AT-HOME SEAFOOD CONSUMPTION IN KENTUCKY: A DOUBLE-HURDLE MODEL APPROACH

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Abstract

This study investigates demographic and socioeconomic factors contributing to at-home consumption of seafood in Kentucky through a 2010 survey. The Tobit and Cragg's double-hurdle model are analyzed and tested. Numbers of people in the household, household income, race and employment status are significant determinants of at-home seafood consumption in Kentucky.

Key Words: Seafood consumption, At-home, Kentucky, Double-Hurdle Model

At-Home Seafood Consumption In Kentucky: A Double-Hurdle Model Approach

Introduction

Seafood is considered a healthy component of a balanced diet. Health-conscious consumers increasingly realize the importance of consuming seafood. U.S ranked 3rd in total seafood consumption behind China and Japan, but US is one of the biggest major importers of fishery products – over $13 billion per year in 2008 (NMFS 2009). Interestingly, after peaking in 2004, per capita seafood consumption in the U.S. gradually declined in recent years possibly due to seafood safety scares and the recent high cost of seafood relative to meat and poultry (NOAA website, 2011). Given this trend, seafood production has become increasingly competitive. Industry participants need to understand seafood consumption better than ever before to strategize production and marketing strategies. One possible approach is to examine factors that affect at-home seafood consumption.

On an annual basis, results from a seafood consumption survey screener showed that 65% of U.S. households purchased seafood for at-home consumption at least once in the previous year (NOAA Fisheries National Seafood Consumption Survey, 2005-2006). Although a variety of demographic and socioeconomic factors have been considered in previous studies of consumers' at-home seafood consumptions nationally (Cheng and Capps, 1988; Dellenbarger et al., 1992; Wellman, 1992; Hanson, Rauniyar, and Herrmann, 1995; Herrmann et al., 1994), there has been little research for a specific region such as Kentucky. Given the potential health benefits associated with consuming seafood, this study contributes to efforts to understand and subsequently increase the portion of seafood in individuals' regular diet in a relatively less-healthy state such as Kentucky.

Keithly (1985) found that some socioeconomic and demographic factors such as region, urbanization, race, household size, and income were all contributing factors affecting at-home seafood consumption based on food consumption survey data. Cheng and Capps (1988) had the similar findings regarding to the socio-demographic factors that affecting at-home expenditures on seafood after they analyzed the demand of Fresh and Frozen Finfish and Shellfish in US. Yen and Huang (1996) also believe that geographic region, race, and life-cycle variable significantly affect the probability and level of seafood consumption. Burger and Stephens (1999) investigated race and education levels are important factor to determine seafood consumption. Blacks ate larger fish meals of fish and ate more often than Whites. House et al (2003) indicate that the probability of oyster consumption depended on several factor include male consumers and geographic reasons.

This study investigates factors contributing to at-home consumption of seafood in Kentucky through a survey conducted in 2010. The analysis attempts to explain seafood consumption by consumers' characteristics such as their demographic and socioeconomic conditions. The Tobit model is analyzed as a baseline model. In addition, we use Cragg's double-hurdle model and test between the two models. The double-hurdle model assumes correlation between the two stages dictating whether to and how much seafood to consume while recognizing truncation in the second stage. Policy implications on seafood producers, retailers, importers, and policy makers are drawn based on understanding of Kentucky consumers' at-home consumption patterns.

Models

Since the values of dependent variable in this study are all zeros and positive values, the Ordinary Least Square method (William H. Greene, 2007) will not yield consistent estimates. A widely used approach, the Tobit model (Tobin, 1958) was developed to alleviate the problems caused by OLS. However, it is still very restrictive by assuming variables which determine the probability of consumption also determine the level of consumption. The Cragg's independent model (Cragg, 1971), which is a double-hurdle model, relaxes the Tobit model by allowing separate stochastic processes for the participation and consumption decisions (Yen and Huang, 1996). Define a participation equation:

(1) $$d_i^* = \alpha' z_i + \nu_i$$

and a consumption equation:

(2) $$y_i^* = \beta' x_i + \varepsilon_i$$

where d_i^* is a latent participation indicator, y_i^* is latent consumption, z_i and x_i are vectors of explanatory variables, α' and β' are vectors of unknown coefficients to be estimated, the error terms ν_i and ε_i have the distribution:

(3) $$\begin{bmatrix} \nu_i \\ \varepsilon_i \end{bmatrix} = N\left\{0, \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix}\right\} \; where \; \varepsilon_i > -x_i\beta'$$

where ρ is the correlation coefficient between ν_i and ε_i. So the observed consumption is:

(4) $$y_i = \begin{cases} y_i^* \ \textit{if}\ d_i^* > 0 \ \textit{and}\ y_i^* > 0 \\ 0 \ \ \textit{otherwise} \end{cases}$$

This framework can describe Tobit, Cragg and Heckman models, and the differences between these models are summarized in Table 1. When $\rho = 0$, the above model reduces to Cragg's independent double-hurdle model. When $\rho = 0, x = z,$ and $\alpha = \beta/\sigma$, it reduces to the Tobit model.

And we can perform a likelihood ratio test:

(5) $$\chi^2_{R+1} = 2(logL_{participation} + logL_{consumption} - logL_{tobit})$$

where χ^2_{R+1} follows chi-square distribution with R+1 degrees of freedom(R is the number of regressors) between Tobit one-step model and the Cragg's two-step model to figure out if the restriction $\alpha = \beta/\sigma$ holds (same coefficients for the discrete and continuous decisions, in favor of Tobit model) or not (different coefficients for the discrete and continuous decisions, in favor of Cragg's model).

Unconditional marginal effects of Tobit model can be calculated by

(6) $$dE(y)/dx = \beta\varphi\left(\frac{x'\beta}{\sigma}\right)$$

and conditional marginal effects of Cragg's consumption model can be calculated by

(7) $$dE(y \mid y > 0)/dx = \left[1 - \frac{x'\beta}{\sigma}\lambda\left(\frac{x'\beta}{\sigma}\right) - \lambda\left(\frac{x'\beta}{\sigma}\right)^2\right]\beta$$

Independent variables in our study are whether grown up near coast, urbanization of living area, household size, sex, age, racial group, level of education, employment status, household's annual pre-tax income, and whether consumer seafood at home; while the dependent variables is weekly consumer's expenditure on seafood eaten at home. The descriptive statistics of variables used in the analysis are listed in Table 2.

Survey and Data Description

Consumers' demographic and socioeconomic characteristics associated with at-home seafood consumption in Kentucky were collected through Seafood Preferences Survey, which was conducted by the University of Kentucky in summer of 2010. The first part of this survey provides basic seafood consumption information including whether consumer consume seafood and consumer's weekly expenditure on seafood eaten at home; The second part contained choice set question to investigate consumer preferences for various characteristics/attributes associated with each species; The third part provides consumer's demographic and socioeconomic information such as gender, age, race, household size and income, in order to capture and summarize character of the sample. This survey was conducted online which saved time and cost and also ensured the accuracy and completeness of the survey. It was launched on Thursday, July 22, 2010 at 4:09 PM and closed on Sunday, July 25, 2010 at 6:04 PM. A total of 631 respondents in Kentucky through this online survey were studied and 13 of them were not usable due to lacking key information or missing too many values.

Sample descriptive statistics of some socio-demographic variables are reported in Table 3. When compared to the census data from 2000 published by the US Census Bureau, we can see that our sample is comparatively representative of the average household size which is 2.61 compare to the Kentucky's general population which is 2.47. The sample has some slight bias towards the census data on age, education level and gender. Since our survey only included people who are older than 18 years old, it tended to have more respondents who are elder and well educated.

