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Web-based survey, calibration, and economic impact assessment of spending in nature based recreation

Abstract

The cost and response rate are two major concerns with the face-to-face interview and survey instrument in collecting data in recreational studies, respectively. With the advancement of web technology and an increase use of the web, a survey response collected through the web can be a viable low-cost alternative to the traditional mode of data collection. However, the reliability of the information obtained from an internet survey remains questionable. The authors employed a stochastic frontier regression model to calibrate the values obtained from the web-based survey. The researchers compared these values to the values obtained from on-site survey. The authors extended the analysis to estimate the economic impact of a nature based recreation on a local economy. The results indicate that with a careful calibration, a web-based survey can be used to understand the recreational use of respondents as well as to calculate the economic impacts of recreation-spending on a local economy.

Keywords: calibration, onsite survey, stochastic frontier approach, web-based survey.
JEL Classification: C59, C67, C83, Q50.

Introduction

Web-based survey (also known as online or internet survey) has been used to gather information in various fields of research (Canavari et al., 2005; Marta-Pedroso et al., 2007; Olsen, 2009) mainly because it is relatively cheaper compared to other modes of survey, it offers an easy access to respondents and information collected can readily be used for analysis rather than having to code and put data in spreadsheet after survey is completed.

A major concern over the use of a web-based survey on an empirical study is the reliability of collected information because of uncertainty over the validity of data and sampling issues, low response rate and self-selection bias. Availability of reliable survey software packages and services may make web as the survey mode of choice in future thereby replacing hitherto commonly used survey modes (Wright, 2005).

At least in the case of stated preference literature, some have found higher (Canavari et al., 2005), lower (Marta-Pedroso et al., 2007; Lee et al., 2014) and similar (Fleming and Bowden, 2009; Olsen, 2009; Lindhjem and Navrud, 2011a; Nielsen, 2011; Windle and Rolfe, 2011) willingness to pay values when information is collected from online survey compared to the onsite survey. Maguire (2009) indicated that willingness to pay value in contingent valuation survey could be mode dependent. Lindhjem and Navrud (2011b) mentioned that internet survey may give equal or slightly less welfare values than the other modes of survey. They indicated that although internet survey has potential to be useful it also suffers from issues like representation and nonresponse bias.

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Lindhjem and Navrud (2011a) compared the use of internet vs. face-to-face survey mode to calculate a willingness to pay (WTP) value in contingent valuation (CV) survey. They found that mean willingness to pay (WTP) between internet survey and face to face interview were equal. Additionally, the share of "don't knows", zeros and protest responses to the WTP question with a payment card is very similar between internet survey and face-to-face interview. Nielsen (2011) also compared the effectiveness of face to face interview mode with internet survey and found that mean and median willingness to pay values are similar to these two modes of survey. Windle and Rolfe (2011) the effects of internet and paper based survey method in conjoint analysis. They found that both methods produced equivalent household willingness to pay value to improve the condition of Great Barrier Reef in Australia.

These mixed results suggest a need to derive method that can help one to guide how online survey should be utilized and if needed how effectiveness (such as using mixed mode strategy) of online survey be enhanced in empirical research.

Calibration has been an accepted procedure for creating estimates from survey responses (List and Shogren, 1998; Hofler and List, 2004; and Fox et al., 1998). Loomis (2014) pointed out that several ex post methods can be used to make stated preference values devoid of hypothetical bias. Some of the calibration methods that have been used are orbit model (Davies and Loomis, 2010); CVM-X (Fox et al., 1998), stochastic frontier method (Hofler and List, 2004), Calibration method has been used to reduce hypothetical bias in stated preference experiment (Norwood, 2005). An approach similar to that used by Hofler and List was used to calibrate the responses obtained from the online survey. If responses from a web-based survey are subject to review and adjustment, a reliable method to calibrate and compare results would increase its validity.

