health; hence, an increase in seafood consumption would fit the healthy eating trend (Kissinger et al., 2010).

Many studies and experiments have studied consumer preferences for seafood products. Studies have found that consumers have changed their preferences from red meat (e.g., beef) to seafood or other white-meat products due to non-socio-economic factors (Mangen & Burrell, 2001; Rickertsen, 1996). Moschini (1991) examined the ratio of white-meat products (e.g., chicken and seafood) and found that there is a significant consumption bias against red meat (e.g., beef and lamb). USDA (2015) and Raatz et al. (2013) pointed out that Americans do not consume the recommended amount of seafood, which is about 8 ounces weekly. This can be compared to the current consumption of 4.5 ounces per week by the average American household, which represents a 44% deficit

(USDA, 2015; National Marine Fisheries Service (NMFS), 2015). In recent years, global demand for seafood around the world has been growing steadily, and the global seafood market has been expanding rapidly due to major developments in the supply chain and international trade (Delgado et al., 1997; Asche & Zhang, 2013; Tveterås et al., 2012). However, in the US, the demand for seafood in the last few years has been relatively decreasing (NMFS, 2015). This study seeks to understand what drives seafood consumption in the United States, and assess whether relevant demographic and socio-economic determinants are behind the observed decrease in consumption of seafood products.

Moreover, the Food and Agriculture Organization of the United Nations (FAO) published a report in 2014 on the state of the world's fisheries, and found that the United States is the third-largest seafood consumer in the world, after China and Japan. For instance, the World Bank reported that, in 2030, 70% of the global consumption will be from Asia regions. Moreover, only 38% of the seafood consumed will be coming from wild-caught seafood, while 62 % will be farm-raised. In addition, an estimated 37% of global seafood produced will be from China while 38% will be consumed by Chinese consumers (Msangi et al., 2013)

In the US, the level of food consumption varies according to geographical region, income, race, age, gender, education level, and marital status (Singh et al., 2014; Daniel et al., 2011; Blisard et al., 2002; Yen & Huang 1996). The current level of per capita consumption might be reflected by determinants that affect the households' expenditure pattern on seafood products. This thesis will focus on the consumption patterns associated with consumer demographic and socio-economic characteristics that influence

consumer seafood expenditures. Given the nature of seafood products compared to other food products, it will be considered that decisions made by households might affect the participation decision and the quantity spent on seafood products. With this objective, this thesis may serve as a tool to aid policy makers and people in the aquaculture sector to devise strategies or advertise plans for seafood products. The next section of this chapter will develop the research questions and the hypothesis tested in this thesis.

1.2. Objectives, research questions and hypotheses

The overall objective of this thesis is to identify the factors explaining seafood consumption in the US, in order to devise strategies to reverse the declining trend in consumption. Historically, the development of the seafood industry has been driven by rising incomes and urbanization. This development has also been facilitated by a strong expansion in seafood production and more efficient distribution channels. The rapid increase in the US population has been mirrored in the demand for food to rise hastily. On the other hand, seafood consumption per capita has steadily decreased over the past ten years. Also, various demographic and socio-economic characteristics play important roles in each household's decision to switch to seafood consumption, or, to expand their existing consumption. Thus, these factors might have strong explanatory power on what to consume and how much to spend on seafood products. Two main hypotheses are formulated and tested to reach the objective in this thesis in relation to US seafood consumption.

Hypothesis I*: Household decisions of participation in the seafood market (whether to consume) and of amount of expenditure on seafood (how much to consume) are sequentially determined rather than jointly determined.*

The first hypothesis is to test whether the household decision to consume seafood and the amount of their expenditure are jointly, or sequentially, determined. The study will consider various econometric approaches for a broad and robust result. First, it uses the Tobit model, focusing on household expenditures on seafood. Then, the Tobit is compared to the double-hurdle model that accounts for the possibility that seafood consumption might be a sequential decision with a household deciding whether to consume or not, and then, determining how much to spend.

Hypothesis II*: Demographic and socio-economic factors (e.g., age, family size, gender, region, income, education level, race, marital status, gender, and proximity to coastal area) are significant determinants of the household's decision to participate in the seafood and the decision of how much to spend on seafood.*

The second hypothesis aims to identify the demographic and socio-economic factors that explain the decision of US consumers to purchase and consume various types of seafood products. In particular, the study tests whether the size, income, and race of the household were significantly associated with the decision to consume seafood and the amount of money spent on seafood. The analysis also explores whether the gender, marital status, education level, and age of the head of the household was positively or negatively correlated with seafood consumption. The analysis extends to assess the effect

of geographical variables (e.g., region and coastal areas) on seafood consumption. It is presumed that households that reside in coastal states will have a different expenditure pattern than those living in non-coastal states. This may affect the decision to consume seafood or how much to spend on these products. The results will shed light on the motives of household decisions to consume seafood, and what factors explain the expenditures on these products. The results will be particularly useful for the seafood industry, including producers and distributors, as it will inform them about the profile of seafood consumers. As a result, they can guide their decisions and investments to target these marketplaces.

This thesis is organized into five chapters. Chapter 1 explains the research context within which the research questions and objectives are addressed. Chapter 2 presents an overview of seafood consumption and production in the US, including a literature review to support the research questions, the selection of empirical models, and the selected variables. Chapter 2 also discusses relevant studies based on the same dataset and different datasets. The methods and data used to investigate the five research questions will be explained in Chapter 3. Chapter 4 reports the results of the empirical models. Finally, the conclusion of this study is reported in Chapter 5. This chapter also addresses some implications of the results for the seafood industry and suggestions for future research.

CHAPTER 2 – BACKGROUND AND LITERATURE REVIEW

2.1. Seafood Consumption, Production and Trade

Seafood consumption and production over the past few decades have changed around the world. It has also attracted the attention of food economists. On the production side, global seafood production is growing rapidly (i.e., 60 million tons in 1970 to 160 million tons in 2012). This is interpreted as a consequence of increases in aquaculture production. World seafood consumption rose from an average of 35.7 pounds in 2004 to 41.6 pounds per capita in 2012; this was an increase of 16.5% (FAO, 2006; 2014). In addition, total world exports of seafood increased rapidly; from 2004 to 2012, it increased by 80.5% to US$129.1 billion. World imports of seafood reached US$129.4 billion in 2012, a 72.5% increase over the last decade, as compared with 2004 (FAO, 2006; 2014). The surge in the popularity of seafood products has generated numerous sellers in the marketplace

Population growth is an indicator for increasing the level of consumption in food chain. Even though the population of the US has increased from 292.8 million in 2004 to 320 million in 2014, the seafood demand has decreased for the past ten years (U.S. Census Bureau, 2015). The US is ranked as the fifteenth seafood producer in the world. It had a 0.6% of the total production of seafood in 2014 (FAO, 2014). Based on the above knowledge, it seems that population number is not a mechanism for food consumption that might affect the current level of seafood demand. Therefore, the current level in seafood consumption by the US households might be determined by other factors.

Seafood consumption depends on the availability of disposable income, as it is considered a costly food around the globe. Considering that the income level per household influences the demand for certain kind of food, the median income of US

households in 2014 was $53,657: a decrease of 3.4% since 2004 (U.S. Census Bureau, 2015). In addition to this, total expenditures on seafood accounted for $91.7 billion, which can be divided into $61.4 billion for dining out and $29.9 billion valued for household consumption (NMFS, 2015). In accordance with the higher prices of seafood in the US compared to other protein sources, income levels are found to be directly affecting the consumption level of seafood. For instance, Drewnowski and Specter (2004) pointed out that households with higher incomes can consume seafood more often than those having a lower income. Moreover, households with lower levels of income may consume seafood in their meals, but their consumption level is mostly periodic. Besides, they spend money on seafood for special occasions, and thus, seafood purchases constitute a small portion of their total income. For these reasons, seafood is considered to be a luxury item for many American consumers.

Despite the previous finding, Tonsor & Marsh (2007) state that determinants other than price and income strongly influence the consumption of meat and seafood. Accordingly, this rise in income levels in the past ten years has exhibited the total expenditure and consumption levels of the US household, which show a decrease in the spending rate on seafood products.

From 1990 to 1995, the annual per capita seafood consumption by American households was constant over time and hovered at 15 pounds. After this period of stability, seafood consumption rose, peaking at the highest level of seafood consumption in 2004 at 16.6 pounds per capita. However, despite the global demand for seafood increasing, the per capita US consumption of seafood has gradually decreased, from 16.6 pounds annually in 2004 to 14.6 pounds in 2014 (Figure 2.1).

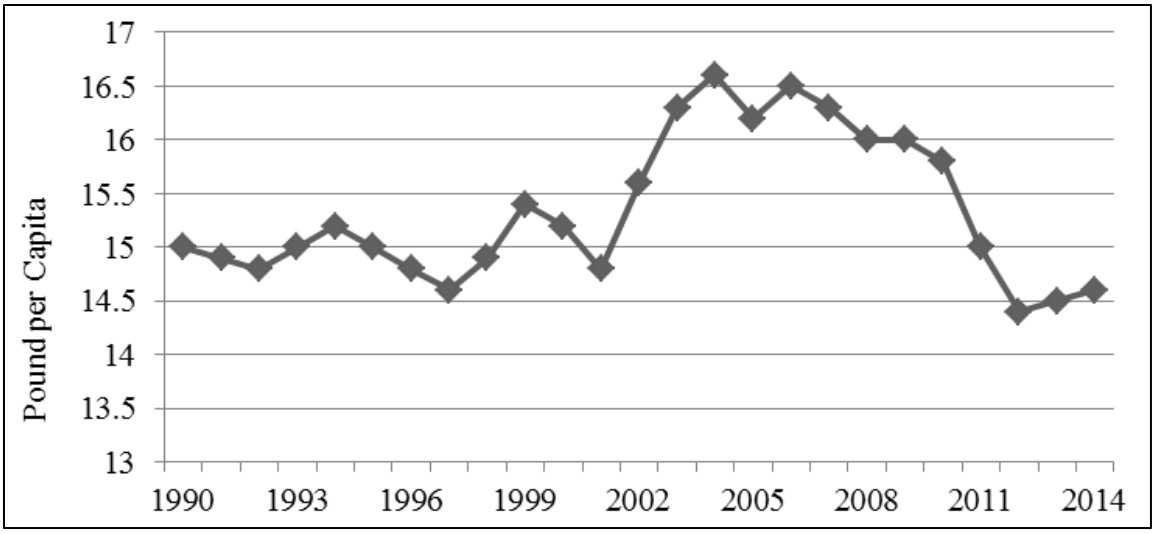

Figure 2.1: The Consumption Level of Seafood Products 1990-2014 (NMFS, 2014)

To be more precise regarding the decrease since 2004, as Figure 2.2 indicates, the drop in consumption levels is due to a decline in the consumption of fresh and frozen seafood, and resulted in a reduction of 0.9 pounds (U.S. Census Bureau, 2015; NMFS, 2015).