Results and Discussion

Estimation result of the Tobit model is presented is Table 3. The estimated value of *б* is highly significant which suggest a highly significant IMR in the model so that the Tobit model is preferred to the OLS model. The estimation result of the Cragg's model is presented in Table 4. As we mentioned, the standard log likelihood ratio test between the Cragg's independent model and the Tobit model can be conducted since the Tobit model is nested in the Cragg's model. The log likelihood values of the Cragg's probit regression model, Cragg's truncated regression model and the Tobit model are -270, -1822 and -2144. The P-value of the likelihood ratio test among the two models is highly significant in favor of the Cragg's model used in this study. And the value of ρ in the Heckman's sample selection model, which was conducted using all the same variables as in those two models is insignificant from 0, suggested that the participation and consumption steps are independent, and the use of Cragg's model is appropriate here.

So the results from the Cragg's model are interpreted in the following text because they provide the most appropriate results among the models. From the parameter estimates in participation equation, individuals who grow up near the coast are more likely to have positive seafood expenditures at home, and young individuals are less likely to have positive seafood expenditures. In consumption equation, the number of people in the household, household's income and employment status has significantly positive impact on at-home seafood consumption, while the racial group has the significant negative impact. The rest dependent variables including grow up near the coast, living in urban area, sex, whether consume seafood at home, age group and education level are insignificant to explain the dependent variable.

The average weekly expenditure on at-home seafood consumption in Kentucky is $11.09 among all 618 usable respondents. Expenditure on weekly at-home seafood consumption will increase by $1.99 on average if household size increases by 1 person. It is obvious to see that each additional person in the household needs more food to feed, diversification in personal tastes arises, and also the cost for big families to eat away from home would be much more than small families, so at-home seafood expenditure is highly associated with household size.

When household's annual pre-tax income increases by $10,000, the expenditures on weekly at-home seafood consumption will increase by $0.30. High income households are willing to pay more on seafood consumption maybe because they like the higher nutrition attribute food (seafood is considered to be healthier food) and can also afford the comparatively higher price of seafood.

White people are considered to be less seafood consumers compared to other racial groups in previous studies. The results in this studied also showed the same trend. In Kentucky, white people spend \$6.81 less on weekly at-home seafood consumption than people in other racial groups. This impact is huge because it is about 60% of the average expenditure among all the respondents and it should be taken into account for seafood marketers and sellers. As Kentucky is an inland state, most people here may not have the eating habit to consumer seafood as coastal states, and white people do not have the tradition to consumer a lot of seafood as part of culture.

Full-time employees are likely to spend \$1.96 more on weekly at-home seafood consumption than the others. This result could be update information particularly for Kentuckians while Nayga and Capps (1995) found that employed individuals are more likely to eat fish and shellfish away from home than unemployed individuals but employment status had no significant impact on at-home consumption using nationwide food consumption data in 1988.

Individuals who grown up within 50 miles from coast are not likely to spend more on weekly at-home seafood consumption on average than those who do not grown up near the coast, but they are more likely to have positive expenditures. Young individuals are less likely to have positive expenditures on weekly at-home seafood consumption. Maybe young people prefer to eat away from home or prefer to cook less time-consuming food.

Urbanization is not a significant determinant of weekly at-home seafood consumption in Kentucky may be due to the less urbanization in Kentucky State or less seafood restaurants for people to go out for meals. Education level is not significant either, maybe because people with high education may know more about the benefits of having seafood as healthier food source and also know that seafood have high risk of been contaminated, thus it not obviously whether they would consume more or not. Sex is also not significant in this study.

Conclusion

In this article, we suggest the lasted information about at-home seafood consumption in Kentucky. From the results and discussions above, we can draw the conclusion that the Cragg's independent double-hurdle model is more appropriate for dealing with dependent variable that do not have negative values than the Tobit model and Heckman's model in this study. Our analysis shows that people who belong to other racial group besides white, live with larger household size, have full-time job and earn high household's income are most likely to consume seafood at-home.

So producers, retailers and other partitions could benefit from these results. With knowing what types of consumers are most likely to consume seafood at-home, they can better target their producing and marketing strategies. For instance, they can broaden seafood sales to other racial group people and big families by providing quantity discounts, grow and sell the most favorable seafood by specific racial groups, etc.

