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Convergent validity of stated preference methods to estimate willingness-to-pay for seafood traceability: The case of Gulf of Mexico oysters*

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Abstract

In this study we compare willingness to pay for a seafood traceability system form contingent behavior demand and contingent valuation referendum vote models using data from a survey of Gulf of Mexico oyster consumers following the BP oil spill in 2010. We estimate a fixed effects model of oyster demand using contingent behavior data and find that a traceability program increases demand and consumer surplus. We estimate a referendum model for the seafood traceability program using contingent valuation data. We find that welfare estimates from the contingent behavior and contingent valuation methods are convergent valid under certain conditions.

Keywords: Contingent behavior, contingent valuation, convergent validity, oyster, traceability

JEL Codes: Q22, Q51

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1. Introduction

Determination of the validity of willingness-to-pay estimated with stated preference methods is important for their use in benefit-cost and other policy analyses. One approach for establishing convergent validity is through a valuation comparison study in which theoretically similar valuation estimates from two or more methodologies are compared. Estimates that are statistically similar (i.e., overlapping confidence intervals) achieve convergent validity increasing the confidence in both valuation estimates. There is some consensus that the contingent valuation method can achieve convergent validity with revealed preference methods (Carson et al. 1996).

Previous seafood demand valuation studies have used only one type of stated preference data such as contingent behavior (Huang, Haab, and Whitehead 2004, Parsons, et al. 2006, Morgan, Martin, and Huth 2009, Morgan, et al. 2013, Beaumais and Appéré 2013, Morgan, Whitehead, and Huth 2015, Morgan, et al. 2016), contingent ranking (Johnston and Roheim 2006), contingent valuation (Lin and Milon 1995, Whitehead et al. 2012, Salladarré et al. 2016) and discrete choice experiments (Johnston, et al. 2001, Fonner and Silvia 2015, Bi, House and Gao 2016, Petrolia, Walton and Yehouenou 2015). Whitehead, Haab, and Parsons (2003) present both contingent behavior and contingent valuation welfare estimates but are unable to compare these under similar scenarios.

In this study we compare willingness to pay for a seafood traceability program from similar contingent behavior demand and referendum vote contingent valuation scenarios using data from a survey of Gulf of Mexico oyster consumers following the BP oil spill in 2010. On January 4, 2011, the Food Safety Modernization Act (FSMA) was signed into law in the U.S. While there are several components to the new law, essentially FSMA shifts the food-safety focus from reaction and response to prevention. One component of FSMA that relates directly to this research charges FDA with improving traceability within the U.S. food supply. FSMA requires FDA to ultimately establish a product tracing system to quickly track and trace food in the U.S. We estimate a fixed effects model of oyster demand using contingent behavior data and find that an FDA traceability program increases consumer surplus. We estimate a referendum model for the seafood traceability program using contingent valuation data. We find that convergent validity is achieved statistically between contingent behavior and contingent valuation methods under certain conditions but differences in welfare estimates are large.

2. Stated Preference Survey

We conducted an internet-based surveys of oyster consumers (aged 18 and over), sampled from the U.S. states in which there are documented cases of oyster-related deaths: Florida, Alabama, Mississippi, Louisiana, Texas, and California. Due to a request from Georgia Sea Grant, we also sampled consumers from that state. The survey was administered on November and December, 2010, approximately 7 to 8 months after the *Deepwater Horizon* oil spill by Online Survey Solutions. The survey asked respondents questions designed to elicit attitudes regarding the spill, seafood safety concerns, expectations regarding the length of the oyster harvest ban in Louisiana, and stated preference consumption behavior based on expected ban length and the imposition of a new seafood traceability system.

After a revealed preference oyster meals question, respondents were asked seven similarly worded stated preference questions. Respondents were asked whether, compared to the number of meals they revealed they consume in a typical year, they expected to eat more, less, or the same number of oyster meals next year.[1] Respondents were then prompted to state how many more or less they would eat. Respondents were asked to state whether they would eat more, less, or the same number of meals under both a price increase and a price decrease scenario (while being informed that the price of all other food products remained the same). Each respondent was presented with one randomly assigned price increase of $1, $3, $5, or $7 and one randomly assigned price decrease of either $1, $2, $3, $4.

