Recreational Boater Willingness to Pay for an Atlantic Intracoastal Waterway Dredging and Maintenance Program[1]

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Recreational Boater Willingness to Pay for a Dredging and Maintenance Program for the Atlantic Intracoastal Waterway in North Carolina

Abstract: We estimate the changes in value of recreational boating with a dredging program along the Atlantic Intracoastal Waterway (AIWW) in North Carolina. We use willingness to pay data from the contingent valuation method and stated preference data on trip changes. Willingness to pay depends in expected ways on the magnitude of trip change and income. We find that each recreational boater would be willing to pay $97 annually in the form of a surcharge on their boat registration fee. The aggregate annual benefits of the dredging and maintenance policy are $20.5 million.

Keywords: Atlantic Intracoastal Waterway, Recreational Boater, Willingness to Pay, Dredging

Introduction

The U.S. Congress authorized the Atlantic Intracoastal Waterway (AIWW) in 1919. The purpose of this sheltered passageway was to provide the commercial shipping industry with a safer alternative to navigation in the open Atlantic Ocean. Recreational use of the AIWW by private boaters, both as a route to ocean inlets and as a final recreation destination, has grown tremendously since construction of the AIWW. The U.S. Army Corps of Engineers (USACE) is responsible for maintenance and operational dredging of the AIWW. The AIWW has an authorized navigable depth of 12 feet. It is actually maintained at depths ranging from 7 to 12 feet. The average depth of the North Carolina portion of the Atlantic Intracoastal Waterway is 10 feet. Federal funding for maintenance and operational dredging of the AIWW has diminished causing numerous concerns for those entities that rely on the AIWW for navigation and their livelihood.

The purpose of this paper is to estimate the changes in value of recreational boating with a dredging program along the AIWW in North Carolina. Previous research on the AIWW has focused on economic impacts. In contrast, we use the contingent valuation method to estimate the economic benefits of changes in dredging activities. We link stated preference value and behavior data in an application of a model proposed by Whitehead (2005). We conclude with an aggregation of benefits appropriate for benefit-cost analysis.

Theory

Willingness to pay depends on the quality of boat outings (e.g., depth), the cost of a boat outing (i.e., travel cost) and household income and other socioeconomic variables. Willingness to pay is the difference in expenditure functions

$$
\begin{aligned}
WTP &= e(p,q',u) - e(p,q,u) \\
&= e(p,q',v(p,q,y)) - e(p,q,v(p,q,y) \\
&= e(p,q',v(p,q,y)) - y \\
&= s(p,q',q,y)
\end{aligned} \tag{1}
$$

where *WTP* is willingness to pay, *e*(.) is the expenditure function, *v*(.) is the indirect utility function, *s*(.) is the variation function, *q* is the current quality of boat outings, *q'* is a degraded quality of boat outings, *p* is the cost of a boat outing (i.e., travel cost) and *y* is household income.

Willingness to pay should increase with quality, decrease with the cost and increase (decrease) with income if boating is a normal (inferior) good. Measurement of the cost of a boat outing in the AIWW context is problematic due to a large number of potential access points. The potential measurement error associated with trip cost and the absence of historic data on quality suggests a model of willingness to pay in which the change in boat trips that would arise from a dredging policy that affects boating quality is included as an independent variable

$$WTP = s(\Delta x(q,q'),y) \tag{2}$$

Willingness to pay is expected to increase with the change in the number of boat outings.

Survey

We developed a survey instrument to be administered to recreational owners of boats longer than 16 feet utilizing the AIWW in North Carolina (Herstine, Dumas and Whitehead, 2007). The survey instrument was designed to elicit responses from both transient and local recreational boaters along the AIWW in North Carolina about frequency of use of the AIWW, expenditures while using the AIWW and the impact that

dredging or the lack of dredging of the AIWW and its associated shallow draft inlets would have on future use of the AIWW.

