An Application of the Double Hurdle Model to U.S. Saltwater Recreational Fishing Expenditures

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This study used cross-sectional data extracted from the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation to analyze individual trip-related expenditures associated with saltwater recreational fishing in the United States, based on the utility maximization framework in the double hurdle model. Empirical results (income, age, gender, ethnicity, urban setting, fishing license, fishing on a boat, fish types) showed significant effects on U.S. saltwater recreational fishing trip-related expenditures. The results of this study can provide insight into the determinants of U.S. saltwater recreational fishing trip-related expenditures, which can be used for saltwater recreational fisheries management and policy.

INTRODUCTION

Wildlife-related recreation such as fishing, hunting, and wildlife watching plays an important role in outdoor recreation in the United States. In 2011, 90 million U.S. residents 16 years old and older participated in wildlife-related recreation activities. Among the 33 million anglers in the United States, 27.5 million participated in freshwater fishing while 8.9 million participated in saltwater fishing [U.S. Fish and Wildlife Service, 2014].

In 2011, anglers spent $41.8 billion on fishing expenditures. Out of the total expenses, anglers spent $21.8 billion on trip-related costs, $15.5 billion on fishing equipment, and $4.5 billion on other fishing expenses including land leasing and ownership, magazines and books, membership dues and contributions, licenses, stamps, tags, and permits (U.S. Fish and Wildlife Service, 2014).

Freshwater anglers spent more than $25.7 billion on their fishing trips and equipment in 2011, while saltwater anglers only spent $10.3 billion. Out of the saltwater angler expenditures, they spent a total of $7.3 billion on trip-related costs – $2.4 billion on food and lodging, $1.5 billion on transportation costs, and $3.4 billion on other trip costs such as equipment rental, bait, and guide fees; and a total of $2.9 billion on fishing equipment – $1.4 billion on equipment (rods, reels, etc.), $217 million on auxiliary equipment (camping equipment, binoculars, etc.), and $1.3 billion on special equipment such as boats, vans, and so forth (U.S. Fish and Wildlife Service, 2014).

In the 2001, 2006, and 2011 National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation, the number of all anglers in the United States decreased from 34.1 million in 2001 to 30.0 million in 2006 then increased to 33.1 million from 2006 to 2011. The total fishing expenditures increased from $45.3 billion in 2001 to $47.0 billion in 2006, and decreased to $41.8 billion from 2006 to

2011. The total number of saltwater anglers decreased from 9.5 million in 2001 to 7.7 million in 2006, but increased to 8.9 million from 2006 to 2011. Total expenditures on saltwater fishing trip-related costs and equipment increased slightly from \$8.4 billion in 2001 to \$8.9 billion in 2006 then increased to \$10.3 billion from 2006 to 2011 (U.S. Fish and Wildlife Service, 2002, 2007, 2014).

The purpose of this study is to analyze the determinants of saltwater recreational fishing trip-related expenditures in the United States, based on the utility maximization framework. The data analysis on saltwater recreational fishing trip-related expenditures works within the framework, where an individual must allocate a constrained budget to maximize utility. This improves our understanding of the trade-offs made in this process. Expenditure analysis not only provides information about how different socio-economic groups allocate their resources toward saltwater recreational fishing activities, but it may also contribute to a better understanding of current and future individual behavior of U.S. saltwater recreational fishing participation and consumption.

METHOD

Econometric Model

According to the consumer demand theory, an individual will attempt to maximize her or his utility subject to budget constraints. That is, the following constrained utility maximization problem can be solved as:

$$\mathrm{Max}_q\ [u(q, SE) \mid pq = I] \tag{1}$$

where u(.) represents the utility function which is assumed to be continuous, increasing, and quasi-concave, q is a vector of market goods, p is a vector of corresponding market prices, SE denotes a vector of individual's socio-economic characteristics, and I is individual's income.