Future works could explore these directions:

1. Design proper ways to get away-from-home seafood consumption data and make comparison with results of this study to provide a comprehensive view of seafood consumption pattern in Kentucky;
2. Decompose the some variables into specific compositions and take the interaction of several variables or compositions into account to figure out more specified impacts of different socioeconomic and demographic determinants, such as the interaction between income and racial group, age and marital status.

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Table 1. Comparison of Tobit, Heckman, and Cragg Model

Measure	Tobit	Heckman	Cragg
Probability of market participation	1	$\Phi\left(\frac{\beta' Z_i}{\sigma_v}\right)$	$\Phi\left(\frac{\alpha' Z_i}{\sigma_v}\right)$
Probability of nonzero consumption given market participation	$\Phi\left(\frac{\beta' x_i}{\sigma_\varepsilon}\right)$	1	$\Phi\left(\frac{\beta' x_i}{\sigma_\varepsilon}\right)$
Overall probability of nonzero consumption	$\Phi\left(\frac{\beta' x_i}{\sigma_\varepsilon}\right)$	$\Phi\left(\frac{\beta' Z_i}{\sigma_v}\right)$	$\Phi\left(\frac{\beta' x_i}{\sigma_\varepsilon}\right)\Phi\left(\frac{\alpha' Z_i}{\sigma_v}\right)$
Conditional mean, $E\left(y_i \mid y_i > 0\right)$	$\beta' x_i + \sigma_\varepsilon \frac{\varphi\left(\beta' x_i / \sigma_\varepsilon\right)}{\Phi\left(\beta' x_i / \sigma_\varepsilon\right)}$	$\beta' x_i + \rho\sigma_\varepsilon \frac{\varphi\left(\alpha' z_i / \sigma_v\right)}{\Phi\left(\alpha' z_i / \sigma_v\right)}$	$\beta' x_i + \sigma_\varepsilon \frac{\varphi\left(\beta' x_i / \sigma_\varepsilon\right)}{\Phi\left(\beta' x_i / \sigma_\varepsilon\right)}$
Unconditiona l mean, $E\left(y_i\right)$	$\Phi\left(\frac{\beta' x_i}{\sigma_\varepsilon}\right) E\left(y_i \mid y_i > 0\right)$	$\Phi\left(\frac{\alpha' z_i}{\sigma_v}\right) E\left(y_i \mid y_i > 0\right)$	$\Phi\left(\frac{\beta' x_i}{\sigma_\varepsilon}\right)\Phi\left(\frac{\alpha' z_i}{\sigma_v}\right) E\left(y_i \mid y_i > 0\right)$

Table 2. Descriptive Statistics of Households Characteristics

Variable	Label	Mean	Std. Dev.
WKHCons	Dependent Variable; Continuous variable; Household's weekly at-home seafood expenditure	11.091	11.726
NumberHH	Continuous variable; Household size	2.615	1.241
HHIncome	Continuous variable; Annual household's pre-tax income	5.255	3.506
Coastal	Dummy variable; Grow up 50 miles near coast	0.0938	0.292
Urban	Dummy variable; Live in urban area(including suburban area)	0.544	0.498
Female	Dummy variable; Whether the respondent is female	0.714	0.452
White	Dummy variable; Caucasian	0.948	0.222
Employed	Dummy variable; Employed full-time	0.369	0.483
Sfhome	Dummy variable; Whether consumer seafood at home	0.799	0.401
Young	Dummy variable; Age under 35	0.113	0.317
Mage	Dummy variable; Middle age (35-64)	0.759	0.428
Older	Dummy variable; Age above 64	0.128	0.334
Hschool	Dummy variable; Master degree above	0.281	0.450
College	Dummy variable; Bachelor/Associate degree	0.578	0.494
Pcollege	Dummy variable; Some college, no degree	0.141	0.348