Satisfaction of the stated objectives is inherent in the remaining structure of the paper. Discussion of a stochastic frontier estimation technique used to calibrate the estimates obtained from a web-based survey and impact analysis model were presented first. Calibrated responses are assessed relative to onsite responses. Description of data section is provided right after the method section. Assessments from stochastic frontier analysis along with the findings from the use of input-output models is reported in the results section. A conclusion and set of implications from using a stochastic frontier methodology to calibrate survey responses from a web-based survey are presented at the end.

Methods

We used stochastic frontier approach developed by Aigner et al. (1978) to calibrate the values. An absence of theoretical support for discerning the direction of the one-sided error term creates confusion as to whether the online respondents have systematically over or understated their true values. Earlier researchers (see Kumbhakar and Lovell, 2000) using stochastic frontier methodology used a test of misstatement direction to detect the direction of a one-sided error term. More recent research claims that a simple skewness test provides enough information to determine the direction of error (Hofler and List, 2004). On the strength of this claim, an ordinary least square regression was used to determine the skewness of the random error. This allows the online expenditure response in each category l $\left(Y_i^l\right)$ to be defined as:

$$\ln(Y_i^l) = \beta_0 + \sum_{j=1}^{6} \beta_i \ln X_{ij} + v_i + u_i, i = 1,....,n. \quad (1)$$

Here, the error term is $\varepsilon_i = v_i + u_i$. It is assumed that v_i is normally distributed with zero mean and constant variance. The one sided error term is u_i. Depending on the assumption whether the online values stated by respondents are higher or lower than the on-site face to face values stated by respondents, the one sided error term $\left(u_i\right)$ could take only nonnegative values or non-positive values. As explanatory variables in the regression model, the X_{ij} include the purpose of the trip, income, age, job status, gender and marital status of each online respondent. The equation, $\ln(Y_i^l) = \beta_0 +$, $+\sum_{j=1}^{6} \beta_i \ln X_{ij} + v$ represents the maximum (frontier) value of a recreational expenditure in category 'l' by an individual as estimated by a stochastic frontier regression model.

An actual value of the recreational expenditure is estimated using the online survey expenditure as a dependent variable in a stochastic frontier regression function. The predicted and observed values are then used to calculate the calibration ratio as defined by:

$$TE = \frac{f(x;\beta)\exp(v_i - u_i)}{f(x;\beta)\exp(v_i)} = \exp(-u_i) = \frac{observed \quad value}{predicted \quad value}. \quad (2)$$

This formula is similar to the calibration ratio developed in the literature (Hofler and List, 2004). The online responses are adjusted by multiplying each online observation by the calibration ratio derived in equation (2).

Economic impact estimation. In the second stage, the calibrated online survey data are used to estimate the economic impacts attributable to the presence of a recreational site. The input output (I-O) model has been a widely used tool for documenting the regional economic impacts of development projects, tourism industries and policy changes. Recently, the input-output model has also been used to estimate the economic impacts of recreational visits within regional, state and national level economies (Bergstrom et al., 1990, Cordell et al., 1990; Deisenroth et al., 2012; English and Bergstrom, 1994; English, 2000; Lee and Choi, 2004; Lothrop et al., 2014). The model estimates the monetary value of transactions within an economy over a defined period of time. It identifies the economic interdependency existing in the economy for policy makers (Henry and Deane, 1997). The main goal of the I-O model is to evaluate the economic impacts of a new final demand change on the producing sectors of a local economy (Weiler and Seidl, 2004). An impact analysis identifies economic interdependencies and assigns values to those interdependencies such that the impact of changes in one sector of an economy can be identified, traced and measured in terms of output multipliers through all the interdependent economic activities within the defined unit of a region, state or nation.

Output multipliers estimated from a standard I-O model can be expressed as:

$$q = \left[I - A\right]^{-1} f, \quad (3)$$

where, $\left[I - A\right]$ represents the Leontief inverse matrix that translates a particular level of final demand into the direct and indirect outputs from each sector of the defined unit's economy required to meet that final demand.