The individual's demand function can be derived from analyzing the utility maximization problem in terms of market prices, socio-economic characteristics, and monetary budget. Empirically, it is assumed that all individuals face the same relative prices with the cross-sectional data that are usually used to estimate the relationship between individual's income and her or his expenditures for some commodities that can be denoted as:

$$y = f(I, SE) \tag{2}$$

where y denotes one's expenditures for some commodities. In general, the demand function gives the quantity of a market good that the individual will purchase as a function of market prices and the individual's income. This relationship is referred to as an Engel curve.

The Engel curve can be used to estimate the relationship between expenditures and income, holding price constant. Hence, given the individual's income and prices of goods, the quantities demanded by the individual can be determined from the individual's demand function (Deaton & Muellbauer, 1980; Henderson & Quandt, 1980; Silberberg, 1990; Varian, 2010). Prices are typically assumed to be constant with the cross-sectional data that are usually used to estimate the Engel function.

In order to develop the relationship between trip-related expenditures on saltwater recreational fishing activities, the anglers' income and their socio-economic characteristics, sample recognition and data related issues (censored, truncated samples), which are common to expenditure models, improve measurement reliability. A better understanding of the nature of this data helps select an appropriate econometric model for this expenditure analysis.

Modeling consumer behavior with cross-sectional data is complicated by a significant proportion of zero expenditures in the sample. In practice, the sample containing observations with reported zero expenditure presents a unique problem with cross-sectional survey data. Using traditional econometric techniques, the parameter estimates are biased and inconsistent (Maddala, 1983; Judge, et al. 1988; Greene, 2008). For example, regression analysis based on nonzero observations of the dependent variable can lead to biased parameter estimates.

Typically, researchers have often used the Tobit model, first represented by Tobin (1958), to consider the fact that the expenditure, the limited dependent variable of the regression model, cannot be negative when analyzing household expenditures on durable goods. Thus, the Tobit model can be used to analyze the demand for any specific goods when household expenditures can be observed only in a limited value, usually zero. Under the Tobit specification, zero expenditure implies zero consumption. Hence, it represents a true corner solution (Gould, 1992). Statistically, the Tobit model can be defined as:

$$y_i = y_i^* \text{ if } \quad y_i^* = x_i'\beta + e_i > 0 \qquad i = 1, \dots, n \tag{3}$$
$$y_i = 0 \quad \text{otherwise}$$

where y_i is a vector of individual observed expenditures, y_i^* is a vector of the corresponding desired expenditures, x_i is a vector of regressor that influence expenditures, β is a vector of unknown parameters, and e_i is an independently distributed error term with distribution $N(0, \sigma^2)$.

However, the double hurdle model has been widely applied in consumer demand models, which draws attention to the importance in empirical applications associated with a significant proportion of zero expenditures in the sample. The studies that use the double hurdle model include Deaton & Irish (1984) on household expenditures, Haines, et al. (1988) and Popkin, et al. (1989) on food consumption, Reynolds (1990) on fresh vegetable consumption, Jones (1989, 1992) on cigarette expenditure, Yen (1993) and Jensen & Yen (1996) on food expenditure away from home, Yen & Huang (1996) on finfish consumption, Burton & Young (1996) on meat consumption. Yen & Jones (1997) on household cheese consumption, Newman, et al. (2003) on household expenditure on prepared food, Fabiosa (2006) on wheat consumption, Aristei, et al. (2008) on alcohol consumption, Akinbode & Dipeolu (2012) on fresh fish consumption, and Eakins (2014) on petrol and diesel household expenditures.