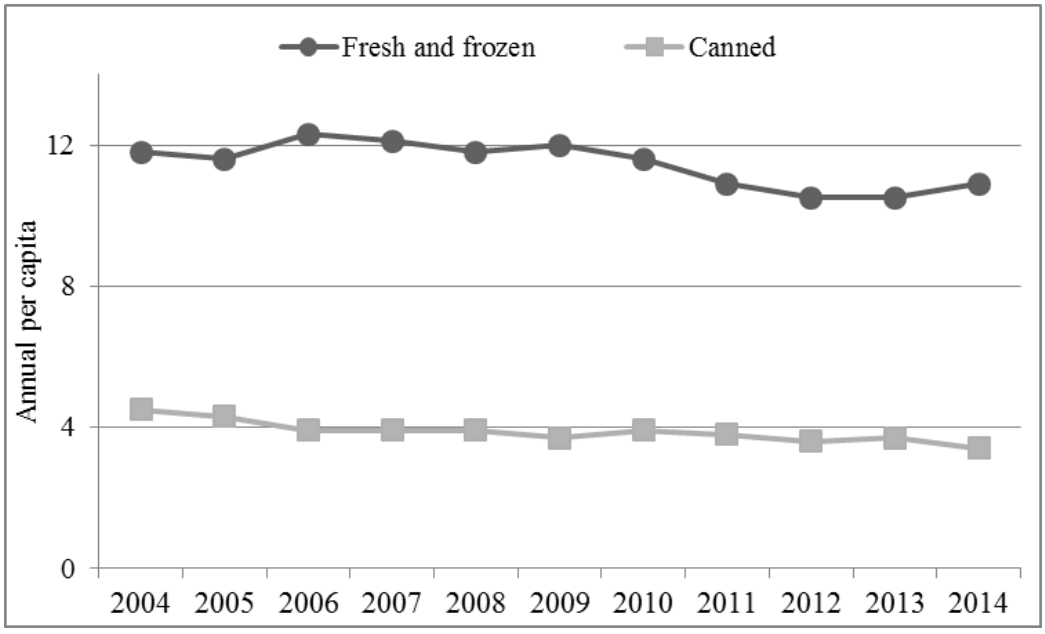

Figure 2.2: The consumption of fresh and frozen and canned seafood products in the US 2004-2014

Figure 2.3 illustrates forty-four years of time series data, providing the current best estimates for the imports and exports of seafood products. In the US, imports and

exports of seafood products have been dramatically increasing since 1970. Upward trends were recorded in 2014, regarding the importing and exporting of seafood products (including fresh and frozen shrimp, salmon, tuna fillets, steaks, canned products, and caviar), peaking at 2.5 and 1.5 million metric tons, respectively. Furthermore, Figure 2.3 illustrates an increase in the imports of seafood products in the US over time; this was valued at $20.2 billion in 2014, which was 78.8% higher than it was in 2004. In contrast, the exported products (including salmon, lobster, surimi, cured caviar and roe) were valued at $5.3 billion in 2014, which was 56.76% higher than they were in 2004 (NMFS, 2015). This information expresses the current level of US imports and exports, which appear to be increasing for the seafood industry, creating more conflict between the previous and present levels of consumption.

Figure 2.3: Imports and Exports of Fishery Products 1970-2014 (NMFS, 2015)

2.2. Literature Review

The literature review is organized into four general parts. The first part explores the relevant studies from the US, based on the demand for seafood, using different datasets and methods. The second part represents an overview of the usage of the Consumer Expenditure Survey (CE), provided from early and recent studies. Finally, the third and fourth parts offer insight into the applications discussed in the selection of empirical models based on studies that have used the Tobit model and the double-hurdle model.

2.2.1. Previous studies on seafood demand

The demand for seafood has grown substantially across the globe (Delgado et al., 1997; Asche & Zhang, 2013; Tveterås et al., 2012). As a result, an extensive amount of chronological research has been conducted in the US (Bell, 1968; Tsoa et al., 1982; Bell, 1986; Anderson and Wilen, 1986; Lin et al., 1988; Cheng and Capps, 1988; Hermann and Lin, 1988; DeVoretz and Salvanes, 1993; Hermann, 1993; Wallström and Wessells, 1995; Greenberg et al., 1995; Zidack et al., 1992; Kinnucan and Thomas, 1997; Kinnucan and Miao, 1999) (Appendix 1). To offer insight into seafood consumption patterns and reveal the remarkable aspects and determinants of the demand for seafood products, extensive recent studies, especially in the US, are discussed in this section.

The included studies have looked at seafood demand from many different angles and have covered a wide variety of seafood products. One strand of the literature considers the effects of imported seafood on domestic demand. In one study, Lee and Kennedy (2010) examined the impact of imported seafood on domestic catfish demand and found that imported salmon, tuna, and shrimp negatively affected domestic catfish

demand. On the other hand, imported catfish, tilapia, and trout had no effect on domestic catfish demand. The theory could be that imported seafood might affect domestic demand due to the increased cost of imports products.

In later studies, Asche and Zhang (2013) measured the effect of structural changes on imported seafood demand and found that price flexibility was intertemporal. Also, this possibly agrees with the theory that the globalization of seafood products might decrease the current price of seafood products over time. Further concerned with price elasticity, Chidmi et al. (2012) studied the demand for six species of imported seafood: catfish, crawfish, clams, shrimp, tilapia, and salmon. They observed that the demand for catfish, crawfish, clams, and salmon was elastic, but the demand for shrimp and tilapia was inelastic. In addition, they found that promotional activities could positively impact the demand of imported shrimp, tilapia, and salmon. In their results, they indicated that American consumer preferences were toward imported seafood rather than domestic catfish. In general knowledge, the higher prices of imported seafood may prevent some consumers from purchasing it frequently. However, if the domestic seafood were more desirable, perhaps the demand for seafood would be affected in an increased way.

Similarly, imported seafood such as frozen catfish affects consumer preferences into fresh domestic catfish. Muhammad & Hanson (2009) discussed the preferences of American consumers on imported fish, and indicated that imported seafood was likely to affect the demand for domestic frozen catfish. This literature suggests that there is a large amount of variation in imported seafood demand and its effect on the purchases of domestic products. This is an indicator that American consumers are not provided with

the promotion of fresh domestic seafood, which possibly leads to a reduction in purchasing seafood products.

The next strand of the literature review concerns the effect of income and price elasticities. An introductory seafood study in 1968 focused on the specific determinants that impact seafood consumption. Bell (1968) analyzed seven classes of seafood (sea scallops, yellowtail, large haddock, small haddock, cod, ocean perch, and whiting) from monthly data in the Northeast region of the US and found that the demand for six of the seven species of seafood (except for small haddock) were impacted by the income level; demand for all seven were price elastic. Likewise, Gallet (2009) examined the demand for seafood using a meta-analysis of combined data from 168 studies. This finding indicated that the US own-price elasticity of seafood demand was elastic, as compared to other countries. In addition, Capps (1982) observed that the price of seafood was positively correlated with households' expenditures on seafood. With this result, the income and price elasticities reveal a possible connection to purchasing trends of seafood products.

This strand of the literature review investigated the socio-economic and demographic determinants of the consumption of seafood products. Taking finfish and shellfish into consideration, Cheng & Capps (1988) indicated that expenditures are significantly influenced by the income and the number of members of the household for finfish and shellfish. Moreover, Capps & Lambregts (1991) found positive own-advertising impacts for finfish and shellfish, and an elastic demand for these species (not for oysters). Furthermore, Sing et al. (2014) observed that the seasonal demand for finfish is unitary elastic. Yen & Huang (1996) found that the demand for finfish is influenced by

price, purchase frequency, region, age, race, and marital status. Davis et al. (2007) showed that white and Hispanic households spent less on freshwater finfish compared to black and Asian households. The previous studies suggest that each household has a different expenditure pattern than other households in terms of the price of the product, income, race, household size, age, and region toward finfish and shellfish.

Socio-economic and demographic determinants also influence the purchasing decisions in home or dining out consumption. Nayga & Capps (1995) showed that the likelihood that households will consume seafood at-home and away-from-home is generally influenced by the geographical region, employment, diet status, household size, age, income, urbanization, and race. It was observed that socio-economic and demographic determinants have an impact on seafood spending.

Furthermore, most seafood demand studies take into account the impact of household income. Several studies indicated that income was likely to influence household seafood demand. Davis et al. (2008), Wan & Hu (2012), and McDowell et al. (1997) investigated the effect of income level on food purchases. Davis et al. (2008) observed that the expenditure elasticities among income groups were substantially different. They realized that high-income households spent more on seafood than low-income households. Blisard et al. (2002) and Wan & Hu (2012) found that consumers with high incomes consumed more seafood. McDowell et al. (1997) found that greater income inequality led to spending more on dining out. Previous studies imply that higher income households positively affect the demand for seafood.