In general, an I-O model is created around a number of assumptions. First, it assumes that an economy consists of *N* number of sectors each producing one commodity and a final demand sector. Second, the firms show a constant return to scale such that there are no external economies or diseconomies. Third, firms have no supply constraints insatisfying an increased demand. Fourth, there is a linear dependence between the inputs and outputs in an economy. And finally, there is no substitution of intermediate inputs. Despite these limiting assumptions, I-O models have been widely used in estimating the contributions of tourism and other economic activities to a unit's economy because, to date, there have not been any more reliable and appropriate tools to use.

Use of I-O in recreational studies. A considerable number of studies have been conducted on water based recreation that estimate the economic impact from spending of recreational visitors. Many of these studies use input output models in estimating regional impacts of tourism and outdoor recreation on an overall regional economy (Bergstrom and Cordell, 1990a; Cordell and Bergstrom, 1991; Cordell et al., 1990; Heng and Low, 1990; English, 2000; Weiler and Seidl, 2004; Wiersma et al., 2004; Deisenroth et al., 2012; Lothrop et al., 2014). These studies provide multipliers for changes in level of economic activity on such variables as output, income and employment based on survey samples. However a lesser number of studies have focused on dealing with the problem how an online survey data might be used to estimate the regional economic impacts of recreation.

Bergstrom et al. (1990) examined local economic effects of recreational expenditures in selected rural areas using a regional input-output model. The study used data from the Public Area Recreation Visitor Study using onsite and follow-up sampling techniques. The respondents were asked to provide information regarding trip related expenditures on the mail survey. Givensuch sampling techniques, special care was taken in order to correct the bias incurred through disproportionate representation of respondents belonging to different sets of recreational interests. Post sampling weights were used before estimating the impact multipliers. Their study showed that the recreational spending contributes significantly to major macroeconomic sectors and therefore suggested outdoor recreation as a viable development strategy for a rural economy.

Similarly, English and Bowker (1996) estimated multipliers associated with the economic impact of white water rafting. Their study employed samples obtained from mail surveys. Per person, per trip expenditures were treated as final demand for goods purchased in the impacted region. The expenditure information was allocated to IMPLAN (Minnesota IMPLAN Group, 2000) sectors to obtain multipliers for economic impact on selected states. Hamel et al. (2002) estimated regional economic impacts of recreational activities allowing the demand for recreation to vary due to individual decision making criteria. The study combined a recreation demand model with a regional impact model to allow a direct evaluation of economic impact of change in individual or trip characteristics. Since the IMPLAN model did not have detailed recreational sectors studied in the research, a disaggregated set of IMPLAN sectors were identified to create an expenditure profile of recreation-based activities outside the IMPLAN model.

Similarly, Criddle et al. (2003) used a binary choice model to model the individual decision to participate in recreational fishing. The study used mail survey data from randomly selected anglers holding fishing licenses. To obtain more informative impact estimates, the study first calculated the probability of taking a recreational trip using a probit model. The estimates were then used to obtain regional economic impacts. The integrated model explained the change on regional impact associated with change on trip cost and amount of catch. The study also provided potential effects of an increase or decrease on expected catch on the regional economy.

Lothrop et al. (2014) estimated the economic impacts of government stocking of striped bass at Lewis Smith Lake, Alabama to the local counties and the state of Alabama. They found that the economic impact of this program was 2:1 for local region and 7:1 for the state of Alabama. Consumer surplus from striped bass stocking in Lewis Smith Lake was estimated to be $0.6 million whereas the consumer surplus for each angler visit was estimated to be $77.

Data

Recreational costs and demographic information for individuals traveling to coastal Louisiana for recreational purpose are collected using web-based intercept and internet survey questionnaires. The online based information is collected by posting the questionnaire on a website created by the Louisiana State University Agricultural Center. The survey questionnaire remained on the web for the seventy-seven day period May 15-July 31, 2003. Survey announcements and participation requests via the website were made through a variety of media outlets including mail, radio, newspapers, magazines, websites and newsletters.