Systematically, the double hurdle model, originally proposed by Cragg (1971), was established as a useful extension of the univariate Tobit model. It allows two separate stochastic processes for participation and consumption. The double hurdle model can be defined as:

$$y_i = y_i^* \text{ if } \quad w_i = z_i'\alpha + u_i = 1, \quad y_i^* = x_i'\beta + e_i > 0 \qquad i = 1, \dots, n \tag{4}$$
$$y_i = 0 \text{ if } \quad w_i = z_i'\alpha + u_i = 1, \quad y_i^* = x_i'\beta + e_i \le 0$$
$$\text{or} \quad w_i = z_i'\alpha + u_i = 0, \quad y_i^* = x_i'\beta + e_i > 0$$
$$\text{or} \quad w_i = z_i'\alpha + u_i = 0, \quad y_i^* = x_i'\beta + e_i \le 0$$

where w_i characterizes the decision of whether to participate, z_i is a vector of regressor that influence participation; α is a vector of unknown parameters; and u_i is an independently distributed error term with distribution N(0, 1).

For the observations y_i that are zero,

$$\text{Prob}(y_i = 0) = 1 - \text{Prob}(w_i > 0)\, \text{Prob}(y_i > 0) = 1 - \Phi(z_i'\alpha)\, \Phi(x_i'\beta/\sigma) \tag{5}$$

For the observations y_i that are greater than zero,

$$\text{Prob}(y_i > 0)\, f(y_i \mid y_i > 0) = \Phi(z_i'\alpha)\, (1/\sigma)\, \phi[(y_i - x_i'\beta)/\sigma] \tag{6}$$

where $\phi(.)$ and $\Phi(.)$ are the standard normal density and distribution functions, respectively. Using 0 to denote zero observations and + denote positive observations, the likelihood function for the double hurdle model can be specified as:

$$L = \Pi_0[1 - \Phi(z_i'\alpha)\, \Phi(x_i'\beta/\sigma)]\, \Pi_+\{\Phi(z_i'\alpha)\, (1/\sigma)\, \phi[(y_i - x_i'\beta)/\sigma]\} \tag{7}$$

The maximum likelihood estimation technique can also be used to estimate the unknown parameters. Based on the assumptions of normality and independence of the error term, the probability of non-zero consumption can be expressed as:

$$\text{Prob}(y_i > 0) = \Phi(z_i'\alpha)\, \Phi(x_i'\beta/\sigma) \tag{8}$$

Because the dependent variable y_i is truncated at zero, the expected value of conditional consumption is simply $x_i'\beta$ plus the expected value of the truncated normal error term, which can be expressed as:

$$E(y_i \mid y_i > 0) = x_i'\beta + \sigma[\phi(x_i'\beta/\sigma) / \Phi(x_i'\beta/\sigma)] \tag{9}$$

Based on (8) and (9), the expected value of total consumption is directly related to the expected value of conditional consumption via the probability of non-zero consumption. The expected value of total consumption can be expressed as:

$$E(y_i) = \text{Prob}(y_i > 0)\, E(y_i \mid y_i > 0) = \Phi(z_i'\alpha)\Phi(x_i'\beta/\sigma)\{x_i'\beta + \sigma[\phi(x_i'\beta/\sigma) / \Phi(x_i'\beta/\sigma)]\} \tag{10}$$

The probability of non-zero consumption in the double hurdle model considered here requires consideration of the probability from the participation and consumption equations simultaneously.

Otherwise, the maximum likelihood estimates of the expected value of total consumption with respect to the explanatory variable would be biased.

The double hurdle model may also provide a better interpretation of consumer behavior that takes into account the probability of consumption and the level of consumption. The double hurdle model is identical to the Tobit model when $\Phi(z_i'\alpha) = 1$, as the Tobit model is nested in the double hurdle model. The Tobit model is also a particular form of the double hurdle model when $z_i = x_i$ and $\alpha = (\beta/\sigma)$ in this case.