Researchers have also investigated the variation of race on household seafood demand. García-Jiménez & Mishra (2011) found that Caucasian households spent less on

seafood and poultry than Hispanic households. Davis et al. (2007) indicated that Hispanic and white households consume less than black and Asian on fresh domestic seafood. Lin et al. (2006) found that black households spent more on seafood products while dining out; Asians, on the other hand, spent more on seafood products for home consumption and eating out, as compared to white households.

Moreover, Blisard et al. (2002), Capps (1982) and Wan & Hu (2012) showed that race appeared to have an important effect on the level of seafood consumption. Singh et al. (2014) pointed out that Asian and African American consumers considered tilapia a staple product. Shirley (2006) studied expenditure patterns of Asian households and found that Asian households reported an increase in the consumption of seafood products. Paulin (2001) found that Central and South Americans spent less on seafood than Cubans. The previous studies have provided evidence that the impact on seafood consumption is different among race groups. In contrast, Diaz-Valenzuela et al. (2008) observed that demographic variables do not necessarily affect Hispanic household spending on seafood. The observation is that race and ethnicity may play a large part in seafood consumption.

Another set of determinants, which were evaluated in the literature review, looked at the impacts of gender and education on the expenditure on seafood. Burger (2000) indicated that gender did not necessarily impact the consumption level of seafood. Furthermore, she found that women ate less seafood than men. She also found that 9% of the men she interviewed would change their eating patterns towards less seafood when their wives became pregnant. Daniel et al. (2011) found that women were expected to eat less seafood than men due to the general tendency of women to consume less protein than

men. Similarly, Lin et al. (2006) illustrated that women spent less on seafood products than men and that unmarried women consumed more seafood than married women. In addition to marital status, Yen & Huang (1996) stated that unmarried consumers tend to spend more on seafood products than married consumers. Moreover, Miranda et al. (2011) and Lando et al. (2012) observed that pregnant women tend to consume less seafood due to worries about other health concerns.

Seafood consumption can also be related to the education level. Blisard et al. (2002) indicated that households with more educated heads were more likely to increase their consumption of seafood products. Furthermore, Daniel et al. (2011) indicated that highly educated consumers would consume seafood after some intervals, while less educated consumers would prefer to consume seafood whenever they would find it easily. McDowell et al. (1997) found that the education level did not necessarily affect the expenditures in relation to food patterns. It is observed that perhaps education level is a weak indicator among households' demographics. This previous literature provided a broader frame of results based on the impact of gender and education on the household consumption of seafood. Of interest to this study is the examination of whether participation in the seafood market or the quantity consumed is different in households headed by different genders and levels of education.

It is an important realization that the there is a link between the way in which geographical factors affect the household's expenditures on food, particularly seafood products in the US. Lin et al. (2006) found that households located in the Midwest spent less on seafood than households located in the northeast; households located in the south and west spent more on seafood products for home consumption than households located

in the northeast. This might show an evidence of the density of population in the Northeast, which is greater than any other area in the US. On the other hand, Diaz-Valenzuela et al. (2008) found that households located in the Northeast increased their consumption of seafood, but this is limited to the Hispanic population. Taking into consideration specific kind of seafood products, Davis et al. (2007) found that households that reside in the east spend more on shrimp and canned tuna than those on west. In contrast, western households spend more on saltwater finfish. Also, central households spend less on canned tuna. In addition to this, Singh et al. (2014) and Capps (1982) indicated that geography positively impacts the demand for seafood, showing that consumers located in the mountain regions, which have an abundance of freshwater sources, consider catfish as a staple food; they also consider salmon as a staple food when its price is low.

Furthermore, the US geography also has access to seaports or lake ports on every side; that is in the east, west, south, and access to the Great Lakes from the north. This proximity to sea and lake ports allows easy availability of seafood items from all over the world. The effect of coastal states is also worth special notice. Studies have been done on seafood consumption in coastal areas in different countries. Recent studies have revealed that the level of global seafood consumption was likely to increase according to the households residing near the coasts of other countries (Moya, 2004; Da Costa et al., 2005; Bemrah et al., 2009). Another important factor this study considers is whether their members grew up in coastal areas (Wan & Hu, 2012). At this point of this research, a key limitation of these recent studies, especially in the US, is that there is a lack of studies investigated the demand for seafood for households residing in coastal areas. Thus,

coastal areas might influence the participation decisions in the seafood market, and also reflect the level of seafood expenditure. Households that reside in coastal states have a different expenditure pattern than those who live in non-coastal states. Most of the studies focused on the impact of common household's determinants that affect the expenditure. A number of studies examine the individual consumption of seafood focusing on a specific demographic or specific seafood product. Therefore, this study will analyze the household level of expenditure on seafood from recent data. In addition, this study considers the factor of US coastal states to determine whether coastal states have a significant effect and a link on seafood consumption.

2.2.2. Relevant studies on the Consumer Expenditure Survey (CE) data

A variety of studies have employed Consumer Expenditure Surveys (CE) for durable and non-durable goods to examine household food expenditure patterns, and to observe the variations in household characteristics. Each of the following study utilized this CE data in order to study a different kind of seafood products. Capps (1982) examined the demand for seafood products from the CE data of 9,066 households between 1972 and 1974 using the quadratic expenditure system. Shimshack et al. (2007) used the CE data for seafood consumption from 1999-2002 using both parametric and non-parametric procedures to discuss consumer responses to the US Food and Drug Administration (FDA) advisory. The data used in these previous studies allows observing the household expenditure on seafood products.

A number of studies employed CE data to examine the spending habits of household's seafood consumption. Diaz-Valenzuela et al. (2008) investigated the determinants that impact the demand for food eaten at home, including seafood, among

Hispanic consumers obtained from the 2005 CE data. Additionally, CE data aids with the analysis of gender as a determinant of household expenditures. Kaushal & Gao (2011) used a multivariate analysis of US households that were headed by low-educated single mothers using 1994 to 2004 CE. For the 1990-2003 CE, Ziol-Guest et al. (2006) investigated the differences in food consumption between households headed by married and single-parent families. Similarly, Kroshus (2008) used the 2004 CE data to examine gender and marital status on commercially prepared food expenditures. Jang, Ham, and Hong (2007) estimated senior household expenditures on the FAFH by using the CE. In the previous literature, CE data received a great deal of attention, illustrating the importance of using this type of dataset to represent national level consumption. The survey utilizes a diary survey and an interview survey to glean the measurements of households which repeatedly purchase the same product. Focusing on the household level of consumption, this study will construct a recent nationally-representative data to analyze the expenditure on seafood products.

2.2.3. Relevant studies using the double-hurdle model

The double-hurdle model was proposed by Cragg (1971). It has been employed, especially in cross-sectional studies, to handle censored dependent variables, including household consumptions. This approach has received considerable attention in many studies (Jones, 1989; Blaylock & Blisard, 1992; Yen, 1993; Blaylock & Blisard, 1993; Yen, 1994; Burton et al., 1996; Dong & Gould, 1999; Jang, Ham, and Hong, 2007). Currently, few studies have applied the double-hurdle approach in the seafood industry. An early study on seafood products applying the double-hurdle model was presented in Yen & Huang (1996). In their study, the inverse hyperbolic sine transformation (IHS) of

the dependent variable was employed to account for the non-normality and heteroskedasticity of the error terms. Their findings indicate support for applying the double-hurdle model on seafood expenditures since there is a distinguishable difference between the participation decision in the seafood market and the expenditure decision.

More recently, Wan & Hu (2012) observed the at-home consumption of seafood and applied the double-hurdle model on data from the Seafood Preferences Survey conducted in Kentucky. Their results reveal that the double-hurdle model seems to be more efficient than the Tobit and Heckman approaches. Their finding aids in understanding the usage of the double-hurdle approach in this study. Several studies applied the Cragg (1971) approach to different areas of the food industry beyond seafood products. Blisard & Blaylock (1992) conducted the double-hurdle model on the effectiveness of cheese advertisements using time-series data. In their estimates, they observed that generic advertising was proven to be efficient in increasing the number of consumers participating in the market. Similarly, Dong et al. (2004) analyzed the generic advertising effect on the consumption of fluid milk from a panel dataset consisting of 1,320 households. Their analysis of the double-hurdle model approach indicated that there was a positive impact of generic advertising and temporal dependence on fluid milk.

Moreover, using the double-hurdle model has been widely beneficial in considering sequential decisions for additional non-seafood products. For instance, Yen et al. (1996) employed the IHS approach and focused their research on the effects of demographic factors and health concerns on egg consumption. Their results suggest that health concerns negatively affect the demand for eggs.

2.2.4. Relevant studies using the Tobit model

The Tobit model was proposed by Tobin (1958) in 1958. It has been used to analyze the demand for household foods. Numerous studies food expenditure studies employed the Tobit model to account for zero consumption for a variety of food products (Stewart & Blisard, 2008; Shirley, 2006; Kaushal & Gao, 2011; Haines et al., 1988; Paulin, 2001; McDowell et al., 1997; Gifford and Bernard, 2006). One of these studies, Stewart & Blisard (2008), investigated the demand for fresh vegetables in the US from the CE using the Tobit model and censored the least absolute deviations estimator. Moreover, Gifford and Bernard (2006) used the Tobit model on the preference and consumer behavior for organic food based on grocery store data.