Respondents were also asked stated preference questions under different information treatments. In the first treatment, respondents were informed that following the *Deepwater Horizon* oil spill, the State of Louisiana Health and Hospitals closed several Louisiana shellfish harvest areas to the harvest of oysters and other shellfish. Respondents were then asked to imagine that the Louisiana ban on harvesting oysters from affected areas lasts for about another *x* months, where *x* was randomly assigned and varied across respondents from a list of four possible values: "1 month", "3 months", "6 months", or "9 months". Then, supposing that the average price of their oyster meals stays the same, respondents were asked for the number of meals they would eat. All respondents were then presented with a traceability scenario:

> Seafood traceability can be thought of as a system for maintaining and making available detailed information on a particular seafood product throughout each step of harvest, processing, distribution, and sales. In land based agriculture traceability is termed "farm to fork". Here it might be termed "harvest to home" as the path from the harvest bed to the final consumer is recorded and traceable.

[1] Respondents were informed that oyster meals included any meal in which the main course was oysters, or oysters were an important ingredient in the dish (like gumbo), or meals in which they are an oyster appetizer. Pictures were also displayed to provide examples of oyster meals.

Respondents were told to assume that the Louisiana ban continues for the same period of time as in the previous question, but now there is a traceability system in place making the labeling of the location of catch for all oyster products mandatory such that the state of harvest is always known to the consumer. Again assuming that the average price of an oyster meal is unchanged, respondents were asked to state the number of annual oyster meals that they would consume.

Respondents were then asked a similar behavior question having been told that the Louisiana ban on oyster harvesting from all affected areas is lifted right now but again, the traceability system is in place. The final question asked respondents to state their expected number of annual oyster meals with the ban lifted, a traceability system in place, but now due to the additional costs incurred by oyster producers to label their product, the program will result in an increase in the price of an average oyster meal for all consumers. The price increase was randomly assigned to consumers from $1, $3, $5, or $7.

The oyster consumption questions were followed by a contingent valuation referendum vote scenario:

> Suppose that the seafood traceability system is put to a national referendum. The system will make mandatory the labeling of the location of catch for all oyster products such that the state of harvest is always known to the consumer. However, because of the additional costs incurred by oyster producers to label their product, the program will result in an increase in the price of an average oyster meal for all consumers. Imagine that you have the opportunity to vote in this national referendum. If more than 50% of those voting vote for the FDA

Oyster Food Safety Modernization Act, the FDA would be required to put the new Act into practice. If you could vote today and you knew that the price of your average oyster meal would go up by [ΔP] but the price of all other food would stay the same, would you vote for or against the proposed law?

Respondents could answer “for,” “against,” or “undecided.” The price increase [ΔP] is the same as presented to respondents in the contingent behavior questions. Those who voted “for” the policy were asked a question about their certainty: How sure are you about your choice to vote for the proposed law? Respondents could answer “not sure at all,” “not very sure,” “somewhat sure,” or “very sure.”

3. Data

There were 795 oyster consumers that completed the survey. Almost one-half of these had participated in a similar survey before the BP/DWH oil spill (see Morgan et al. 2016). A number of respondents answered the demand questions in ways that suggest a lack of attention to the scenario or basic irrationality. For example, 101 respondents increase/decrease their stated preference consumption of oyster meals with a price increase/decrease and 126 respondents state that they would consume fewer oyster meals with a traceability program. For the purposes of this paper we discard these 162 respondents in order to test convergent validity for the subsample that behaves rationally with respect to price and would prefer the traceability program at zero cost. We use the remaining 633 respondents in the contingent behavior and contingent valuation analyses.