In practical applications, the LR test seems to be popular selection in empirical expenditure analysis between the Tobit model and the double hurdle model, which is based on the principle of maximum likelihood estimation. It can be used to test the hypotheses that the Tobit model performs as well as the double hurdle model by comparing the values of the maximized likelihood functions under the restricted (H_0) and unrestricted (H_1) models. Systematically, the LR test is based on the statistic:

$$\lambda_{LR} = -2[L(H_0) - L(H_1)] \quad (11)$$

where (H_0) and (H_1) are the maximized values of the log-likelihood function under the restricted and unrestricted models, respectively. The null hypothesis (H_0) is rejected when $\lambda_{LR} > \chi^2_c$, where χ^2_c is a chosen critical value from the $\chi^2_{(j)}$ distribution, and j is the number of the restrictions under the null hypothesis (Judge, et al. 1988; Greene, 2008).

Empirical Model

Based on the consumer demand theory, the choice of explanatory variables (Table 1) selected for U.S. saltwater recreational fishing trip-related expenditure equation estimated in this study can be expressed as:

Trip-related Expenditures = *f* (Age, High Income, Male, Graduate, White, Urban, Exemption, License, Boat, Salmon, Striped Bass, Bluefish, Flatfish, Redfish, Seatrout, Mackerel, Marlin, Tuna, Dolphin, ULUA, Shellfish) (12)

Previous studies on outdoor recreation expenditures have suggested that income level has a strong influence on outdoor recreation expenditures, as did other socio-economic characteristics including age, gender, ethnicity, level of education and marital status (Bergstrom & Cordell, 1991; Cordell & Bergstrom, 1991; Davis & Mangan, 1992; Walsh, et al. 1992; Dardis, et al. 1994; Arlinghaus, 2006; Dalrymple, et al. 2010; Brida & Scuderi, 2012). Most of these studies have been designed to understand outdoor recreation participation behavior, including characteristics of the individual, characteristics of the resources, and willingness to pay for outdoor recreation experiences (Walsh, et al. 1992; Arlinghaus, 2006; Dalrymple, et al. 2010; Brida & Scuderi 2012).

TABLE 1
EXPLANATORY VARIABLES OF U.S. SALTWATER RECREATIONAL FISHING EXPENDITURE ANALYSIS

Variable	Definition
Expenditure	Trip-related expenditures on recreational saltwater fishing activities
Age	Respondent's age (in year; 16 years old and older)
High Income	1 if respondent's household income greater than $50,000; 0 otherwise.
Male	Respondent's gender; 1 if male; 0 otherwise.
Graduate	Respondent's education level; 1 if graduate or professional degree; 0 otherwise.
White	Respondent's ethnicity; 1 if white; 0 otherwise.
Black	Respondent's ethnicity; 1 if black; 0 otherwise.
Urban	1 if respondent lived in the urban settings; 0 otherwise.
Exemption	1 if respondent exempted from buying a fishing license; 0 otherwise.
License	1 if respondent bought a fishing license; 0 otherwise.
Boat	1 if respondent fished on the boat; 0 otherwise.
Salmon	1 if Salmon was one type of targeted fish; 0 otherwise.
Striped Bass	1 if Striped Bass was one type of targeted fish; 0 otherwise.
Bluefish	1 if Bluefish was one type of targeted fish; 0 otherwise.
Flatfish	1 if Flounder, Flatfish, or Halibut was one type of targeted fish; 0 otherwise.
Redfish	1 if Red Drum (Redfish) was one type of targeted fish; 0 otherwise.
Seatrout	1 if Sea Trout (Weakfish) was one type of targeted fish; 0 otherwise.
Mackerel	1 if Mackerel was one type of targeted fish; 0 otherwise.
Marlin	1 if Marlin was one type of targeted fish; 0 otherwise.
Tuna	1 if Tuna was one type of targeted fish; 0 otherwise.
Dolphin	1 if Dolphin (Mahi-Mahi) was one type of targeted fish; 0 otherwise.
ULUA	1 if ULUA was one type of targeted fish; 0 otherwise.
Shellfish	1 if Shellfish was one type of targeted fish; 0 otherwise.