The Tobit model has been effective in the analysis of racial demographic influence on food spending. A recent study by Shirley (2006) examined the expenditure patterns of Asian households from the 2003 CE with an Ordinary Least Squares (OLS), Heckman two-stage estimation procedure, and the Tobit model. Haines et al. (1988) employed the Tobit technique and a two-step analysis on food expenditures using two samples of data. They concluded that the Tobit model was efficient in explaining the household decision, while the two-step analysis examined both the decision and how much the food the households consumed. In addition, Paulin (2001) applied the Tobit model on expenditure patterns of Hispanic households. McDowell et al. (1997) employed a univariate analysis and the Tobit model to examine the determinant of income class over food purchases.

The most recent available studies have employed several empirical models beyond the Tobit model and double-hurdle model to study the demand for seafood. These

models include an Almost ideal demand system model (Tonsor & Marsh, 2007; Chidmi et al., 2012; Asche and Zhang, 2013; Singh et al., 2014), a Heckman (1979) two-step approach (Shirley, 2006; Davis et al., 2007; Davis et al., 2008; Diaz-Valenzuela et al., 2008), and other methodologies (Burger, 2000; Burger, 2002; Lin et al., 2006; Gallet, 2009; Muhammad & Hanson, 2009).

Most of the studies focused on the impact of an individual expenditure on certain products based on their natures, such as cigarettes and alcohol, by employing the double-hurdle approach in their analysis. Focusing on the level of household's consumption of seafood products, the Tobit model and the double-hurdle model are considered to account for the possibility that the demand for seafood might be sequential decisions with households in which they decide first to participate in the market, and second, determine the quantity to consume.

CHAPTER 3 – METHODS AND DATA

3.1. Data

The database used in this thesis is from the 2014 Consumer Expenditure Survey (CE), conducted by the US Bureau of Labor Statistics (BLS). The CE is representative of the total non-institutionalized population of the US. The survey was designed to gather detailed data on income, expenditures, and consumer unit characteristics. Additionally, it measures the number of repeated households' purchase of the same product frequently, providing two elements: the diary survey and the interview survey.

The diary survey, which is adopted in this thesis, provides expenditure data for items purchased each day by households for two consecutive 1-week periods over all 52 weeks of the year. Through the first visit by the Census Bureau interviewer, participating households started to record all expenses on products in the diary survey during the first week. Then, in the second week, interviewer received the first diary, and distributed a second diary to the household to record the purchases for the second week. This component represents data concerning actual food expenditure in-home and away from home, plus auxiliary beverages, tobacco products, personal care products, and nonprescription medicines and supplies.

In this thesis, the diary survey has been utilized for a period of 12 months for analysis in order to understand, in greater detail, US seafood consumption that is affected by the demographic and socio-economic characteristics of the households. The original sample size was 13,305 households. After cleaning the data and omitting certain households with missing information, the final sample size included in the analysis is 11,574 observations.

3.2. Variables selection and descriptive statistics

The dependent variable in the models is the total household expenditure on seafood products, defined as canned, fresh, or frozen finfish and shellfish. The size of the household, the income, and race are included in the analysis to account for differences in seafood consumption in terms of the decision to consume seafood, and the amount of money spent. Additionally, the gender, marital status, education level, and age of the head of the household are included to determine whether these variables are positively or negatively correlated with seafood consumption.

The analysis also considers the influence of the varied geographical regions, in which the household resides (West, Northeast, Midwest, and South). In addition, the impact of the coastal states is worth special notice regarding the demand for seafood for households living in coastal areas. Households that reside in coastal states might have a different expenditure pattern on aquaculture products versus those living in non-coastal states. Thus, coastal areas might influence the level of seafood consumption and the participation decision in the seafood market. As a consequence, the region of the households in areas such as the Atlantic Coast, the Great Lakes, the Pacific Coast, and the Gulf Coast are likely to suggest whether significant differences exist in the decision to consume seafood, or, on how much to spend on these products.

Table 3.1: Definitions of the Variables in the Analysis. (N=11,574)

Dependent variable		**Abbreviations**
Seafood	Household weekly expenditures on seafood.	**SEAFOOD**
Explanatory variables		
Family Size	Number of household members; continuous variable.	**FAM_SIZE**
Age	Age of the household's head; continuous variable.	**AGE**
Income	Income class of household based on income before taxes; Dummy variable.	
Lower Income	1 if household income is less than $30,000, 0 otherwise.	**IN_LOW**
Middle Income	1 if household income is less than $70,000, 0 otherwise.	**IN_MID**
Higher Income	1 if household income is $70,000 and over, 0 otherwise.	**IN_HI**
Male	Sex of reference person, where 1 if a person is male, 0 is female; Dummy variable.	**MALE**
Education	The education level of reference person; Dummy variable.	
Lower Education	1 if the respondents obtained a lower education, 0 otherwise.	**EDU_LOW**
Middle Education	1 if the respondents obtained high school graduate, 0 otherwise.	**EDU_MID**
Higher Education	1 if the respondents obtained a high education, 0 otherwise.	**EDU_HI**
Married	Marital status of the household, where 1 if reference household is married; 0 if otherwise; Dummy variable.	**MARRIED**
Race	Race of household's head; Dummy variable.	
White	1 if reference person is white, 0 otherwise.	**WHITE**
Black	1 if reference person is black, 0 otherwise.	**BLACK**
Asian	1 if reference person is Asian, 0 otherwise.	**ASIAN**
Other	1 if reference person is Native Hawaiian, other Pacific Islander, American Indian, Alaskan Native or multi-race, 0 otherwise.	**OTHER**
Region	Region of household; Dummy variable.	
Northeast	1 if household is in northeast, 0 otherwise.	**NORTH**
Midwest	1 if household is in midwest, 0 otherwise.	**MIDW**
South	1 if household is in south, 0 otherwise.	**SOUTH**
West	1 if household is in west, 0 otherwise.	**WEST**
Coast	Whether household lived near the coast; Dummy variable.	
The Atlantic Coast	1 if household is located near the Atlantic Coast, 0 otherwise.	**ATLANTIC**
The Pacific Coast	1 if household is located near the Pacific Coast, 0 otherwise.	**PACIFIC**
The Gulf Coast	1 if household is located near the Gulf Coast, 0 otherwise.	**GULF**
The Great Lakes	1 if household is located near the Great Lakes, 0 otherwise.	**GREAT**

From this data, the socio-economic and demographic variables that accommodate the ability and desire of the households to buy and consume various types of seafood products can be identified. As presented in Table 3.2., the full sample consisted of 6,083 women (52.6%) and 5,491 men (47.4%) who ranged in age from 15 to 87 years, with a mean age of 50.4. The average family size of the household ranged between 2 to 3 persons (mean=2.5). Adapted from U.S. Census Bureau (2014), about 37% were high-income households, based on income before taxes ($70,000 and over). Nearly one-third of households were middle-income (higher than $30,000 and less than $70,000), and 30% of the households were lower-income (less than $30,000).

Approximately 51 percent of households had married couples and 47% percent indicated that they were widowed, divorced, separated, or single households. The majority of the households were white (80%); 12% of the households were African American. A total of 6.2% of the households sampled were Asian, and a total of 2.1% classified themselves as American Indian, Alaskan native, or Native Islander (e.g., Hawaiian). The majority (33%) of the households were located in the Southern US. A total of 25% of the households sampled were in the West; almost 22 percent were in the Northeast. Additionally, 19.8% were located in the Midwest.

Over a half of the respondents (66.3%) had higher education (some college and advanced degrees, such as a Ph.D. or master's degree). Additionally, 23% of the respondents were high school graduates and 10.6% had a low education level (ninth through twelfth grade or less). A total of 34.3% of the respondents were located near the Atlantic Coast, while 30.4% of the households lived near the Great Lakes. Additionally, 18% were located near the Pacific Coast and the Gulf Coast.

The mean value of the variables included in the analysis was presented in Table 3.2. In the full sample of 11,574 households, only 2,503 households reported positive expenditures on seafood products, with a mean of $12.90 weekly, in comparison to $2.79 weekly for the full sample. Over 78% of the households (9,071) reported non-expenditure on seafood products during the survey period. The fourth column describes the level of statistical significance using the means comparison test between households reported seafood consumption, and households did not report seafood consumption during the survey period.

Table 3.2: Mean values of the variables (N=11,574)

Variable	Full sample	Consuming households	Non-consuming households	Mean Comparison
Age	50.41	50.97	50.26	-0.71
	(17.31)	(16.21)	(17.59)	[-1.82]*
Family Size	2.45	2.77	2.37	-0.40
	(1.41)	(1.45)	(1.39)	[-12.68]***
Male	0.47	0.47	0.48	0.00
	(0.50)	(0.50)	(0.50)	[0.25]
Married	0.51	0.62	0.48	-0.13
	(0.50)	(0.49)	(0.50)	[-12.02] ***
Higher Income	0.37	0.46	0.34	-0.11
	(0.48)	(0.50)	(0.48)	[-10.24] ***
Middle Income	0.33	0.31	0.34	0.03
	(0.47)	(0.46)	(0.47)	[2.69] ***
Lower Income	0.30	0.23	0.32	0.08
	(0.46)	(0.42)	(0.46)	[8.00] ***
Higher Education	0.66	0.68	0.66	-0.02
	(0.47)	(0.47)	(0.47)	[-2.23]**
Middle Education	0.23	0.21	0.24	0.02
	(0.42)	(0.41)	(0.42)	[2.61] ***
Lower Education	0.11	0.11	0.11	0.00
	(0.31)	(0.31)	(0.31)	[-0.15]
Black Race	0.12	0.11	0.12	0.01
	(0.32)	(0.31)	(0.33)	[1.87]*
Asian Race	0.06	0.10	0.05	-0.05
	(0.24)	(0.30)	(0.22)	[-8.35] ***
White Race	0.80	0.77	0.80	0.03
	(0.40)	(0.42)	(0.40)	[3.40] ***
Other Race	0.02	0.02	0.02	0.00
	(0.14)	(0.14)	(0.14)	[0.27]
Northeast Region	0.22	0.24	0.22	-0.02
	(0.41)	(0.43)	(0.41)	[-2.22]**
Midwest Region	0.20	0.18	0.20	0.02
	(0.40)	(0.39)	(0.40)	[1.95]*
West Region	0.25	0.26	0.25	-0.02
	(0.43)	(0.44)	(0.43)	[-1.68]*
South Region	0.33	0.32	0.34	0.02
	(0.47)	(0.47)	(0.47)	[1.85]*
Atlantic Coast	0.34	0.37	0.34	-0.04
	(0.47)	(0.48)	(0.47)	[-3.32] ***
Pacific Coast	0.18	0.21	0.18	-0.03
	(0.39)	(0.41)	(0.38)	[-3.32] ***
Gulf Coast	0.18	0.18	0.18	0.00
	(0.39)	(0.39)	(0.39)	[0.18]
Great Lakes Coast	0.30	0.29	0.31	0.01
	(0.46)	(0.46)	(0.46)	[1.22]
Sample Size	11,574	2,503	9,071	

Note: T-test statistics are reported in brackets []; standard deviation are in parenthesis ();
***, **, and * indicate significance at 1%, 5% and 10%, respectively.