Table 3. Descriptive Statistics of Seafood Preferences Survey vs. US Census Bureau on Kentucky Population Demographic Distribution

	US Census Kentucky (2000) (%)	Our Study (2010) (%)
GENDER		
Male	48.9	28.8
Female	51.1	71.2
AGE		
Under 20 years	27.5	0.0
20 to 24 years	7.0	1.3
25 to 34 years	14.1	10.0
35 to 44 years	15.9	15.2
45 to 54 years	13.8	25.7
55 to 59 years	5.1	18.7
60 to 64 years	4.1	14.4
65 to 74 years	6.8	13.6
75 years and over	5.7	1.1
RACE		
African-American	7.3	3.4
Caucasian	89.3	94.8
Latino or Hispanic	1.5	0.5
Asian/Pacific Islanders	0.9	0.5
Native American	0.7	0.5
Other	0.3	0.3
HIGHEST EDUCATION		
Less than high school diploma	25.8	1.9
High School only	33.6	26.2
Some college, no degree	18.5	28.4
Associate’s degree	4.9	11.8
Bachelor’s degree	10.3	17.6
Graduate or professional	6.9	14.1
EMPLOYMENT STATUS		
Employed (Full/Part-time)	57.4	47.8
Unemployed	3.5	6.8
Not in labor force (Student, retired, Homemaker)	39.1	45.4
HOUSEHOLD’S ANNUAL PRE-TAX INCOME		
0 to 14,999	22.3	7.3
15,000 to 24,999	15.4	13.7
25,000 to 49,999	30.2	38.4
50,000 to 74,999	17.2	20.2
75,000 to 99,999	7.7	11.3
100,000 to 149,999	4.6	6.6
Above 150,000	2.6	2.5

Table 4. Estimation Results of Tobit Model with Marginal Effects

Variable	Coefficient	Std. Err.	Marginal Effect	Std. Err.
Constant	15.420***	3.593		
NumberHH	2.344***	0.437	1.808	0.213
HHIncome	0.258	0.161	0.199	0.0235
Coastal	4.854***	1.765	3.744	0.441
urban	0.703	1.069	0.542	0.0638
Female	-1.675	1.169	-1.292	0.152
white	-11.297***	2.354	-8.715	1.025
employed	1.650	1.148	1.273	0.150
sfhome	0.643	1.289	0.496	0.0584
young	-3.788	2.330	-2.922	0.344
mage	-1.167	1.645	-0.901	0.106
hschool	-1.917	1.753	-1.479	0.174
college	-2.068	1.561	-1.596	0.188
Sigma	12.452***	0.398		

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

Table 5. Estimation Results of Cragg Model- the Participation Equation

Variable	Coefficient	Std. Err.
Constant	1.716***	0.516
NumberHH	0.0549	0.0533
HHIncome	0.00129	0.0200
Coastal	0.820**	0.321
urban	0.106	0.130
Female	-0.180	0.147
white	-0.447	0.380
employed	-0.0460	0.138
sfhome	0.124	0.151
young	-0.598**	0.290
mage	-0.279	0.225
hschool	-0.252	0.222
college	-0.212	0.203

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

Table 6. Estimation Results of Cragg Model- the Consumption Equation with Marginal Effects

Variable	Coefficient	Std. Err.	Marginal Effect	Std. Err.
Constant	-15.222	13.987		
NumberHH	7.766***	1.812	1.986	0.939
HHIncome	1.160**	0.566	0.297	0.140
Coastal	8.297	5.691	2.122	1.004
urban	1.011	3.911	0.259	0.122
Female	-2.270	4.083	-0.581	0.275
white	-26.639***	7.096	-6.813	3.222
employed	7.678*	4.181	1.964	0.929
sfhome	-0.210	4.754	-0.0537	0.0254
young	-2.635	8.553	-0.674	0.319
mage	-0.194	6.309	-0.0495	0.0234
hschool	-3.458	6.241	-0.884	0.418
college	-4.473	5.353	-1.144	0.541
Sigma	21.189***	2.338		

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