Theoretically, one would expect saltwater recreational fishing expenditures to be positively correlated with income, holding price of saltwater recreational fishing constant. Thus, income was hypothesized to have a positive impact on saltwater recreational fishing expenditures (Blaine & Mohammad, 1991; Walsh, et al. 1992; Dardis, et al. 1994; Arlinghaus, 2006; Dalrymple, et al. 2010; Brida & Scuderi, 2012).

According to studies of traditional recreational fishing activities, men tended to dominate saltwater recreational fishing activities and spent more on such kinds of recreational fishing activities than women did. Thus, men were hypothesized to have a positive impact on saltwater recreational fishing expenditures due to different life styles and different time constraints (Dardis, et al. 1994; Arlinghaus, 2006; Dalrymple, et al. 2010; Brida & Scuderi 2012).

Level of education reportedly had a positive effect on the rates of participation (Arlinghaus, 2006; Dalrymple, et al 2010; Brida & Scuderi 2012). Hence, level of education in graduate school was hypothesized to have a positive impact on saltwater recreational fishing expenditures. In general, non-white individuals have been observed to have a much lower preference for participation in most types of wildlife-based recreation than did white individuals (Walsh, et al. 1992; Arlinghaus, 2006; Dalrymple, et al. 2010; Brida & Scuderi, 2012). Hence, ethnicity, defined in terms of minority individuals, would be expected to have a negative impact on saltwater recreational fishing expenditures.

Saltwater recreational fishing activities has grown in popularity in the United States. Thus, the purpose of trip taken for saltwater recreational fishing would be expected to have a positive impact on saltwater recreational fishing expenditures. Thus, fisheries habitats and populations can be viewed as a critical factor. With an increase in ecosystem and biodiversity of fisheries, the more saltwater recreational anglers would participate and consume (Cisneros-Montemayor & Sumaila, 2010).

Many studies have reported that the opportunity for saltwater recreational fishing expenditures should consider species and numbers of fisheries that participants want to participate in, what species actually are caught, and how many visual encounters with fisheries are made, and the quality of the experiences (Manfredo & Larson, 1993; Arlinghaus, 2006; Cisneros-Montemayor & Sumaila, 2010; Brida & Scuderi, 2012).

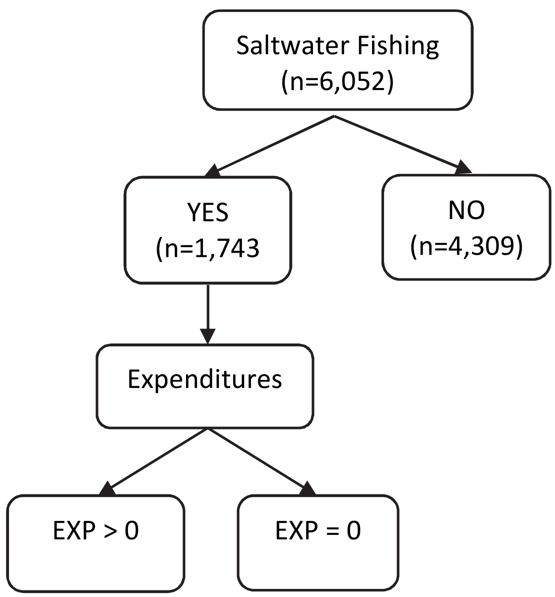
Data

Data used in this study were extracted from the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Fish and Wildlife Service, 2014), which is developed by the U.S. Fish and Wildlife Service and collected by the U.S. Census Bureau every five years.

This national survey was composed of two phases: the screening phase and the detailed phase. In the screening phase, the U.S. Census Bureau interviewed 48,600 households in the United States to identify respondents who had participated in wildlife-related activities in 2011 to gather information on fishing, hunting, and wildlife watching participation, expenditures, and socioeconomic characteristics of respondents.