3.2. Empirical model of seafood consumption

To analyze the factors explaining seafood consumption in the US, the following regression model was postulated as:

$$y_i = \beta_0 + \beta_1 FAMSIZE_i + \beta_2 AGE_i + \beta_3 MARRIED_i + \beta_4 IN_{HI,i} + \beta_5 IN_{MID,i} + \beta_6 MALE_i + \beta_7 EDUCATION_{HI,i} + \beta_8 EDUCATION_{MID,i} + \beta_9 RACE_{BLACK,i} + \beta_{10} RACE_{ASIAN,i} + \beta_{11} RACE_{OTHER,i} + \beta_{12} REGION_{NORTH,i} + \beta_{13} REGION_{MIDW,i} + \beta_{14} REGION_{WEST,i} + \beta_{15} COAST_{ATLANTIC,i} + \beta_{16} COAST_{PACIFIC,i} + \beta_{17} COAST_{GULF,i} + \beta_{18} COAST_{GREAT,i} + \varepsilon_i \quad (1)$$

The definition of the variables included in the analysis is presented in Table 3.1. The regression model is employed using these explanatory variables to obtain the expenditure of seafood products specified in equation (1). The selection of the explanatory variables included is based on the economic theory, previous studies from a literature review, and data availability.

To estimate the model described in equation (1), Ordinary Least Squares (OLS) can be attempted for this purpose. In fact, the empirical analysis was started by estimating the model with OLS. However, in the data used, there are 78% of the households with zero seafood expenditures (Table 3.2). The non-consumption of seafood by these households could be due to many economic and non-economic reasons. Additionally, a variety of food expenditure studies has revealed that censored data is a common concern, especially in cross-sectional household surveys. Studies on this issue reported factors that make the households report zero expenditure on a commodity. These factors can be detailed as: 1) the price of this commodity not being accessible by the household, 2) infrequency of the purchase, due to consuming items that were purchased before the

period of conducting the surveys, 3) non-responses in surveys, and 4) a non-participation for a particular commodity (Blisard and Blaylock, 1993; Blundell and Meghir 1987).

In particular, zero expenditure on seafood could be the result of a household's utility maximization that yielded corner solutions. Consequently, households with zero seafood expenditure are not necessarily randomly distributed in the data. Under these circumstances, it is well-known that Ordinary Least Squares (OLS) estimators are biased and not consistent (Jones and Yen, 2000; Greene et al., 2002). More specifically, a naïve OLS regression, used with the dependent variable having many zero observations, results in downward biased and inconsistent parameters (Stewart, 2013).

3.2.1. The Tobit model

One way to address the problem of many zeros in the dependent variable is to utilize a Tobit model. The Tobit model, introduced by James Tobin (Tobin, 1958), was used to account for truncated data (such as zero purchases for seafood products) reported by a number of the households in data sets. Many studies on household expenditures used the Tobit model to analyze zero values subject to a known upper or lower bound. To overcome this issue, all zero values were interpreted as corner solution in the Tobit model.

To explain this model, the amount of money a household spends on seafood products associated with household socio-economic and demographic characteristics must be considered. In the case of zero observations for seafood products, it is assumed that households do not consume seafood products or do not have time for shopping, due to non-economic reasons, which represent a standard corner solution in the following maximization problem:

$$\max_{y,z} U(y,z) \tag{2}$$

where y explains the expenditure on seafood products, while z represents other types of spending. Thus, the decision of the household as a simple utility maximizing problem was considered, where positive consumption is important for utility maximization (equation 2). However, to determine the expenditure (whether zero or a positive value), the Tobit model allows for the assessment of censored data or truncated for non-consuming households reported as a zero expenditure (a corner solution) on seafood during the survey period. The observed y_i is defined as in the general formulation of the model as follows:

$$y_i = \begin{cases} y_i^* & \text{if } y_i{}^* > 0 \qquad i = 1, 2, \dots, N \\ 0 & \text{if } y_i{}^* \leq 0 \end{cases} \tag{3}$$

$$y_i{}^* = x_i' \beta + \varepsilon_i \tag{4}$$

Defining *N* to be the number of observations (households), y_i denotes the ith observation on the expenditure of seafood, and $y_i{}^*$ is a latent variable representing the expenditure of seafood by equation (3). x_i' is a row vector of explanatory variables, β is a column vector of unknown coefficients, and ε_i is the residual term that is assumed to be independently normally distributed with a mean of zero and a constant variance $\varepsilon_i \sim N(0, \sigma^2)$. Thus, $y_i{}^*$ is only observed when it is positive.

Following Verbeek (2008), the log-likelihood function for the Tobit model, corresponding to equations (3) and (4), is:

$$\log(L) = \sum_{y_i=0} \log\left[1 - \Phi\left(\frac{x_i' \beta}{\sigma}\right)\right] + \sum_{y_i>0} \log\left[\frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{-\frac{1}{2}\frac{\left(y_i - x_i' \beta\right)^2}{\sigma^2}\right\}\right] \tag{5}$$

where Φ means the cumulative distribution function (CDF) of the standard normal distribution. Σ_0 and Σ_+represent the summation over the observations for y_i (zero and positive values, respectively). The first term in the left-hand side of equation (5) is obtained from the censored observations (zero or less). Therefore, the contribution to the log likelihood is the log-probability of the particular value of that event. The second term in the right-hand side corresponds to the standard normal regression for the uncensored observations in the likelihood function (Greene, 2010 p. 850; Sigelman & Zeng, 1999).

The marginal effect of a change in explanatory variables x_i' has on the weekly expenditure on seafood is formally presented as:

$$\frac{\partial E[y_i|x_i']}{\partial x_i'} = \beta\Phi\left(\frac{x_i'\,\beta}{\sigma}\right) \tag{6}$$

$\beta\Phi\left(\frac{x_i'\beta}{\sigma}\right)$ represents the estimated probability of observing an uncensored observation at x_i'. Furthermore, the coefficient β gives the marginal effect at those particular values of x_i'. Thus, the coefficient of the parameters and the marginal effects are used to draw conclusions and implications.

3.2.2. The double-hurdle model

The act of consuming seafood products and the total spending on these products are two decisions made by households. In the Tobit model, these decisions are treated jointly. This presents an issue, because it is likely that the decision to consume seafood and the amount of seafood consumption are not made simultaneously. In general, it is more common that households decide first that they want to eat seafood, and later, make the expenditure allocation according to their needs and means. Thus, it is necessary to account for this sequence in the decision process. Also, these two processes could be

determined by a different set of factors. One way to address this problem is to invoke the double-hurdle model.

The double hurdle model was developed by Cragg (1971) to model appropriately sequential decisions with households deciding first, whether or not to consume a product and second, how much to spend on the consumption. It is a good alternative to the Tobit model when the factor explaining the decision, also termed as participation, and those explaining the consumption could be different.

In order to recognize the positive amount of seafood, two separate processes must be determined. The first hurdle is used to estimate the household's decision to participate in the seafood market. The second hurdle is used to determine the level of the expenditure (Blundell and Meghir, 1987).

The double-hurdle model has two separate equations:

$$peq = \begin{cases} 1 & \text{if } y_{1i}^{*} > 0 \\ 0 & \text{otherwise} \end{cases} \qquad y_i = \begin{cases} y_{2i}^{**} & \text{if } y_{2i}^{**} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

$$y_{1i}^{*} = x_{1i}' \beta_1 + \varepsilon_{1i} \quad \text{Participation decision} \tag{8}$$

$$y_{2i}^{**} = x_{2i}' \beta_2 + \varepsilon_{2i} \quad \text{Expenditure decision}$$

where y_{1i}^{*} is a latent variable representing the household's decision to participate in the first hurdle, y_{2i}^{**} is a latent variable corresponding to the expenditure decision in the second hurdle, y_i is related to the observed dependent variable when the participation decisions in the market $(y_{1i}^{*} > 0)$ and the expenditure decisions $(y_{2i}^{**} > 0)$ are made by the household for seafood products, x_{1i}' is a vector of explanatory variables explaining the decision to participate, x_{2i}' is a vector of explanatory variables explaining the decision to

consume, and β_1 and β_2 denote the parameters vectors. ε_{1i} the error term in the participation equation, and ε_{2i} is the error term in the expenditure equation:

$$\begin{pmatrix}\varepsilon_{1i}\\ \varepsilon_{2i}\end{pmatrix} \sim N\ (0, \Sigma), \Sigma = \begin{pmatrix}1 & \sigma_{12}\\ \sigma_{12} & \sigma\end{pmatrix} \tag{9}$$