In Table 1 we present the contingent behavior oyster meals for the seven hypothetical scenarios. In the baseline scenario, 15 oyster meals are consumed. When the price increases oyster meals fall to 13 and with a price decrease oyster meals rise to 17. With the gulf shellfish harvest ban in effect oyster meals are 15. The traceability program increases oyster meals slightly with the ban in place and slightly more when the ban is removed. With the traceability program and a price increase oyster meal consumption is about one meal greater compared to the price increase scenario.

Forty-four percent of respondents voted "for" the seafood traceability program in the referendum, 28% voted "against" and 27% were "undecided." Of those who vote "for" 53% were very sure about their votes and 94% were at least "somewhat sure" about their vote. In Table 3 we present the referendum votes in the contingent valuation scenario for the seafood traceability system. The percentage of "for" votes falls from 58% to 36% as the price change increases from \$1 to \$5 and increases to 39% at \$7. We recode "for" votes to against/undecided for those who are "very sure" or at least "somewhat sure" about their vote. The pattern of recoded "for" votes is similar to the pattern for all of the "for" votes. The differences in each treatment of the frequency of "for" votes across the price changes is statistically significant according to the chi-squared statistics with three degrees of freedom.

4. Regression Results

We estimate a fixed effects count data Poisson demand model:

$$ln\lambda_{it} = \beta_i + \beta_1 \Delta P_i + \beta_2 BAN + \beta_3 TRACE$$

where ΔP is the change in the price of an oyster meal, individuals are indexed i = 1, …, 633 and t = 1, …, 6 denotes annual oyster meals under six stated preference scenarios. Variables for the fishing ban ($BAN = x$ months when $t = 4$ and 5) and the traceability program ($TRACE = 1$ when $t = 5$, 6 and 7) are included. The distribution of meals conditioned on u_{it} is Poisson with conditional mean and variance, λ_{it}.

Table 3 presents the regression results from the fixed effects Poisson oyster demand model. The coefficient on the change in oyster meal price is negative and statistically significant, so the sampled oyster consumers are behaving in line with economic theory. The coefficient on BAN is not statistically significant so the expected length of the remaining ban is not important in altering behavior. The coefficient on the traceability program is positive and statistically significant indicating an increase in oyster demand.

If willingness to pay (WTP) is distributed log-normal, $WTP = \exp(\alpha + \varepsilon)$ where ε is $N(0, \sigma^2)$, the probability of a "for" response to the referendum question is the probability that the willingness to pay is greater than or equal to the change in price:

$$
\begin{aligned}
\Pr(for) &= \Pr\left(\exp(\alpha + \varepsilon) \geq \Delta P\right) \\
&= \Pr\left(\alpha - \ln \Delta P \geq \varepsilon\right) \\
&= \Pr\left(\frac{\alpha - \ln \Delta P}{\sigma} \geq \frac{\varepsilon}{\sigma}\right)
\end{aligned}
$$

where α / σ is a probit intercept coefficient and $-1/\sigma$ is the probit coefficient on $ln\Delta P$ (Cameron and James, 1987).

The probit referendum models are presented in Table 4. The coefficient on the natural log of the change in the oyster meal price is negative and statistically significant for each of the three measures of the "for" votes with increasing certainty. The increasing certainty is captured in the constants with only the constant in the "all for" vote model being statistically significant at the

90% confidence level. The constant in the "somewhat sure for" model is not statistically significant. The constant in the "very sure for" model is negative and statistically significant.

5. Convergent Validity

With the semi-log functional form the baseline consumer surplus per meal is: $CS = \frac{-1}{\beta_1}$ (Bockstael and Strand 1987). The change in consumer surplus per meal as a result of traceability program is: $\Delta CS = \frac{-\beta_3}{\beta_1}$. Consumer surplus estimates are calculated together with 95% confidence intervals constructed using a bootstrapping procedure (Krinsky and Robb 1986). The consumer surplus per meal estimate is $27.04 (with a 95% confidence interval ranging from $24.47 to $29.61). The traceability program increases consumer surplus per meal by $0.89 with a 95% confidence interval ranging from $0.48 to $1.29.