From this initial phase, 6,052 saltwater recreational anglers were selected for a detailed interview about their participation and expenditures associated with saltwater recreational fishing activities in the United States in 2011, based on the question "Respondent fished in saltwater in the United States in 2011?" and "When you were fishing in the U.S. chiefly in saltwater during 2011, how much was spend for your share of (…)?" (Figure 1).

FIGURE 1
U.S. SALTWATER RECREATIONAL FISHING EXPENDITURES



Trip-related expenditures on saltwater recreational fishing activities include: (1) food, drink, and refreshments; (2) lodging of motels, cabins, lodges, campgrounds, etc.; (3) public transportation, including airplanes, trains, buses, and car rentals; (4) the round trip cost for transportation by private vehicle; (5) guide fees, pack trip or package fees; (6) public land use or access fees; (7) private land use or access fees (not including leases); (8) equipment rental as boats, camping equipment, etc.; (9) boat fuel; (10) other boat costs (such as launching, mooring, storing, maintenance, pump out fees, insurance); (11) heating and cooking fuel; and (12) bait (live, cut, prepared) and ice.

RESULTS

Descriptive statistics for the explanatory variables selected in this analysis are presented in Table 2. In 2011, average trip-related expenditures were $249.30 for the total sample, but average trip-related expenditures were $957.94 for the sample with positive expenditures in the United States. About 74 percent of respondents reported zero expenditure in this study. In order to test which variables are collinear with other variables, a collinearity diagnostic test based on condition indexes was performed. In this analysis, the value of the largest condition index, from the principal component analysis, was 17.85. Thus, suggests that the explanatory variables selected explains that U.S. saltwater recreational fishing expenditures were not correlated in this case (Belsley, et al. 1980).

TABLE 2
DESCRIPTIVE STATISTICS OF U.S. SALTWATER RECREATIONAL FISHING EXPENDITURES

Variables	Total Sample (N = 6,052)		Sample of Expenditure>0 (N = 1,575)		Sample of Expenditure=0 (N = 4,477)	
	Mean	S. D.	Mean	S. D.	Mean	S. D.
Expenditure	249.30	1061.40	957.94	1910.94	------	------
Age	46.60	16.08	48.33	15.25	45.98	16.33
High Income	0.60		0.64		0.53	
Male	0.74		0.78		0.73	
Graduate	0.12		0.17		0.10	
White	0.91		0.86		0.92	
Black	0.04		0.05		0.03	
Urban	0.52		0.61		0.49	
Exemption	0.19		0.20		0.19	
License	0.68		0.61		0.70	
Boat	0.19		0.67		0.02	
Salmon	0.02		0.08		0.00	
Striped Bass	0.08		0.28		0.01	
Bluefish	0.04		0.14		0.00	
Flatfish	0.06		0.23		0.01	
Redfish	0.03		0.11		0.00	
Seatrout	0.03		0.09		0.00	
Mackerel	0.02		0.06		0.00	
Marlin	0.01		0.02		0.00	
Tuna	0.02		0.06		0.00	
Dolphin	0.02		0.05		0.00	
ULUA	0.01		0.04		0.00	
Shellfish	0.03		0.09		0.00	

Based on the LR test results, the hypothesis that the Tobit model performs as well as the double hurdle model in modeling saltwater recreational fishing trip-related expenditure analysis was strongly rejected at the 0.01 significance level. Thus, participation and consumption decisions in the saltwater recreational fishing trip-related expenditure analysis were not based on the same decision-making structure. As a result, drawing inferences about the effects of the explanatory variables selected on participation and consumption based on the Tobit model for the saltwater recreational fishing trip-related expenditure analysis would lead to erroneous conclusions.

The double hurdle model for the U.S. saltwater recreational fishing trip-related expenditure analysis was estimated by maximizing the logarithm of the likelihood functions. Empirical results of the double hurdle model are presented in Table 3. All observations can be used in the estimation for participation decision, but only positive observations which pass through participation and consumption decisions simultaneously can be used in the estimation based on a censored and truncated sample.

