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Testing the Reliability of the Benefit Function Transfer Approach

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This article presents an experiment designed to test the reliability of the benefit function transfer approach using contingent valuation methods. The experiment uses data collected from anglers surveyed across eight contiguous Texas Gulf Coast bay regions over three distinct time periods. Results indicate that the benefit function transfer approach tends to over-estimate benefits, implying that, at least for the case of recreational saltwater fishing in Texas, the benefit function transfer approach is not reliable.

I. INTRODUCTION

Benefit transfer is a process by which a benefit estimated for a particular ‘‘study site’’ for which data exist is transferred to a ‘‘policy site’’ for which little or no data exist [3, 4]. The process generally involves the direct transfer of benefit estimates or the transfer of an entire benefit function. In the first approach, the benefit estimate from the study site is directly transferred to the policy site. In the second approach, the estimated benefit function for a study site is transferred to a policy site and its coefficients are used to compute the policy site benefits.

The benefit function transfer approach has been described as an ideal transfer approach [5, 10]. This approach was evaluated by Loomis [10] who, in the context of a travel cost model, tested whether the coefficients of a study site benefit function were statistically equal to the coefficients of a policy site benefit function. Implicit in this evaluation, however, is the notion that if the estimated coefficients of the two benefit functions are statistically equivalent, the benefits of the study and policy sites will be also. This notion, however, may not be well founded, given that the benefits are a nonlinear function of the estimated coefficients. The nonlinearity could lead to the case where *statistically similar* benefit functions yield *statistically different* welfare measures.[1]

[1] Although in a different context, a series of articles [1, 2, 6] have shown that the nonlinearity of welfare measures produces an effect that suggests that the statistical significance of the coefficients of two benefit functions need not be related to the statistical significance of the resulting welfare measures.

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In the present research we test the reliability of the benefit function transfer approach using contingent valuation methods by investigating whether statistically similar contingent valuation functions yield statistically similar welfare measures. The test is based on data collected from saltwater anglers surveyed in eight contiguous Texas Gulf Coast bay regions in three distinct time periods. The data allow us to treat each region as a study site, while the other seven regions are considered policy sites. Hence, the data allow comparisons to be made across time, both within and across bay regions.

The test is performed as follows. First, we use a dummy variable approach to determine which contingent valuation functions are transferable across time, focusing both within and across bay regions. Second, for each bay region for each year we estimate a contingent valuation function as well as the benefits and their confidence intervals. We assume these benefit estimates are the ‘‘true’’ benefits. Third, we determine which benefit estimates are transferable by examining whether the estimates obtained from a particular function fall within the confidence interval of the estimates obtained from another function. Finally, we test the reliability of the benefit function transfer approach by comparing the results of the first step to the third step.[2]

II. THE CONTINGENT VALUATION FUNCTION AND DATA

Our referendum contingent valuation function is specified as

$$Y_i = \beta_0 + \beta_1 \ln(A_i) + e_i, \tag{1}$$

where $i = 1, 2, \ldots, n$ individuals surveyed, Y_i represents a dichotomous yes/no response to the natural log of the offer amount, A_i, by the ith individual, and e_i is a logistic error term. It is expected that as A_i increases, the probability of a ‘‘yes’’ response decreases. Although the function specified in Eq. (1) is simple, it has been used extensively in prior contingent valuation studies. We chose this simple specification to keep the analysis manageable.

The data were obtained from the Texas Parks and Wildlife Department which conducts yearly, on-site, in-person, intercept surveys. The survey instrument was administered to individuals launching boats at over 160 sites in Texas’ eight major bay regions and it asked questions dealing with the year and place of the interview site as well as other types of information. The contingent valuation question asked respondents, ‘‘Based on your current income, if the total cost of all your saltwater fishing last year was ___ dollars more, would you have quit fishing completely?’’ Values of $50, $100, $200, $400, $600, $800, $1000, $1500, $5000, $10,000, and $20,000 were rotated in the above blank so that each successive interview had a different value.

[2] The present research also contributes to the test–retest literature on the reliability of contingent valuation benefit estimates over time [9, 11]. The majority of this literature assesses the reliability of benefit estimates by applying test–retest procedures to a sample of individuals who were asked to respond to valuation questions at two distinct time periods or to information collected from questions administered at different periods in time to different samples from the sample population. In essence, our research extends this literature by examining the reliability of benefits transfer across time periods within and across geographic regions.

Important characteristics of the data are as follows. Approximately 97% of the respondents reported less than 60 saltwater fishing trips per year and 96% reported spending less than $200 on their fishing trip. To keep the focus on Texas saltwater recreational anglers, non-Texas anglers (3% of the sample) were eliminated from the data. All trips were considered to be single destination by assumption. Data from the 1987, 1988, and 1989 surveys were employed. Descriptive statistics for each Texas coastal bay region and year are presented in Table I. The number of observations across the eight Texas coastal bays ranged from 699 to 1438 in 1987, from 763 to 1499 in 1988, and from 671 to 1238 in 1989. The mean offer amount to individuals across all bays and years ranged from approximately $2000 to $3000 for each of the three years. Across the three years, the yes responses ranged from 50 to 79%.