A combined total of 2,691 responses were obtained from the online and face-to-face surveys. An overwhelming majority of the responses (approximately

92%) were obtained from the online survey. Online survey responses were automatically recorded into a Microsoft Excel spreadsheet as submitted. The internet protocol address was used to identify and delete duplicate responses. Face-to-face or intercept surveys were conducted in Grand Isle, LA and Holly Beach, LA, two popular recreational sites for Coastal Louisiana. Individuals at these recreational sites filling out the questionnaires were randomly selected. Onsite survey respondents were given a baseball cap commemorating the beauty of the Louisiana coast. Multiple visits to the sites were made in conducting the onsite surveys. Slightly over 8% of the responses were obtained using the onsite survey method.

The survey collected responses regarding respondents' socio-demographic characteristics, site quality, and expenditures incurred in recreational and related activities within the Coastal Louisiana recreational area. Responses from the individual expenditure section of the web-based survey are used in estimating the economic impacts.

Results and discussion

The results of the study are presented in two parts. First, a stochastic frontier model using web-based survey responses was used to create an estimate of the actual value of the individual's recreational expenditure. The estimation procedure used seven categories of recreational expenditures (Table 1) as dependent variables which were regressed against to purpose of the trip, income, age, job status, gender and marital status as explanatory variables.

Table 1. Summary statistics of variables used

Variables	Online data			Onsite data		
	Mean	Min	Max	Mean	Min	Max
Expenditure categories used						
Lodging ($ per trip)	69.5	0	2285	101.2	5	1000
Fuel ($ per trip)	54.3	0	1500	39.0	1	400
Food and beverage ($ per trip)	50.2	2	800	70.4	1	400
Equipments ($ per trip)	36.9	0	1000	89.8	5	2000
Supplies ($ per trip)	30.2	0	400	37.9	2	500
Parking and launching ($ per trip)	11.8	0	500	11.4	1	100
Others ($ per trip)	29.9	0	200	7.0	0	300
Explanatory variables						
Age (years)	42.8	17	81	39.3	16	71
Marital status (1 = married, 0 otherwise)	0.8	0	1	0.6	0	1
Gender (1 = male, 0 otherwise)	0.1	0	1	0.3	0	1
Purposes of the trip (1 = day trip, 0 otherwise)	0.6	0	1	0.5	0	1
Job status (1 = full time, 0 otherwise)	0.9	0	1	0.9	0	1
Income (categorical variable)	2.6	1	5	2.2	1	5

The average recreational spending per individual by category of expenditure as compiled from both web-based and onsite survey responses are presented in Table 1. The average expenditure per individual varied from $7 for "other category" to $101 for "lodging" in the case of onsite data. In comparison, it varied from about $12 for "parking and launching" to $70 for "lodging" in case of the web-based data. A preliminary test to understand whether there exists a difference between online and onsite survey data showed that the mean expenditure varied with the method of data collection. The web-based data showed significantly different expenditure values than those which came from the onsite survey indicating some concern over the data collected using a web-based approach. We speculate that some of the differences are inherent in the characteristics of the online and onsite populations. The onsite population probably lived closer to recreational site. The variables arguing against that speculation is difference in means for lodging and food. It would seem as if people who lived closer would spend less on these items. The online population, as a whole, is probably more adept with using computers.

Because of the difference in spending pattern across categories, the residuals from an ordinary least square regression were checked to decide whether the respondents captured through online survey are systematically over or understating the true value of their expenditure. The OLS residuals are positively skewed suggesting that the responses from the online population are over stating the true value of their recreational spending. Work by Canavari et al. indicating a higher willingness to pay responses from web-based survey populations supports this study's finding. Therefore, the asymmetric error u_t is modeled as a non-negative distance from its actual value.

The asymmetric error, u_i, was assessed for its contribution to the total variance. The result showed that σ_u is significantly different from zero in the case of the online population. The likelihood ratio test of the hypothesis $\sigma_u = 0$ for all of the seven types of recreational cost categories suggested that the asymmetric error u_t on ε_i made a significant contribution to the disparities in expenditure categories between the online and onsite populations. However, the same test of onsite population data showed σ_u is not significantly different than zero. This suggests that the categories of expenditures from the onsite population were not sufficiently different from their actual values; therefore supporting the need for calibration of online survey responses.