The double hurdle estimates indicated that the explanatory variables might have different impacts on participation and consumption in sign or magnitude. There is no strong economic theoretical basis to suggest what explanatory variables should be in each hurdle or for predicting the signs of estimated coefficients in each hurdle (Jones, 1989). The variables *High Income*, *Male*, *Age*, *Graduate*, and *License*, all had different signs in the participation and consumption decisions. Even having different signs, the variable *License* was significant for both participation and consumption decisions. The variables *High Income*, *Male*, and *Age* were significant in the consumption decision, but not significant in the participation decision. The variable *Graduate* was significant in the participation decision but not significant in the consumption decision.

As expected, results indicated that high household income had a positive and significant effect on U.S. saltwater recreational fishing expenditures. It also revealed that saltwater recreational fishing is a normal good for which demand increases with high household income. Consistent with the previous studies, males spent more when they participated in saltwater recreational fishing activities. The age of respondents appeared to have a positive and significant impact on the saltwater recreational fishing expenditures. Results also showed that respondents who had graduate or professional degree did not have a significant effect on U.S. saltwater recreational fishing expenditures.

The variable *Urban* was positively and significantly related to saltwater recreational fishing expenditures for both participation and consumption decisions. It revealed that those who reside in the urban settings had a positive and significant impact on saltwater recreational fishing participation and expenditures, implying that demand increases significantly with the urban residents. The variable *White* was negatively and significantly related to saltwater recreational fishing expenditures for both participation and consumption decisions. It indicated that those who were white had a significantly negative impact on saltwater recreational fishing participation and expenditures, implying that demand decreases significantly with the white anglers.

The variables *Boat*, *Striped Bass*, *Flatfish*, *Redfish*, *Marlin*, *Tuna*, and *Dolphin* were significant in the consumption decision, but insignificant in the participation decision. The variable *Boat* had a significantly positive effect on saltwater recreational fishing expenditures, showing that the demand for saltwater recreational fishing activities increases with the satisfaction of fishing on the boat. As expected, the variables *Striped Bass*, *Flatfish*, *Redfish*, *Marlin*, *Tuna*, and *Dolphin* all had a significant and positive impact on saltwater recreational fishing expenditures, indicating that demand increases significantly with the presence of fish categories, including Striped Bass, Flatfish, Redfish, Marlin, Tuna, and Dolphin (Mahi-Mahi), which is the primary purpose of saltwater recreational fishing activities.

Intuitively, saltwater recreational anglers purchasing fishing licenses were less likely to participate in, but tended to consume more for saltwater recreational fishing activities when they fished significantly. Insignificantly, male anglers with high household income and age were less likely to participate in saltwater recreational fishing, but tended to consume more significantly related to saltwater recreational fishing activities. Saltwater recreational anglers holding a graduate or professional degree were more likely to participate in significantly, but not willing to spend more for these types of saltwater recreational fishing activities insignificantly.

In summary, empirical results of this study showed that mature male living in the urban area with higher household income, who has a fishing license, would spend more to go fishing on the boat for Striped Bass, Flatfish, Redfish, Marlin, Tuna, and Dolphin (Mahi-Mahi) in U.S. saltwater areas.