Following Garcia (2013), when x, y, and ρ explain the cumulative distribution function (CDF) of a bivariate normal distribution with the correlation coefficient ρ, the log likelihood, in this case, can be written as:

$$\log(L) = \sum_{y_i=0}\left[\log\left\{1 - \Phi\left(x'_{1i}\,\beta_1, \frac{x'_{2i}\,\beta_2}{\sigma}, \rho\right)\right\}\right] \tag{10}$$

$$+ \sum_{y_i>0}\left(\log\left[\Phi\left\{\frac{x'_{1i}\,\beta_1 + \frac{\rho}{\sigma}(y_i - x'_{2i}\,\beta_2)}{\sqrt{1-\rho^2}}\right\}\right] - \log[\sigma] + \log\left\{\emptyset\left(\frac{y_i - x'_{2i}\,\beta_2}{\sigma}\right)\right\}\right)$$

where the Φ functions denote the standard normal cumulative and $\emptyset$ refers to the probability density function. $\Sigma_{\mathrm{y_i=0}}$ and $\Sigma_{\mathrm{y_i>0}}$ are the summations over the observations for $\mathrm{y_i}$ (zero and positive values, respectively). A positive marginal effect means that a unit increase in the independent variable increases the amount of seafood expenditure incurred by a household. Combining both effects of the participation decision equation and the quantity decision equation, the marginal effect value is formally presented as, where c denote the corner conditional:

$$E\ (y|x'_1, x'_2) = c\{1 - \Pr(y > c|x'_1, x'_2)\} + \Pr\ (y > c|x'_1, x'_2)E\ (y|x'_1, x'_2, y > c) \tag{11}$$

3.4. Model Selection and validation

3.4.1. Model selection

Model selection is a reasonable way to identify the best-fit model through statistical tests. Model specification tests are applied to measure the determinants of expenditures on seafood products. The likelihood ratio (LR), Wald (W) statistics, and Lagrange multiplier (LM) tests are most commonly used to identify possible hypotheses to measure the differences (or the similarities) among the nested models (Greene, 2010 p. 524).

To further determine the most suitable model for seafood consumption, the likelihood ratio test is used to compare the two nested models to test the full model against the restricted models (Verbeek, 2008, p. 181; Yen et al., 1996). In this study, the likelihood ratio test was performed, since the Tobit model is nested within the double-hurdle model. The likelihood ratio test is expressed as:

$$LR = -2[L_T - L_D] \tag{12}$$

where L_T and L_D denote the log-likelihood values of the Tobit model, and the double-hurdle model, respectively. The likelihood ratio test has a chi-squared distribution (χ^2) determined by the number of degrees of freedom (DF) equal to the number of additional parameters observed in the alternative model.

3.4.2. Model validation

For validation purpose before interpretation, it is important to ensure that the models pass a certain number of testing procedures. Furthermore, it is necessary to successively check for multicollinearity, heteroskedasticity, and non-normality.

Two or more explanatory variables might be correlated. This will create a multicollinearity problem. A correlation matrix approach was used for the explanatory variables to detect a multicollinearity problem. Accordingly, the results show that the correlation coefficients were small (typically below 0.5 in absolute value) indicating that the multicollinearity may not be a major issue between the explanatory variables.

A histogram plot of the dependent variable is applied to detect for the non-normality between the error terms. The graph below (Figure 3.1) illustrates that the distribution of seafood expenditures in the original scale is highly skewed to the right. From this chart, it is difficult to infer the normality of the seafood expenditures. Thus, it may cause an inconsistent estimation in the presence of heteroskedasticity. As such, the error terms become non-normally distributed (Jensen and Yen, 1996; Arabmazar and Schmidt, 1982).

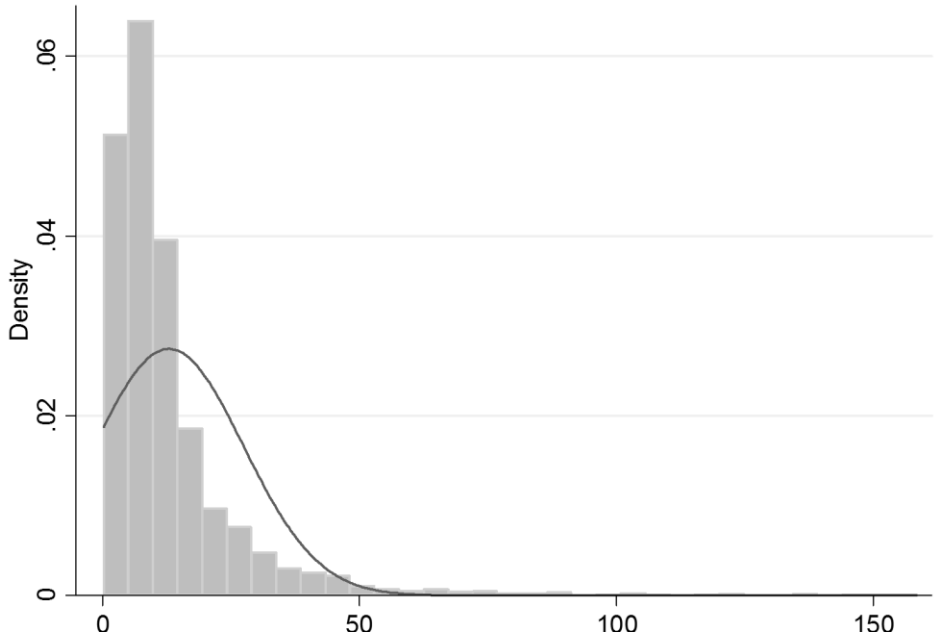

Figure 3.1: Distribution of Seafood Expenditures in the Original Scale.

In this study, an approach adapted from Sprugel (1983), the natural logarithm transformation of the dependent variable was performed to normalize the data for positive

values and avoid the non-normal distribution of the error term[1]. Figure 3.2 shows the distribution of the dependent variable on a natural logarithm scale, presenting the distribution as being more likely to be normally distributed. Also, particular statistical procedures for normality, such as Skewness-Kurtosis test proposed by Jarque and Bera (1980), are conducted after the natural logarithm transformation on the null hypotheses that seafood expenditures are normally distributed. The statistical test rejects the null hypothesis that the shape of the distribution is normal and expresses non-normality in the error term. Figure 3.2 illustrates the shapes as likely to be normally distributed even after the log transformation; the small points (outliers) lead the test to reject the null hypothesis (Elster and Honerkamp, 1992).

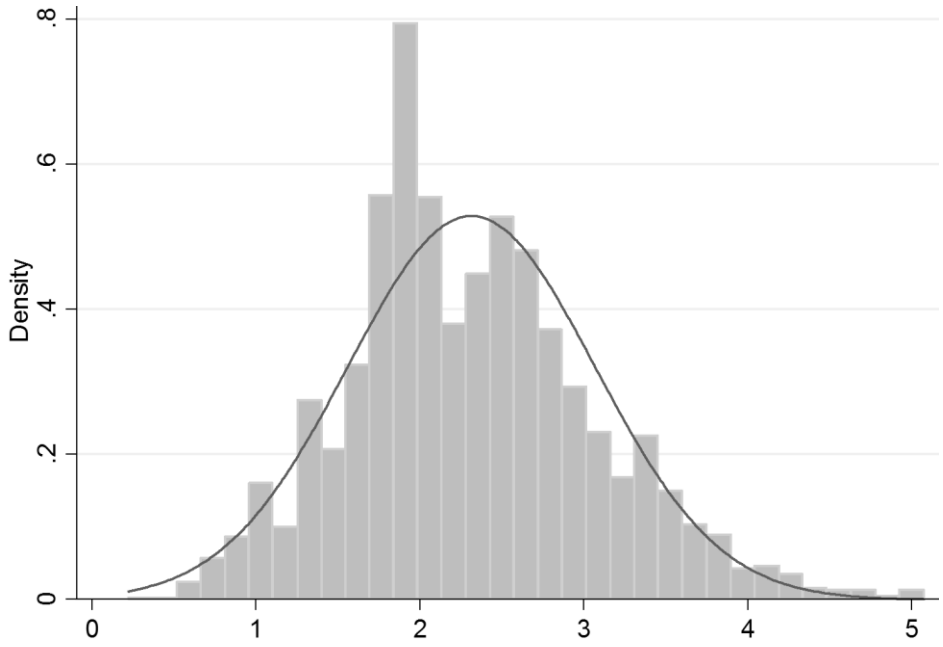

Figure 3.2: Distribution of Seafood Expenditures in a Logarithmic Scale.

To be more precise, Figure 3.3 illustrates the quantiles of seafood expenditures against the quantiles of a normal distribution after the transformation. The argument is

[1] Jones & Yen (2000) used the double-hurdle model with a Box-Cox transformed dependent variable for US beef consumption to account for heteroskedasticity in the residuals.

that statistical tests help make decisions, but do not necessarily illustrate the true distribution shape. For the most part, it can be seen as normal, regardless of the outliers causing non-normality of the error terms.