The stochastic frontier regression is estimated using the log linear form of the model expressed in equation (2). Most of the coefficients associated with the explanatory variables are significant for all categories of expenditures. Income showed a positive effect on recreational expenditure whereas the purpose of the trip showed a negative effect on recreational expenditure. The purpose of a trip dummy variable was significant suggesting that the multipurpose trip facilitated the realization of a recreational benefit at a lower costs than what would otherwise been the case. Age is a positive and significant variable suggesting that an older visitor is more likely to spend more on any particular trip. An older visitor is likely to have a larger income to spend because of more experience in the workforce or to be in a retired status with greater discretionary income as a consequence of having no young children to support. In addition, an older visitor is likely to either have older children who will be greater consumers than smaller children or to have grandchildren whom they are more likely to indulge than their own children. The gender variable suggests that men spend more than women do on recreational activities probably as a consequence of a cultural phenomenon which expects the male to provide for the female.

The value of recreational expenditures for each of the seven categories of recreational activities was predicted using the regression function. Once the actual expenditure under each category was predicted, the calibration ratio was calculated using the predicted and observed values of the expenditure. The calibration factor is defined as the ratio of observed expenditure to the predicted expenditure. Each individual's recreational expenditure was adjusted by multiplying their individual spending response by calibration ratio. Hence, the calibrated values are the unique products of the individual's expenditure and their calibration ratio. For example if an individual had spent $50 on food and his calibration ratio is 0.6 then the person's true expenditure on food is $30. This method is equivalent to one of the two approaches reported in the literature and used to calibrate the hypothetical value of the willingness to pay for a sports card (Hofler and List, 2004).

Table 2. Original and calibrated values and their comparisons using the t-test

	Half normal error specification		Exponential error specification		Uncalibrated values	
Variable	Calibrated means ($)	Differs from means onsite?	Calibrated means ($)	Differs from means onsite?	Online means	Differs from means onsite?
Lodging	39.53	Y	86.81	N	69.48	Y
Fuel	52.32	Y	109.07	Y	54.25	Y
Food and beverage	39.56	Y	82.36	N	50.23	Y
Equipments	27.87	Y	72.57	N	36.94	Y
Supplies	28.09	N	67.92	N	30.23	N
Parking and launching	8.75	N	24.98	Y	11.81	N
Others	37.74	N	93.11	N	29.92	Y

The prediction process was based on two error specifications which were followed in obtaining the predicted values for the seven categories of recreational expenditures. Table 2 compares the predicted values of the calibrated and uncalibrated means for the online responses against the means of the onsite responses. The t-test suggests that the original online values are significantly different from those values based on the onsite responses for five expenditure categories. However, once calibrated using exponential error specification, the values are different only for two of the seven categories of recreational expenditures. Study results suggest that error specification of the model matters since only three categories of recreational costs (supplies, parking and launching and others) are not statistically significantly different as between the online responses and the onsite responses when half-normal error distribution is used in the model.

The calibrated values facilitate estimation of the economic impacts of the recreational expenditures on local economic sectors. Since the prediction using a half normal error term do not show convincing results, only the values using exponential error distribution are used in calculating estimates of the impacts of recreational expenditures. The calibrated values of the expenditure are then used in combination with the Impact Analysis Tool (IMPLAN) to estimate the impacts of recreational expenditure on the local economic sectors. The use of county level data renders the IMPLAN model a regional version of the input-output model. IMPLAN does not define a specific sector such as "tourism" within its default set of 509 economic sectors. A MI-REC spreadsheet which consists of a set of utilities and customized procedures for estimating the economic impact of recreational and tourism spending was used to address this issue. The IMPLAN MI-REC spreadsheet ties mean recreational expenditure by category to the NAIC economics sectors incalculating the estimated dollars spent for recreational activities and their impacts on the local economy. The MI-REC spreadsheet features eleven sectors of recreational-related expenditures from which the data fits into the seven categories that are tied into 509 IMPLAN sectors.

