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Web Surveys, Sample Bias and the Travel Cost Method

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Abstract

Environmental economists have long used surveys to gather information about people's preferences. This is particularly true in the field of non-market valuation, where techniques such as contingent valuation, choice modelling and the travel cost method invariably employ some form of survey instrument. A recent innovation in survey methodology has been the advent of web-based surveys. While popular in many other disciplines, to date, very few non-market valuation studies have employed the Internet as a survey tool. A primary concern of non-market valuation practitioners is the potential sampling biases associated with web-based surveys and the effect this may have on valuation estimates. In this paper the results of two travel cost surveys, one conducted via conventional mail, the other via the Internet, are compared.

Key words: Web-surveys; sample bias; travel cost method.

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1. INTRODUCTION

Environmental economists have long used surveys to gather information about people's preferences. This is particularly true in the field of non-market valuation, where techniques such as contingent valuation, choice modelling and the travel cost method invariably employ some form of survey instrument.

Choice of survey administration mode is one of the more fundamental issues that confront the non-market valuation practitioner when developing an appropriate instrument to elicit the values he or she is seeking. This choice requires consideration of several issues and, to date, no single mode has been proven unambiguously superior to the others (Champ, 2003). 'Conventional' survey administration modes include mail, in-person, telephone and central site. More recently, the use of e-mail and (less frequently) web-based surveys has emerged as another option.

The purpose of this paper is to report on the results obtained from a travel cost questionnaire that was conducted using two alternate survey administration modes; a pen and paper mail survey, and a web-based survey. The pen and paper mail survey mode was chosen as a point of comparison, as it is among the least costly and is favoured by graduate researchers and others on a limited budget. It is, therefore, the mode most likely to be replaced, or supplemented by, web-based surveys. In addition, pen and paper mail surveys are generally agreed to have much in common with web-based surveys in areas such as degree of personal contact between the interviewer and interviewee, access of the interviewee to the questionnaire, and freedom of the interviewee regarding the timing and method of answering the questionnaire. Valid comparisons should, therefore, be able to be drawn between the two modes.

The paper proceeds as follows: Section 2 discusses potential advantages and disadvantages of the web-based survey administration mode compared to more conventional modes. Section 3 reviews existing studies. Section 4 briefly describes the subject of the survey and survey procedures. Sections 5 and 6 report survey results, finally, Section 7 concludes.

2. ADVANTAGES AND DISADVANTAGES OF WEB-BASED SURVEYS

2.1 Advantages

For the researcher

There are several features of web-based surveying that makes it attractive to researchers, of which the most commonly cited is cost. Compared to mail surveys there are no costs for paper, printing, envelopes, stamps and related administrative work. Compared to any interviewer-administered survey, additional cost reductions arise from the absence of interviewers; compared to on-site surveys, travel costs may be reduced (Manfreda, 2001; Madge, 2006a). The comparatively low cost of web-based surveys is advantageous in that it enables large sample sizes, providing an increased potential for sub-group analysis and decreased sampling variance.

The second most often cited advantage of web-based surveys is the speed of data collection. Web-based surveys can be up and running in a matter of days, with immediate access to results. Several authors have reported on the speed of web-based survey data collection in comparison to other modes (see for example, Weible and Wallace, 1998; Jones and Pitt, 1999; Aoki and Elasmar, 2000; Kwak and Radler, 2000). Of these, Aoki and Elasmar (2000) report the most extreme difference, with an average response time for a mail questionnaire of 50 days compared to an average response time of 3 days for an identical web-based survey (Manfreda, 2001).

Web-based surveying can also improve the accuracy of data collection. Responses from online questionnaires can be automatically inserted into spreadsheets, databases or statistical packages, such as Access and SAS. This not only saves time and money, but reduces human error in data entry and coding. Further, data can be collected continuously, regardless of time of day and day of week. Similarly, there are no geographical limitations, with respondents in a number of locations able to be surveyed simultaneously (Manfreda, 2001; Madge, 2006a).