Survey administration began in June 2005 and concluded in late November 2005 at multiple locations from the Virginia – North Carolina border in Currituck County to the North Carolina – South Carolina border in Brunswick County. The survey administration locations in North Carolina along the AIWW included Coinjock, the Dismal Swamp Visitors' Center, Belhaven, Oriental, Beaufort, Morehead City, Atlantic Beach, Swansboro, Scott's Hill, Wrightsville Beach, Carolina Beach and Southport. Approximately 1,400 field surveys were collected from North Carolina resident and non-resident boaters.

Willingness to pay is measured with the contingent valuation method (CVM). The CVM directly elicits economic values in highly structured hypothetical scenarios (Mitchell and Carson 1989). Survey respondents are presented with the following hypothetical AIWW dredging scenario:

> *Federal government funds for dredging of the Atlantic Intracoastal Waterway in NC are threatened. If dredging completely stops, the average depth of the NC portion of the Atlantic Intracoastal Waterway would be about 4 feet. A NC dredging and maintenance program would provide enough funding to maintain an average depth of 12 feet in the NC portion of the Atlantic Intracoastal Waterway. The dredging and maintenance program would be funded by a $A surcharge on your annual boating registration fee. Each registered boater with a boat longer than 16 feet using the NC portion of the Atlantic Intracoastal Waterway would be*

required to purchase a sticker each year to be placed alongside the registration number on the boat. Would you be willing to pay $A in additional annual boating registration fees each year for this program?

One of five dollar amounts, $A = $10, $25, $50, $75 or $100, was randomly assigned to each respondent. Respondents who answered "no" to the willingness to pay question were asked if they would be willing to pay $1. Respondents who answered "yes" to either question were directed to a follow-up question that asked how sure they were that they would really pay the amount if actually placed in that situation.

In order to connect hypothetical willingness to pay responses with behavior, boaters were asked about their boating trips under various conditions, including those presented in the hypothetical scenario. First, boaters were asked for the number of separate boat outings taken on the AIWW in North Carolina in their boat during the past 2 months. Respondents were asked the same question for the past 12 months (RP-Trips10). Boaters are asked about the number of boat outings that they would take on the AIWW over the next twelve months under current conditions (i.e., 10 foot depth, SP-Trips10) and over the next 12 months if dredging of the AIWW was increased and the average depth of the North Carolina portion was about 12 feet (SP-Trips12). Finally, boaters are asked about the number of boat outings that they would take on the AIWW over the next twelve months if dredging stopped completely and the average depth of the North Carolina portion was about 4 feet (SP-Trips4).

Data

After deletion of cases with missing values on key economic variables we consider a sample of 902 North Carolina resident owners of boats greater than or equal to

16 feet in length. Variables considered in this analysis, their description and statistical summary are presented in Table 1. North Carolina residents took an average of 38 boat trips on the AIWW during the 12 months prior to the survey interview. The number of trips expected during the next 12 months with current depth, increased depth and decreased depth are 42, 46 and 23.

The nonparametric signed rank test indicates that differences in trip levels across scenario are statistically significant ($p < 0.0001$ for each comparison). However, these tests may be confounded by other variables. Holding these variables constant in a count data regression analysis allows for a multivariate test for differences in trip levels (Herstine, Dumas and Whitehead, 2007). Control variables include travel cost and income. These tests indicate that differences in trip levels are significantly different. Respondents state that fewer trips would be taken with an average depth of 4 feet and more trips would be taken with an average depth of 12 feet.

Income is typically subject to significant item non-response in household surveys. In this survey, 9% of residents and 12% of nonresidents do not report their household income. For reporting households, household income is $85 thousand. In order to retain willingness to pay information on those boaters who do not report their income we code missing income as zero (Income2) and include a dummy variable for respondents with missing income (Missinc). The average annual household income with 9% of the missing income values coded as zero income is $77 thousand.