Table 3. Impact estimation using calibrated values and original onsite values (US$ per person per trip)

NAICs categories	Using calibrated online data	Using original onsite data
Agriculture and forestry	1.071	0.687
Mining	38.956	14.613
Utilities	4.136	2.997
Construction	3.038	2.613
Manufacture	146.038	71.89
Wholesale	53.291	34.612
Transportation	15.81	10.019
Retail industries	113.137	85.607
Information	20.618	14.587
Finance	6.49	4.832
Real estate	22.887	16.432
Technical	18.392	13.345
Managements	0.588	0.446
Administration	7.762	6.099
Education	0.596	0.44
Healthcare	0.266	0.221
Art and entertainment	85.863	99.375
Hotel	86.351	74.43
Restaurant	0.093	0.069
Other	26.022	14.042
Total	651.403	467.356

Table 3 shows the effect of dollars spent for recreational purposes on local economic sectors. The output effects are categorized according to two digit North American Industry Classification (NAIC) codes. The result suggests that the sectors of the local economy most likely to benefit from the recreational expenditures were manufacture, retail, art and entertainment and hotel industries.

The total economic impacts of recreational spending within NAIC categories differ based on whether the responses were based on online or onsite survey data. The results suggests that individual recreational spending, on average, generated approximately $651 worth of economic activities when based on online or calibrated data as contrasted to $467 when based on onsite data.

The result suggests that there are other sectors of the economy such as wholesale and transportation which benefit both directly and indirectly from recreational spending. More interestingly, the restaurant business sector was not affected by the visitors' spending. This may be related to the remoteness of the Grand Isle and Holly Beach recreational areas. These areas are likely to be staging points for off-shore oil well laborers and fishermen which may account for the relatively large contributions of recreational spending in wholesale and transportation.

Conclusions

Our results indicated that an error term specification in a stochastic frontier model matters in calibration of online values. We found that uncalibrated online mean values were significantly different from the onsite mean values for five of the seven expenditure categories. Using an exponential specification for the one sided error term and adjusting the values accordingly, we found only two of the seven categories had significant difference in mean expenditure values between two survey modes (online vs onsite). The performance of half normal one sided error specification resulted in poor results with only three out of seven categories to be insignificant after the calibration.

The combined use of a stochastic frontier approach and IMPLAN, provided for this study of estimated the economic effects of recreational spending within different economic sectors of Louisiana's economy. Responses from an online survey sample were used to estimate the true value of the recreational expenditures and to offer an explanation for that true value in terms of specific characteristics of the individual respondents. The calibration ratio estimation approach was determined to be consistent with the technical efficiency estimation approach. This determination was made on the documentation of the presence of inefficiency in the online survey responses. A calculated calibration ratio allowed for adjustments of the online values such that they could be used to estimate the economic impacts of recreational categories of expenditures on a local economy.

This study holds implication for researchers intending to use online surveys as means for gathering data. Study results indicated the presence of an inefficiency in the online data giving rise to variations in the data beyond that attributable to normally distributed random errors. Self-selection in the online sample is the obvious factor and probably accounts for the fact that the distribution of online survey data responses differ in a statistically significant manner from the distribution of onsite survey data responses. This observation suggests a search for some *ex post* correction procedure to enhance the reliability of the estimates derived from online survey data responses.

The literature suggests that a stochastic frontier regression approach provides for an appropriate calibration procedure for the adjusting the online data. However, error specification becomes an issue in obtaining reliable estimates as analysis revealed two types of results associated with the use of different error specifications. This observation suggests that attention should be given to both the underlying economic theory and the analytical approach in selection of an error distribution procedure.

The results associated with the economic impact estimation procedure should prove helpful to an understanding of the sources of economic contributions of a nature based recreational site to a local economy. Knowledge of the economic contributions that a recreational area makes to a NAIC category should foster an appreciation for it. That appreciation, in turn, should lead to an enhanced understanding and more informed decisions regarding the management and preservation of a local economy's recreational areas.

Study result also imply that the value of a natural resource is more than just an individual's willingness to pay for the pleasure or the value equivalent of the cost incurred on a particular recreational trip. Creating an awareness of the direct and indirect effects of such spending within the local economy is also an important factor to be taken into consideration when estimating the economic value of a natural resource.

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