Median willingness to pay per meal from the referendum model is $WTP = \exp(\alpha)$ and the 95% confidence intervals are constructed using a bootstrapping procedure (Cameron and James 1987, Krinsky and Robb 1986). The willingness to pay per meal from the "all for" model is $1.79 with a 95% confidence interval of 0.94 to 2.63. The willingness to pay per meal from the "somewhat sure for" model is $1.38 with a 95% confidence interval of 0.65 to 2.11. The willingness to pay per meal from the "very sure for" model is $0.24 with a 95% confidence interval of -0.03 to 0.51.

We find that differences in the consumer surplus and median willingness to pay estimates are not statistically significant. The 95% confidence intervals overlap. However, this obscures large differences in the point estimates. Median willingness to pay from the "all for" and "somewhat sure" models are 101% and 55% higher than the consumer surplus estimate. Median willingness to pay from the "very sure" models is 73% lower than the consumer surplus estimate. Since the "somewhat sure" willingness to pay estimate has the smallest difference from the consumer surplus estimate we consider it our best estimate.

The consumer surplus estimates are robust to alternative econometric models such as random effects Poisson and random and fixed effects ordinary least squares models. In contrast, the contingent valuation welfare measures are very sensitive to the econometric model. The willingness to pay estimates from linear probit models are not statistically different from zero at the 95% confidence level. Linear probability models produce willingness to pay estimates that are at least three times larger than the median willingness to pay estimates from the log-linear probit. Given these results, we judge the log-linear probit models to produce the most reliable estimates of willingness to pay.

6. Conclusions

Willingness to pay estimates from contingent behavior and contingent valuation methods are convergent valid but the differences in point estimates are large. Since stated preference data is typically conducted with an eye towards policy analysis, a meaningful question is what measure of welfare should be used? Given our results, we would recommend that the midpoint of the contingent behavior and contingent valuation estimates, $1.135 per meal, be used, with each estimate included for sensitivity analysis. To illustrate, consider that aggregate benefits of the traceability program are equal to the product of the benefit per meal and the number of meals. Our estimate of the number of Gulf of Mexico oyster meals is based on average annual landings of 17.93 million pounds of Eastern oysters in the Gulf of Mexico (2014). With a 100-pound sack containing about 250 oysters and assuming the average oyster meal containing about 6 oysters, this equates to consumers eating about 7.47 million Gulf of Mexico oyster meals annually. Based on this estimate of oyster meals the annual benefit of the traceability program to oyster consumers is $8.48 million with worst and best case estimates of $6.65 million and $10.31 million. These benefit estimates could be compared to the costs of an oyster traceability program to determine program efficiency (Miller et al. 2014). Convergent validity of the benefit estimates lends more confidence to the comparison of market based cost estimates with stated preference benefit estimates.

Table 1. Contingent Behavior Oyster Meals

Scenario	Mean	Standard Deviation
Baseline	14.92	30.74
Price Increase	12.81	28.70
Price Decrease	17.01	34.45
Ban	15.08	30.86
Ban and Traceability	15.38	30.95
Traceability	15.48	30.94
Traceability and Price Increase	13.78	29.67
Cases	633	

Table 2. Referendum Votes

	Percentage "For" Votes		
ΔP	All	Somewhat Sure	Very Sure
1	58	56	34
3	42	37	22
5	36	34	16
7	39	38	18
Total	44	42	23
$\chi 2$ (df=3)	19.62	20.29	19.00

Table 3. Fixed Effects Poisson Model of Oyster Demand

Dependent variable = MEALS

	Coefficient	S.E.
ΔP	-.0370	0.00174
Ban	-0.00155	0.00187
Trace	.0328	0.00813
Sample size	4433	
Periods	7	
Cases	633	
LL	-7402.80	
AIC	14811.60	

Table 4. Probit Referendum Vote Model

	All For		Somewhat Sure For		Very Sure For	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Constant	0.1604	0.0889	0.0860	0.0887	-0.4199	0.09197
$\ln(\Delta P)$	-0.2766	0.0664	-0.2687	0.0664	-0.2964	0.0716
χ^2	17.51		16.48		17.19	
AIC	855.60		847.50		672.90	

References

Beaumais, Olivier, and Gildas Appéré. "Recreational shellfish harvesting and health risks: A pseudo-panel approach combining revealed and stated preference data with correction for on-site sampling." Ecological Economics 69, no. 12 (2010): 2315-2322.