TABLE 3
DOUBLE HURDLE ANALYSIS FOR U.S. SALTWATER RECREATIONAL FISHING EXPENDITURES

	Participation (N=6052)		Consumption (N=1743)	
Variable	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Constant	-0.8261***	0.1563	-1067.8726***	246.1894
High Income	-0.0064	0.0678	328.7410***	96.1441
Male	-0.0365	0.0735	446.8551***	109.4743
Age	-0.0014	0.0021	11.1497***	3.0139
Graduate	0.2378**	0.0992	-29.0200	122.7843
White	-0.6711***	0.1070	-343.3131**	170.9673
Black	-0.0606	0.1635	-344.4558	257.9421
Urban	0.2529***	0.0683	185.6328**	93.7294
Exemption	-0.0079	0.0872	-23.0885	120.5609
License	-0.5287***	0.0719	408.3999***	102.2814
Boat	7.5455	132.4	546.7474***	103.1611
Salmon	7.3879	361.5	88.8981	170.4558
Striped Bass	7.4943	191.4	224.0249**	110.1934
Bluefish	7.1487	243.7	228.2445	139.6229
Flatfish	7.3514	204.8	231.4237**	110.8002
Redfish	7.2972	280.9	366.8899**	162.1966
Seatrout	7.2419	315.3	51.3910	173.3837
Mackerel	7.2162	373.8	185.3059	191.1820
Marlin	0.1409	724.3	721.4774**	330.7955
Tuna	5.5991	341.9	579.4039***	214.4032
Dolphin	0.0513	461.0	976.0671***	236.0837
ULUA	6.9653	597.1	-94.2885	265.5675
Shellfish	7.6363	357.9	228.2011	158.9927
σ	------		1833.4897	
Log-Likelihood	-3633.347		-14200	

*** denotes statistical significance at the 1% level.
** denotes statistical significance at the 5% level.

DISCUSSION

This study provided an empirical analysis of individual participation and consumption behavior for saltwater recreational fishing using data extracted from the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Fish and Wildlife Service, 2014). The double hurdle analysis of U.S. saltwater recreational fishing expenditures, in this case, is a necessary step in understanding relationship between individual participation, consumption behavior, participants' socioeconomic characteristics, and the attributes of fish species. The results in this study provided insight into the determinants of saltwater recreational fishing expenditures, which can be interpreted in terms of two stochastic processes, participation and consumption, allowing for richer interpretation of saltwater recreational angler behavior.

To compare the Tobit model and the double hurdle model, all observations can be used in the estimation based on a censored sample, but only positive observations which pass through participation and consumption decisions simultaneously can be used in the estimation for the double hurdle model based on a censored and truncated sample. The Tobit model is a one-step model, while the double hurdle model is two-step process. Under the Tobit specification, zero expenditure implies zero consumption, hence represents a true corner solution (Gould, 1992). On statistical grounds, the Tobit model is very restrictive in its parameterization which implies that the probability of consumption and the level of consumption are determined by the same sets of variables and parameters. Hence, drawing inferences from the Tobit model would lead to erroneous conclusions (Bockstael, et al. 1990).

The results of this study are multi-dimensional. First, purchasing a fishing license and fishing on the boat are important driving forces for saltwater recreational fishing consumption. Anglers are more likely to participate in and consume for saltwater recreational fishing activities in order to satisfy their fishing desires.

Second, a mature male living in urban settings with higher income does appear to be a distinguishing factor in saltwater recreational fishing activities. Thus, recreational fisheries managers have an opportunity to target this specific user group in their management plans, expanding a shrinking constituency.

Third, the availability of a diversity of species plays an important role in saltwater recreational fishing. Resource managers should educate the public about the availability or location of diverse habitats to generate continued interest and increased participation in saltwater recreational fishing.

Most importantly, healthy fisheries habitat are not only essential for a healthy fisheries, but are also an essential part of the fishing experience. Saltwater recreational fishing adds to mixed activity vacation venues attracting anglers and families with multiple interests. In particular, saltwater recreational fishing businesses succeed on the quality basis of fishable resources, ancillary experiences of nature, comfort, and well-directed marketing strategies that match specific venues to the needs of various types of anglers (Cisneros-Montemayor & Sumaila, 2010).

In order to continue high quality saltwater recreational fishing experiences for anglers, a healthy environment for fish must be properly provided through well-defined planning and management strategies and decision-making processes. The empirical results of this study provide insight into the determinants of saltwater recreational fishing expenditures, which can be used in analyzing the social and economic impacts of saltwater recreational fisheries planning and management.

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