About 74% of boaters are willing to pay the bid amount. We define "very sure" respondents as those who answer 7 or above on a certainty scale question (Whitehead and Cherry, forthcoming). Over 90% of residents and nonresidents are very sure that they

actually would pay the amount. In order to mitigate hypothetical bias we consider only those 67% who are very sure about their willingness to pay (Yes1sure). The percentage of very sure yes responses declines with the bid (Table 2). Willingness to pay the bid amount falls from 87% to 47% as the bid amount rises from $10 to $100.

The credibility of hypothetical CVM scenarios is a necessary condition for the validity of willingness to pay responses. Several questions were asked of respondents in order to determine the credibility of the CVM scenarios. Boaters are asked for their perceptions of the effectiveness of the dredging program in terms of how likely they think it is that the NC portion of the AIWW would be maintained at an average depth of 12 feet. Most respondents think that it is very likely or somewhat likely. Thirty percent of boaters think that maintenance of this depth is not likely at all. We control for differences in scenario credibility in the model below.

Empirical Model

A regression model is used to estimate the average willingness to pay for the permit that would fund the dredging program and the determinants of willingness to pay. In order to combine the stated behavior and willingness to pay data in a theoretically appropriate way we use the empirical model described by Whitehead (2005)

$$(3) \qquad \begin{aligned} WTP &= \alpha E(\Delta x) + \beta' X_1 + e_1 \\ \Delta x &= \delta' X_1 + \lambda' X_2 + e_2 \end{aligned}$$

The empirical willingness to pay model is a parameterization of the theoretical model described above where α is the coefficient on the change in trips variable, β and δ are coefficient vectors on the vector of independent variables and a constant, X_1, in the willingness to pay and change in trips models and λ is a coefficient vector on instrumental variables, X_2. The error terms e_1 and e_2 are normally distributed.

If this model is estimated independently, the coefficient on the change in trips variable will likely be biased since the change in trips is an endogenous variable. With endogeneity bias, the unobserved variables that affect both willingness to pay and the change in trips will be correlated $r(e_1, e_2) \neq 0$, and the change in trips variable in the willingness to pay model will be correlated with the error term $r(\Delta x, e_1) \neq 0$.

In order to minimize endogeneity bias we estimate the change in trips as a function of all independent variables in the willingness to pay model and a vector of instrumental variables X_2. Instrumental variables are uncorrelated with willingness to pay but highly correlated with the change in trips. The predicted value from the trip change model, $E(\Delta x)$, is used as an independent variable in the willingness to pay model in order to avoid endogeneity bias.

Empirical Results

Since the data is collected with an on-site survey it likely suffers from avidity bias (Thomson, 1991). More avid boaters are more likely to be included in our sample. We weight the regression analysis to reduce the effects of avidity bias. The sample weight is $WT = \bar{x} / x_i$ where $\bar{x}$ is the sample average trips and x_i is the individual number of boating trips.

The dependent variable in the trip change model is the difference in stated preference boating trips with a 12 foot depth and stated preference trips with a 4 foot depth. We estimate the trip change model with the Tobit due to the censored nature (i.e., large number of zeros) of the dependent variable (Table 3). Baseline boating trips, boat draft, boater age and its square are the instrumental variables. The change in trips is increasing in baseline trips, boat draft and age (at a decreasing rate). The coefficient on

household income is the only other variable that is statistically significant. Households with greater income report a larger difference in trips with the change in depth. The predicted value is a change of 17 annual boating trips.

The probability of a yes response is equal to the probability that willingness to pay is greater than or equal to the bid amount. We estimate the probability of a yes response with the censored probit model (Cameron and James 1987)

$$\begin{aligned} \Pr(yes) &= \Pr(WTP > A) \\ &= \Pr\left(\frac{\alpha\Delta x + \beta' X_1 + e_1}{\sigma} > \frac{A}{\sigma}\right) \\ &= \Pr\left(\frac{\alpha\Delta x + \beta' X_1 - A}{\sigma} > \frac{e_1}{\sigma}\right) \end{aligned} \tag{4}$$

Mean willingness to pay and standard errors are constructed using the Delta Method (Cameron 1991).