Bi, Xiang, Lisa House, and Zhifeng Gao. "Impacts of Nutrition Information on Choices of Fresh Seafood Among Parents." Marine Resource Economics 31, no. 3 (2016): 000-000.

Bockstael, Nancy E., and Ivar E. Strand. "The effect of common sources of regression error on benefit estimates." Land Economics 63, no. 1 (1987): 11-20.

Cameron, Trudy Ann, and Michelle D. James. "Efficient estimation methods for 'closed-ended' contingent valuation surveys." The review of economics and statistics (1987): 269-276.

Carson, Richard T., Nicholas E. Flores, Kerry M. Martin, and Jennifer L. Wright. "Contingent valuation and revealed preference methodologies: comparing the estimates for quasi-public goods." Land economics (1996): 80-99.

Fonner, Robert, and Gil Sylvia. "Willingness to pay for multiple seafood labels in a niche market." Marine Resource Economics 30, no. 1 (2015): 51-70.

Huang, Ju-Chin, Timothy C. Haab, and John C. Whitehead. "Risk valuation in the presence of risky substitutes: an application to demand for seafood." Journal of Agricultural and Applied Economics 36, no. 01 (2004): 213-228.

Johnston, Robert J., and Cathy A. Roheim. "A battle of taste and environmental convictions for ecolabeled seafood: A contingent ranking experiment." Journal of Agricultural and Resource Economics (2006): 283-300.

Johnston, Robert J., Cathy R. Wessells, Holger Donath, and Frank Asche. "Measuring consumer preferences for ecolabeled seafood: an international comparison." Journal of Agricultural and Resource Economics (2001): 20-39.

Krinsky, Itzhak, and A. Leslie Robb. "On approximating the statistical properties of elasticities." The Review of Economics and Statistics (1986): 715-719.

Lin, Chung-Tung Jordan, and J. Walter Milon. "Contingent valuation of health risk reductions for shellfish." Valuing Food Safety and Nutrition (1995) (1995).

Miller, Alexander, Dag Heggelund, and Ted McDermott. 2014. Digital Traceability for Oyster Supply Chains: Implementation and Results of a Pilot. 222nd ed. Publication Number vols. Ocean Springs: Gulf States Marine Fisheries Commission Publication. http://www.gsmfc.org/publications/GSMFC%20Number%20222.pdf

Morgan, O. Ashton, Gregory S. Martin, and William L. Huth. "Oyster demand adjustments to counter-information and source treatments in response to Vibrio vulnificus." Journal of Agricultural and Applied Economics 41, no. 3 (2009): 683-696.

Morgan, O. Ashton, John C. Whitehead, William L. Huth, Greg S. Martin, and Richard Sjolander. "A split-sample revealed and stated preference demand model to examine homogenous subgroup consumer behavior responses to information and food safety technology treatments." Environmental and Resource Economics 54, no. 4 (2013): 593-611.

Morgan, O. Ashton, John C. Whitehead, and William L. Huth. "Accounting for heterogeneity in behavioural responses to health-risk information treatments." Journal of Environmental Economics and Policy (2015): 1-15.

Morgan, O. Ashton, John C. Whitehead, William L. Huth, Greg S. Martin, and Richard Sjolander. "Measuring the Impact of the BP Deepwater Horizon Oil Spill on Consumer Behavior." Land Economics 92, no. 1 (2016): 82-95.

Parsons, George R., Ash O. Morgan, John C. Whitehead, and Tim C. Haab. "The welfare effects of pfiesteria-related fish kills: A contingent behavior analysis of seafood consumers." Agricultural and Resource Economics Review 35, no. 2 (2006).