TABLE I
Descriptive Statistics by Bay and Year

Bay[a]	No. of observation	Yes/no responses	Mean offer amount ($)
		1987	
a	943	0.72	2710
b	1015	0.79	2437
c	856	0.76	2387
d	1014	0.76	2604
e	699	0.78	2723
f	839	0.73	2572
g	1438	0.79	2195
h	1239	0.77	2276
		1988	
a	963	0.50	3150
b	824	0.68	2638
c	795	0.60	2949
d	791	0.63	2952
e	764	0.68	2943
f	763	0.64	2996
g	1499	0.69	2660
h	1064	0.72	2574
		1989	
a	671	0.54	3404
b	889	0.73	3141
c	643	0.59	3044
d	571	0.63	2808
e	734	0.70	3028
f	769	0.65	3162
g	1238	0.71	2619
h	887	0.73	2539

[a] a, Sabine; b, Galveston; c, Matagorda; d, San Antonio; e, Aransas; f, Corpus Christi; g, Upper Laguna Madre; h, Lower Laguna Madre,

III. DETERMINING THE TRANSFER OF CONTINGENT VALUATION FUNCTIONS

Given the data at hand, three types of benefit transfers are possible. First, the benefit estimate from the study site can be transferred across different time periods to the same study site. Second, the benefit estimate from the study site can be transferred across different regions within the same time period. Third, the benefit estimate from the study site can be transferred to a future time period and also a different region. In what follows we will be testing the transferability of contingent valuation functions that represent the first and third types of benefit transfer.

To determine which contingent valuation functions are transferable to a future time period (within or across bay regions), we test the equality of estimated coefficients from two functions representing different time periods. Benefit function transfer is possible when the estimated coefficients of the two functions are statistically equivalent. To set up the dummy variable model, pool the N_1 and N_2 observations from two time periods (within or across bay regions) and estimate the function

$$Y_i = \beta_0 + \beta_1 \ln(A_i) + \beta_2 D_i + \beta_3 (D_i * \ln(A_i)) + e_i, \tag{2}$$

where Y_i, A_i, and e_i are defined as in (1) and $D_i = 1$ for observations corresponding to a particular time period and zero for an alternative time period. The implications of (2) given $E(e_i) = 0$ are

$$E(Y_i \mid D_i = 0, \ln(A_i)) = \mathrm{B}_0 + \beta_1 \ln(A_i), \tag{3}$$

$$E(Y_i \mid D_i = 1, \ln(A_i)) = (\beta_0 + \beta_2) + (\beta_1 + \beta_3)\ln(A_i), \tag{4}$$

which are the mean response functions for the two time periods. Equation (2) shows β_2 as an intercept shifter and β_3 as a slope shifter.

Benefit function transferability is determined as follows. If β_2 and β_3 are statistically insignificant we conclude that the function is transferable from one time period (within or across bay regions) to another period. If β_2 is insignificant and β_3 is significant or if β_2 is significant and β_3 insignificant, we conclude that the transferability of the functions is questionable. Finally, if β_2 and β_3 are significant, we conclude that the functions are not transferable.

IV. COMPUTING THE BENEFITS AND CONFIDENCE INTERVALS

To compute the benefits for each of the eight Texas coastal bay regions for each time period we estimated Eq. (1) using a logistic regression technique. Because the data contained a few outliers (designated by yes responses to high offer amounts), we estimated a median willingness-to-pay (WTP) measure. The median WTP measure was computed as $\mathrm{WTP} = -\exp(\beta_0/\beta_1)$ where β_0 and β_1 are the estimated coefficients from Eq. 1 [7].

The confidence interval associated with each median WTP measure was computed as follows. First, using the estimated coefficients and their respective covariance matrix, we use Krinsky and Robb's technique [8] to draw 1000 random coefficients from a multivariate normal distribution. Second, we used the 1000 random coefficients to compute 1000 median WTP measures. Third, we ordered the 1000 median WTP measures from the smallest to the largest value. Fourth, we selected the median value from the ordered vector of median WTP measures. Finally, we selected the 95% confidence limits for the median WTP measures selected from the ordered vector. The location of the limits in the vector were determined as $(1000 + 1)/2 \pm \sqrt{1000}$ [12].

V. EMPIRICAL RESULTS

Equation (2) was estimated by the method of maximum likelihood using the SAS logist procedure. A total of 128 regressions were estimated, representing the pair-wise within and across bay transfers for the years 1987 to 1988 and 1987 to 1989. The estimated coefficients and their respective standard errors as well as the McFadden R^2 statistics are available from the authors. As expected, the offer amount had a negative and significant coefficient, reflecting a decreased probability of an expected yes response for an increase in the offer amount. This was found in all the estimated contingent valuation functions. McFadden's R^2 statistic was calculated to be between 0.08 and 0.16 in all cases. The R^2 statistic compares favorably with other studies employing logit estimation.