The scale parameter, σ, is the negative inverse of the probit coefficient on the dollar amount variable and is positive and statistically significant (Table 3). This result indicates that boaters are less likely to be willing to pay as the dollar amount rises. The probit coefficient vector is multiplied by the scale parameter so that each coefficient can be interpreted as a marginal effect. A marginal effect is the impact on willingness to pay of a one unit change in the independent variable. Resident boaters who think the dredging program is "not likely at all" to be effective are willing to pay $30 less than those who think it is somewhat or very likely to be effective. Boaters are willing to pay $3.20 more for each additional $10,000 increase in income. The income elasticity of willingness to pay is 0.26. Each 10% increase in income increases willingness to pay by 2.6%.

Boaters are willing to pay $1.31 for each additional boat outing. Considering that the average change in boat outings as average depth increases from 4 feet to 12 feet is 17,

the value of these additional outings is about $22 of the $97 total willingness to pay estimate per boater. The remainder of total willingness to pay, $75, can be interpreted as the increased value of boat outings that are currently taken. Evaluating each coefficient at the mean of the independent variable, the average willingness to pay for the AIWW permit is $97.

Conclusions

In this paper we estimate the recreational boater willingness to pay for a dredging program for the NC portion of the AIWW. The aggregate benefits of an AIWW dredging policy is the sum of aggregate benefits to residents and nonresidents of NC. In February 2003, 355,453 boats were registered in NC. Of these, 144,135 were less than 16 feet. Of the 211,318 boats with length greater than or equal to 16 feet almost all, 203,953, have zip codes within the range of the zip codes of the boaters in the AIWW survey sample. We estimate that each recreational boater would be willing to pay $97 annually in the form of a surcharge on their boater registration fee to support a dredging policy that would lead to an average 12 foot depth in the NC portion of the AIWW instead of a 4 foot depth. An estimate of the aggregate annual benefits of this policy to residents is $20.5 million.

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TABLE 1—Data Summary

Variable	Description	Cases	Mean	Std. Dev.
RP-Trips10	Boating trips during past year	902	38.43	43.23
SP-Trips10	Expected boating trips during next year	902	42.33	40.81
SP-Trips12	Expected boating trips during next year with 12 foot depth	902	46.01	45.59
SP-Trips4	Expected boating trips during next year with 4 foot depth	902	23.20	32.99
Income	Household income ($1000s)	818	85.37	25.16
Income2	Household income with zeros for missing ($1000s)	902	77.42	34.50
Missinc	1 if missing income	902	0.09	0.29
Likely	1 if scenario is credible	902	0.70	0.46
Draft	Boat draft in feet	902	3.00	1.36
Age	Age of boater	902	46.27	12.13

TABLE 2—Willingness to Pay

A	Yes1sure	Cases	% Yes
$10	164	188	87%
$25	148	195	76%
$50	112	176	64%
$75	101	170	59%
$100	81	173	47%

TABLE 3—Willingness to Pay Model

	Tobit (Δx)		Censored Probit (WTP)	
	Coefficient	t-statistic	Coefficient	t-statistic
Constant	-30.30	-4.00	24.03	1.51
A	0.01	0.36		
Income2	0.08	3.16	0.32	1.98
Missinc	4.46	1.40	40.85	2.02
Likely	1.48	1.04	30.23	3.08
SP-Trips10	0.35	12.97		
E(Δx)			1.31	2.00
Draft	3.01	6.72		
Age	0.61	1.86		
Age^2	-0.01	-2.02		
σ	18.74	35.18	95.67	7.52
Model χ^2			76.32 ($p < .001$)	
WTP			97.21	12.74

Model is avidity weighted.

a/Predicted from the Tobit model.