Petrolia, Daniel R., William Walton, and Lauriane Yehouenou. "Is There a Market for Branded Gulf of Mexico Oysters?" Mississippi State University Department of Agricultural Economics Working Paper 15-4 (2015).

Salladarré, Frédéric, Dorothée Brécard, Sterenn Lucas, and Pierrick Ollivier. "Are French consumers ready to pay a premium for eco-labeled seafood products? A contingent valuation estimation with heterogeneous anchoring." Agricultural Economics (2016).

Whitehead, John C., Timothy C. Haab, and George R. Parsons. "Economic effects of Pfiesteria." Ocean & coastal management 46, no. 9 (2003): 845-858.

Whitehead, John C., O. Ashton Morgan, William L. Huth, Gregory S. Martin, and Richard Sjolander. Willingness-to-pay for oyster consumption mortality risk reductions. Appalachian State University Department of Economics Working Paper No. 12-07. 2012.

Appendix. Stated Preference Oyster Meal Questions

SP Question	Text
SP1: Expected meals consumed next year	Please think about the number of oyster meals you expect to eat over the next 12 months starting from today. Starting with the [NUMBER] oyster meals you told us that you typically eat in a year, if the average price of your oyster meals stays the same do you think you will eat more, less, or the same number of oyster meals over the next year? *Then*, about how many more or less oyster meals do you expect to eat over the next year?
SP2 and SP3: Expected meals consumed next year with a price increase (decrease)	Oyster prices change over time. For example, if oyster harvests are large, prices go down. When oyster harvests are smaller, prices go up. Suppose the price of your portion of your typical oyster meal goes up (down) by [DOLLAR_UP] [(DOLLAR_DOWN)] but the prices of all other food products stay the same. Compared to the [NUMBER_SP1] oyster meals you said that you expect to eat over the next year, do you think you would eat more, less, or the same number of oyster meals over the next year with the higher (lower) price for each meal? *Then*, about how many more or less oyster meals do you expect to eat over the next year?
SP4: Ban	Imagine that the ban on harvesting oysters from affected areas lasts for about another [NUMBER]. Suppose that the average price of your oyster meals stays the same, compared to the [NUMBER_SP1] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals next year?? *Then*, about how many more or less oyster meals do you expect to eat over the next year?
SP5: Ban and Traceability System	Again assume that the Louisiana ban on harvesting oysters from affected areas lasts for another [NUMBER] but now a seafood traceability system is in place making the labeling of the location of catch for all oyster products mandatory such that the state of harvest is always known to the consumer. Suppose that the average price of your oyster meals stays the same, compared to the [NUMBER_SP4] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals next year? *Then*, about how many more or less oyster meals do you expect to eat over the next year?
SP6: Ban Lifted and Traceability System	Suppose now that the Louisiana ban on oyster harvesting from all affected areas is lifted right now and a seafood traceability system is in place making the labeling of the location of catch for all oyster products mandatory such that the state of harvest is always known to the consumer. If the average price of your oyster meals stays the same, compared to the [NUMBER_SP5] oyster meals you previously told us you expect to eat next year, do you think you will eat

	more, less, or about the same number of oyster meals next year? *Then*, about how many more or less oyster meals do you expect to eat over the next year?
SP7: Ban Lifted, Traceability System, and Price Increase	If the Louisiana ban on oyster harvesting from all affected areas is lifted right now and a seafood traceability system is in place making the labeling of the location of catch for all oyster products mandatory such that the state of harvest is always known to the consumer. However, because of the additional costs incurred by oyster producers to label their product, the program will result in an increase in the price of an average oyster meal for all consumers. Suppose that the price of your portion of your average oyster meal goes up by [DOLLAR_UP] but the prices of all other food products stay the same, compared to the [OYSTER_SP4] oyster meals you previously told us you expect to eat next year, do you think you will eat more, less, or about the same number of oyster meals next year? *Then*, about how many more or less oyster meals do you expect to eat over the next year?