In Table II we provide a summary of the percentage of cases in which the contingent valuation function was transferable, questionable, or nontransferable across time both within and across bay regions for benefit function transfers occurring between 1987 and 1988 and between 1987 and 1989. Of the total of eight potential 1987 to 1988 within-bay function transfers, 63% were transferable, 25% were questionable, and 12% were not transferable. Likewise, the within-bay 1987 to 1989 benefit function transfer approach indicates that 50% of the functions were transferable while 38% were questionable and 12% were not transferable. These results suggest that within-bay benefits functions are transferable across time at least 50% of the time and in some cases as much as 63% of the time.

Focusing on the 1987 to 1988 across-bay benefit function transfers, we can observe that of the 56 potential benefit function transfers 50% were transferable, 36% were questionable, and 14% were not transferable. Similarly, the 1987 to 1989 across-bay benefit function transfer approach also revealed that 41% of the functions were transferable, 39% were questionable, and 20% were not transferable. As in the within-bay benefit function transfer case, these results suggests that

TABLE II
Percentage of Cases the Contingent Valuation Function Was Transferable across Time within and across Bays

	From 1987 to 1988		From 1987 to 1989	
	Within bay	Across bay	Within bay	Across bay
Transferable	63	50	50	41
Questionable	25	36	38	39
Nontransferable	12	14	12	20

the across-bay benefits functions are transferable across time between 50% and 41% of the time.

The benefit function transfer approach indicates that many of the benefit functions are transferable. However, the question that really needs to be answered is, Do these transferred benefit functions also yield statistically similar welfare measures? This is the question we now address.

In Table III we present the median WTP measure and confidence interval for each bay for each year. These median WTP values are per trip per person values which were obtained by dividing the median WTP measure by the median number of saltwater trips and then dividing the resulting value by the median number of persons in the fishing party. The 95% confidence interval is tight in most instances. It can be observed from Table III that none of the 1987−1988 and 1987−1989 within-bay benefits were transferable. It can also be observed that 93 and 91% of the 1987−1988 and 1987−1989 benefits were not transferable across regions

To determine whether statistically similar benefit functions also yield statistically similar welfare measures, we identified which functions were transferable to other time periods (within and across bays) and then examined whether the benefits were statistically similar using the information contained in Table III. The results were startling. For the 1987 to 1988 case, we found that of the 5 within-bay functions that were transferable, none yield statistically similar welfare measures. Likewise, of the 28 benefit functions that were transferable across bays, only 3 yielded statistically similar welfare measure while the other 25 did not. Similar results were also obtained for the 1987 to 1989 benefit function transfer case. For example, none of the 5 within-bay functions that were transferable had welfare measures that were statistically similar, and of the 23 benefit functions that were transferable only 3 had statistically similar welfare measures.

TABLE III

Median WTP and Confidence Intervals per Bay and Year[a]

Bay[b]	1987	1988	1989
a	84.77	62.25	38.12
	(81.82, 88.49)	(59.77, 65.06)	(36.88, 39.47)
b	201.40	80.92	258.20
	(191.89, 212.34)	(77.93, 82.42)	(248.89, 271.40)
c	118.73	70.32	45.20
	(115.33, 123.75)	(68.20, 72.51)	(44.13, 45.87)
d	103.12	79.65	81.71
	(99.89, 106.76)	(77.37, 82.63)	(78.06, 83.9)
e	152.70	127.70	119.22
	(147.53, 160.17)	(123.06, 132.45)	(114.32, 123.43)
f	121.81	85.02	85.91
	(115.76, 129.10)	(82.76, 88.32)	(83.06, 88.65)
g	130.25	106.67	83.06
	(126.76, 134.94)	(103.68, 109.66)	(81.22, 85.44)
h	130.59	98.55	154.95
	(126.56, 134.02)	(95.55, 102.45)	(147.10, 159.80)

[a] In 1989 dollars.

[b] a, Sabine; b, Galveston; c, Matagorda; d, San Antonio; e, Aransas; f, Corpus Christi; g, Upper Laguna Madre; h, Lower Laguna Madre.

VI. CONCLUDING COMMENTS

Given the data used in this study, it can be concluded that the procedure of utilizing the benefit function transfer approach to determine terms of appropriate compensation to harmed individuals at a policy site is unreliable. This is so because many of the benefit functions that were transferable did not yield statistically similar benefit estimates. Other functional forms and model specifications that were estimated and tested for transferability of benefits (but are not reported here) also yielded similar results. Thus, benefits that are transferred from a study site to a policy site using the benefit function transfer approach could be misleading or inaccurate. Our overall conclusion, at least for the data at hand, is that the benefit function transfer approach is not a reliable approach for the transfer of benefits.

Why did the majority of the transferable benefit functions not yield statistically similar welfare measures? We suspect that the nonlinearity of the logit model used to estimate the benefit functions and the nonlinearity of the benefits estimates themselves greatly contribute to this result. The nonlinearities introduce possible asymmetries which lead to the divergence between statistically similar benefit functions and their respective benefit estimates. We suspect that the results found here could also be extended to benefit function transfers using the travel cost model because here too the benefits are functions of nonlinear random variables.

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