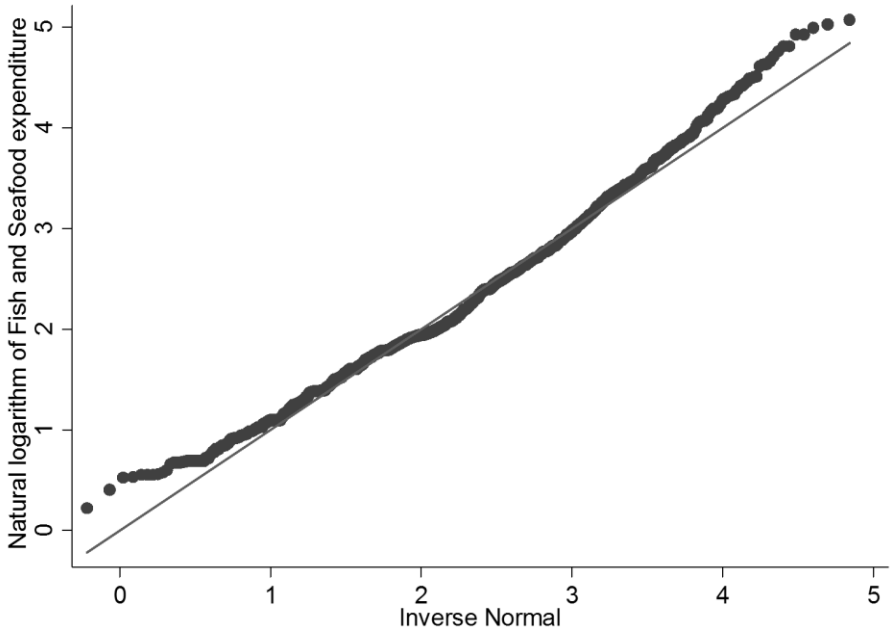

Figure 3.3: Quantiles of Seafood expenditures against quantiles of a normal distribution.

Heteroskedasticity, especially in cross-sectional data, denotes an issue that the variance of some residuals is different from others. Several consequences have appeared in recent years when heteroskedasticity is present. The consequences of the presence of heteroskedasticity are the model being inefficient anymore, the estimation of the error term of the variance coefficient being incorrect, and the value of the t-statistic and F-statistic being inaccurate. Accordingly, the correction for heteroskedasticity involves weighting each observation by the inverse of its associated standard deviation. In this study, to prevent a heteroskedasticity problem, it is necessary to compute a robust standard error for each coefficient to avoid incorrect standard errors.

CHAPTER 4 – RESULTS

The empirical analysis starts with the simple OLS estimation of equation (1). The results of this estimation are presented in Table 4.1. This baseline model is a useful starting point. However, for many reasons exposed in the empirical model section above, the OLS results are biased and inconsistent. First, the model is not appropriate to deal with the censored nature of the data with many zeros for non-consumption of seafood. Also, the OLS does not model the decision to consume seafood along with the amount of seafood consumption. Therefore, the rest of this section will concentrate on the results from the Tobit model and the double-hurdle models.

4.1. Testing for the sequence of the participation in seafood market and the expenditure of seafood

To test the first hypothesis, both the Tobit and the double-hurdle models were estimated by using maximum likelihood estimators in (5) and (10) respectively. Both models are suitable to deal with the censored nature of the data for non-consumption of seafood. Table 4.2 summarizes the findings of the Tobit model and the double-hurdle model.

An examination and comparison of the results of the two models provide indication of the first hypothesis. If households' decision were jointly made, then the Tobit model would be preferred. On the other hand, if the household decisions to consume seafood and the amount spent are sequential, then the double-hurdle model would be more appropriate. For the double hurdle model in equation (8), each parameter appears in two separate equations that are the quantity decision equation and participation decision equation. In the Tobit model (equation 4), each parameter appears in one equation indicating that the Tobit model is restricted. The result of the likelihood ratio

test in equation (12) is 2,992.56, which is larger than the critical value (9.39). Thus, the null hypothesis is rejected, showing that the restriction imposes by the Tobit is not appropriate. Additionally, a test of comparing of the two models is performed by examining the correlation ρ between the error terms in the participation decision equation and the expenditure decision equation from the double-hurdle model. This correlation is at the bottom of column (6) of Table 4.2. The correlation is statistically different from 0 at the 1% level. As a result of the test, the null hypothesis is rejected, indicating that the double-hurdle model is preferred. This suggests that the decision to participate in the market for seafood and the amount consumed are sequential. The double-hurdle model represents a suitable model to match the data used and to identify both decisions to cosnume seafood and how much to spend. As a consequence, the focus of the results will be on the empirical findings of the double-hurdle model.

4.2. Determinants of the participation in seafood market and the expenditure of seafood

The average marginal effects of the Tobit model and the double-hurdle model for all explanatory variables were calculated and shown in column (3) and (8) of Table 4.2. The marginal effects in each model provide additional information on the impact of a one-unit change in the value of the explanatory variables on expenditures for seafood. In the empirical results, no negative marginal effects are reported among the significant variables.

Table 4.2 reveals that the two decisions' approach in the double-hurdle model for each variable demonstrates different classes of significance. Several of the parameters

estimated in both equations (the decision to consume and how much to consume seafood products) are significant at the 1%, 5%, and 10% levels.

Holding everything else constant, measure at the sample mean, the results identify the major demographic and socio-economic determinants that have a positive influence on seafood spending. The variable representing the number of household members not only has a positive effect in the decision to participate in seafood markets, but its coefficient is also highly significant on the quantity consumed of seafood products. It confirms the expectation that one more member in the household is likely to increase the expenditure on seafood products by 6.5%. These results agree with other studies in which the number of family members positively affect home consumption (Nayga & Capps, 1995; Yen & Huang, 1996) while it will negatively affect dining-out consumption (Nayga & Capps, 1995).

Another variable with a significant coefficient for expenditure is household head age. The age of household head has a positive effect on the participation in the market for seafood, but no significant effect on the quantity consumed. It shows that age factor is associated with developing a habit of consuming seafood products. The sign of significance at 1% in quantity decision implies that when the two decisions were combined, the expected expenditure becomes significant. On average, this indicates that one more year of a person's age is expected to increase the probability of consuming seafood products by 0.3%. Similarly, this finding concurs with those of Nayga & Capps (1995) and Yen & Huang (1996).

The marital status of the households' head positively influences both the participation and quantity decisions in the seafood market. In particular, once the decision

of consumption is made by a married household, they will tend to consume more seafood than households headed by a single-parent. This finding was quite surprising and indicated that the expected expenditure on seafood will positively increase by 12.7% in households headed by married couples.

Gender has an impact on how much seafood is consumed, but no influence on the decision to purchase seafood. A household headed by a male tends to increase the level of consumption, but not the likelihood of deciding to purchase seafood products, as compared to a household headed by a female. These results are in concert with Burger (2000), Daniel et al. (2011), and Lin et al. (2006), who found that men are more likely to consume seafood than women. In contrast, Burger (2000) confirms, in her interview sample, that 9% of men change their food habits to eating less seafood when their wives become pregnant out of concern for health of the mother and fetus.

It is crucial to consider race as a highly influential indicator on the expenditure on seafood products. An important concern that significantly increases the expenditure on seafood is found among Asian households compare to White household. The findings show that being an Asian household has a positive effect on the decision to participate in seafood markets, and the decision to consume seafood products. When the decision to participate is made by a household headed by an Asian family, they are more likely to increase their spending on seafood by 28.7%. These findings are congruent to Lin et al. (2006), Shirley (2006), Singh et al. (2014), and Nayga & Capps (1995), who found that Asian households spend more on seafood than white households. On the other hand, Davis et al. (2007) found less expenditure on canned tuna than red meat among Asian households.

Moreover, being in black and other racial groups is positively associated with the quantity consumed, but not with the decision to consume. Thus, black households tended to increase their expenditure on seafood by 5.8%, over white households. These findings are consistent with the conclusions in Yen & Huang (1996) and Nayga & Capps (1995); they also confirm the eating out habits in Lin et al. (2006). Another observation found that most studies are in agreement with white households spending less on seafood, as compared to Hispanic and other racial groups (García-Jiménez & Mishra, 2011; Davis et al., 2007). This reflects the influence of European heritage and cultural traditions which favor beef, poultry, or pork in that cuisine.

Income levels have shown a substantial effect on the total expenditure on seafood product for the households. It is observed that the level of income is distinguished in both decisions related to each household. The findings imply that being in middle and high-income households is positively significant with the decision to consume seafood. It shows that middle income households tend to develop the habit of participating in seafood market. However, once higher income households decide to consume seafood, they are inclined to spend 15.8% more than middle-income households, while middle-income households spend 5.3%, as compared to lower income households. This confirms the findings obtained by Davis et al. (2008), Blisard et al. (2002), Wan & Hu (2012), and McDowell et al. (1997), who indicate that high-income households spend more on seafood than lower income households.

Geographical location gives an important indicator of the level of consumption per household. Considering the status of geographical regions on seafood demand, living in Northeast and Midwest have no impact on the quantity consumed, but both are

positively significant in the participation decision, indicating a probability to participate in seafood market. Compared to the south region, the Northeastern and Midwestern households tended to increase their expenditures by 10.1% and 11.7%, respectively. There were similar results found by Nayga & Capps (1995) and Davis et al. (2007).

Further considering the impact of region on the total expenditure on seafood, other studies find that certain Hispanic households eat more seafood than other Hispanics, depending upon which region of the world they have immigrated from (Diaz-Valenzuela et al., 2008). Additionally, Hispanics living in the Northeast of the US spent more on seafood products when compared to their same ethnic group members living elsewhere in the US. Lin et al. (2006) also found that households located in the Northeast spent more on seafood than households in the Midwest. They spent less than households located in the South and the West. On the other hand, it was found that households residing in the western region have a positive impact on the quantity consumed, but not in the participation decision. Therefore, they spend 8.8% more on seafood products than households in the southern region. In addition, Lin et al. (2006) found that the western region spent more on seafood for in-home consumption than the northeast region. In contrast, Davis et al. (2007) found that the eastern region consumed more of seafood than red meats. They were found to spend more on canned tuna and shrimp than those who reside in the West.

Furthermore, the proximity to the coasts has shown significant effects on seafood consumption. Households residing near the coastal regions, such as the Atlantic Coast and the Gulf Coast, are more likely to participate in the seafood market. They also tend to spend more on seafood products. Additionally, households near the Pacific Coast

represent higher levels of participation in the market when compared to non-coastal areas. Thus, being a household in the Atlantic, the Pacific, and the Gulf Coast will positively increase the expected expenditure by 13.8%, 11%, and 10.8% respectively.

The coastal states findings are also similar to that of Moya (2004), Da Costa et al. (2005), and Bemrah et al. (2009), who state that households in coastal areas are likely to eat more seafood than other households in non-coastal areas. A recent study by Wan & Hu (2012) confirmed the findings that consumers who grew up in coastal areas are more likely to consume seafood, as compared to consumers who grew up in non-coastal areas. This can be traced to the food habits of the members of the households (typically the head of household, or the primary food preparer) for those who are accustomed to preparing and consuming seafood products.

There are several factors which were found to be insignificant among the other demographic and socio-economic determinants. For instance, in the coastal states, it was observed that households which lived near the Great Lakes were found to have no effect on whether to consume seafood or how much to consume compare to non-coastal states. Additionally, another factor considering the level of education of the head of the household was not found to be a significant factor in impacting the participation decision, or, the quantity decision. This finding is in agreement with McDowell et al. (1997), but not with Daniel et al. (2011) and Blisard et al. (2002), who find that highly educated households positively impact seafood consumption.

Table 4.1: Results of the OLS model (N=11,574)

Variable	Coefficient	Standard Error
Family Size	0.069***	0.008
Age	0.003***	0.001
Married	0.119***	0.023
Higher Income	0.151***	0.027
Middle Income	0.036	0.024
Male	-0.006	0.019
Higher Education	0.001	0.032
Middle Education	-0.030	0.035
Black Race	0.052*	0.030
Asian Race	0.362***	0.039
Other Race	0.078	0.066
Northeast Region	0.103***	0.038
Midwest Region	0.109**	0.045
West Region	0.073	0.049
Atlantic Coast	0.131***	0.028
Pacific Coast	0.122***	0.042
Gulf Coast	0.097***	0.034
Great Lakes Coast	-0.017	0.034
R^2	0.04	
Adj R^2	0.04	
F-stat	28***	

***, **, and * indicate significance at 1%, 5% and 10%, respectively.

Table 4.2: Results of the Tobit model and double-hurdle model (N=11,574)

Variable	Tobit model			Double hurdle model				
				Participation decision		Quantity decision		
	Coefficient	Rob. Standard Error	Marginal effects (%)	Coefficient	Rob. Standard Error	Coefficient	Rob. Standard Error	Marginal effects (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family Size	0.282***	0.033	0.064***	0.086***	0.011	0.034***	0.012	0.065***
Age	0.013***	0.003	0.003***	0.004***	0.001	0.000	0.001	0.003***
Married	0.512***	0.101	0.117***	0.144***	0.032	0.142***	0.035	0.127***
Higher Income	0.675***	0.121	0.154***	0.200***	0.039	0.111***	0.045	0.158***
Middle Income	0.226**	0.114	0.052**	0.065*	0.036	0.041	0.042	0.053**
Male	-0.091	0.084	-0.021	-0.036	0.027	0.059*	0.030	-0.011
Higher Education	-0.106	0.146	-0.024	-0.042	0.047	0.065	0.054	-0.014
Middle Education	-0.217	0.157	-0.050	-0.069	0.050	0.000	0.059	-0.046
Black Race	0.168	0.137	0.038	0.033	0.043	0.164***	0.051	0.058*
Asian Race	1.178***	0.155	0.269***	0.352***	0.052	0.234***	0.056	0.287***
Other Race	0.108	0.303	0.025	-0.014	0.094	0.393***	0.112	0.076
Northeast Region	0.430***	0.167	0.098***	0.131**	0.054	0.063	0.057	0.101***
Midwest Region	0.519***	0.204	0.119***	0.160***	0.065	0.045	0.075	0.117***
West Region	0.290	0.230	0.066	0.070	0.072	0.192**	0.081	0.088*
Atlantic Coast	0.566***	0.129	0.129***	0.164***	0.041	0.127***	0.049	0.138***
Pacific Coast	0.485***	0.196	0.111***	0.146**	0.062	0.055	0.066	0.110***
Gulf Coast	0.434***	0.156	0.099***	0.124***	0.050	0.116**	0.057	0.108***
Great Lakes Coast	-0.089	0.150	-0.020	-0.036	0.048	0.059	0.056	-0.011
ρ				-0.165***	0.039			
F- statistics	24.49***							
Pseudo R^2	0.0198							
Log likelihood	-10112.52			-8616.24				

***, **, and * indicate significance at 1%, 5% and 10%, respectively.

CHAPTER 5 – CONCLUSION

5.1. Summary

The primary objective of this study was to explore the factors that influence consumer expenditures on seafood in the US. The methods used were based on the Tobit and double-hurdle models, given the nature of the censoring data to investigate the relationships between total household weekly expenditures and household socio-economic and demographic characteristics. The marginal effects were also estimated to determine the expected expenditures.

The data employed in this paper was collected by the US Bureau of Labor Statistics during 2014. The sample size consisted of 11,574 households. One of the major advantages of using the double-hurdle model is that the decision is sequential as to whether to consume and how much to consume. Following the quantity decision that outlines how much to spend on seafood; Asian, black, and other race households; married heads of the households; the size of the households; the male head of the households, high income households; households residing in the West; as well as households living near the Atlantic Coast and the Gulf Coast, were significant determinants, and were more likely to impact the level of consumption.

Under the participation decision in the seafood market, the findings indicate that family size, age of the head of the household, marital status, high income households, Asian households, households residing in the Midwest, households living near the Atlantic Coast and the Gulf Coast, households living in the North, households living near

the Pacific Coast, and middle income households were likely to impact the participate decision in seafood market.

5.2. Implications

This study was motivated by the decreasing consumption of seafood that has occurred in previous years. Factors were examined that influence the demand for fish products and focused on the significance of each determinant that accommodates the desire of American households to purchase and consume seafood products.

The demographic and socio-economic variables were identified associated with the decision to consume seafood, and the amount of money spent. The methodology explored the household demographic, the effect of geographical variables, and population growth in coastal states. The results are effective in identifying consumer socio-economic and demographic characteristics for producers and marketers to increase the product values in terms of maximizing their profits, and targeting their marketing strategies, to make improvements accordingly to increase sales. The findings reveal what motivates household decisions to spend, and what explains the spending on seafood products. The interaction between these variables is notable among different households, including different decisions concerning the quantity spent, and the participation in the seafood market. Information provided in this study can be applied to draw an advertisement frame of seafood for American consumers. Additionally, the advantages of these results are to illuminate the profile of the American households towards fish and seafood products for the aquaculture industry, and for producers and distributors to conduct strategies and investments to target these marketplaces. It might open an opportunity to expand the

seafood market into places where it is currently not popular, such as the interior of the US.

5.3. Limitations and opportunities for future research

CE data offers an excellent opportunity to examine households' expenditures on seafood. However, some problems that were faced while choosing this data are related to the lack of data on the households' dining-out activities. Besides, one more limitation in the dataset is that the price variable of the seafood products is not available. Although the study used cross-sectional data, the possibility of using panel data from 2004 to 2014 is not possible since households have no identification number which could have been used to track previous expenditures. Health status might change the probability of consuming certain food, so that this variable might include standard medical histories such as diabetes, heart disease, obesity, etc. of the head of each household. As a consequence, it might help the researcher to investigate the food pattern based on the medical status of the households. This could hold great potential for other applications in the medical field, healthy food, and further applications.

Concerns on the same data used in this study, and more research into different regions such as United Kingdom, China, and Japan will be taken into account to address the impact of households' demographics on seafood expenditure. In future work, it is intended to consider an A. C. Nielsen Homescan data or retailer scanner data recorded over time to examine households' spending on seafood products. In addition to this, further study will employ different alternative econometric methods, such as the censored quantile regression analysis, for unobserved expenditure reported by the household. Several other seafood products will be involved in more future research to offer a

complete understanding of households' preference for consuming these products as staples. It is recommended that a follow-up paper be written that investigates advertising expenditures on seafood in the media, and the impacts of these campaigns on the consumption of seafood products.

APPENDIX

Study	Product	Own-Price Elasticity[i]
Bell (1968)	Sea scallops	-1.53
	Yellowtail	-2.29
	Large Haddock	-2.17
	Small Haddock	-2.19
	Cod	-3.15
	Ocean Perch	-250
	Whiting	-17.05
Tsoa, Schrank and Roy (1982)	Cod fillets	-0.46
	Flatfish fillets	-1.04
	Redfish fillets	-0.7
	Fish blocks	-2.89
Bell, (1986)	Crawfish	-2.44
Anderson and Wilen (1986)	Pacific salmon	-3.62
Lin, Richards and Terry (1988)	Pacific Halibut	-5.56
Cheng and Capps (1988)	Shellfish	-0.89
	Finfish	-0.67
Hermann and Lin (1988)	Norwegian Salmon	-1.97
DeVoretz and Salvanes (1993)	Atlantic salmon	-2
Hermann, Mittelhammer and Lin (1993)	Norwegian salmon	-1.35
Wallström and Wessells (1995)	Canned Tuna	-0.47
Greenberg, Herrmann and McCracken(1995)	Alaska Snow and Tanner Crab	-1.43
Zidack, Kinnican and Hatch (1992)	Catfish	-1.01
Kinnucan and Thomas (1997)	Catfish	-0.87
Kinnucan and Miao (1999)	Catfish	-0.71

[i] Adapted from Asche et al. (2005)

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KNOWLEDGE & SKILL AREAS

- Teaching.
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- Project Planning.
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EDUCATION

- **Masters of Agricultural Economics, Expected May, 2016**
  UNIVERSITY OF KENTUCKY, USA
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  KING SAUD UNIVERSITY, KSA

EXPERIENCE

- **Teacher Assistant,** 2012- Present at KING SAUD UNIVERSITY, KSA
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