More than any other survey mode, web-based surveying allows innovative questionnaires to be developed. For example, visual and audio stimuli can be incorporated, prompts can alert respondents if they skip or incorrectly answer questions, drop-down boxes can present respondents with a range of possible answers, pop-up windows can provide additional information,² questions can be ordered randomly, skip patterns may be built for ease of navigation, even multi-lingual formats are possible.

Other advantages include: ease of access to research populations (web-based surveys can be useful in providing direct access to small socially and physically isolated groups); increased profile for the host institution through web page links from the survey; and the fact that the website can be kept up and running until a desired number of responses have been obtained. Finally, Couper (2000) argues that the relative ease of implementation of web-based surveys allows this research tool to be available to the masses, thus 'democratising' survey implementation.

² The ability to provide more information is not necessarily advantageous; there is a considerable body of literature on information effects in non-market valuation (particularly CVM). Reviews can be found in Blomquist and Whitehead (1998) and Munro and Hanley (2001).

For the respondent

As with all self-administered surveys, web-based surveys are convenient for respondents who can answer the survey at their own pace, whenever, and from wherever, they choose. Moreover, people can have a sense of privacy when answering a web-based survey and several researchers present examples from evaluation questions or respondents' comments, which show that respondents in general like this mode of survey administration (Manfreda, 2001).

Colours, innovative question displays, split screens, animation, sound tracks and other advanced design features may make the web-based questionnaire more appealing for respondents. Finally, the growth in email, online banking and bills being paid on the Internet suggest that, at least for some, the Internet is a more convenient medium than more traditional means of communication.

2.2 Disadvantages of web-based surveys

For the researcher

The most commonly cited disadvantage of web-based surveys is sample frame bias,³ i.e. the nonrandom exclusion of individuals from the sample frame. In most populations there remains an enduring social and spatial divide in access and use of the Internet which can induce sample biases to any online research. Trends in Internet coverage (see Figure 1), however, suggest webbased surveys are increasingly becoming a more viable survey mode. Nonetheless, at the present time, certain social groups are underrepresented among Internet users, including older people, people with lower incomes, the unemployed and those living outside metropolitan areas (ABS, 2006).

³ Also known as coverage bias or non-coverage error (Edwards and Anderson, 1987; Dillman, 2000).



Figure 1: Proportion of Australian households with Internet access 1998 - 2005

Source: ABS (2006)

Non-response bias, the bias introduced when respondents within the sample frame have very different attitudes or demographic characteristics to those who do not respond, may also be of concern. In web-based surveys, non-response bias is increased when different levels of technical ability are present among potential respondents, and it becomes a particular problem when response rates are low.

In a related issue, respondent recruitment can be difficult. There is little point in setting up an online questionnaire and passively waiting for eligible respondents to find the site: more active enrolment is needed (Madge, 2006b). Furthermore, lack of human contact can have some negative influences on response and data quality. Severe self-selection bias can occur; respondents may not be motivated enough to complete a whole questionnaire without interaction with another person and abandonment of the questionnaire may be a problem. Web-based surveys can easily be ignored and deleted at the touch of a button so getting a reasonable response rate can be challenging. In addition, probing is not possible, this can be particularly problematic for questions with multiple responses and for open-ended questions. Because of the unobserved process of data collection, it is also not known whether respondents understand and follow the given instructions (Manfreda, 2001). These issues are not unique to web-based surveys and are also a factor in the alternative pen and paper mail survey mode considered in this paper.

Another disadvantage of web-based surveying is the fact that the researcher has no way of discerning if there are several respondents at one computer address, or if one respondent is completing a questionnaire from a variety of computers. Finally, caution is needed regarding the compatibility of the equipment used by respondents, their graphics resolution and required download times. Respondents may be turned off the questionnaire if they have to wait too long for it to download. Fortunately, as Internet speeds increase, this is becoming less and less of an issue.⁴

For the respondent

There are a small number of potential disadvantages to web-based surveying from the respondent's point of view. First, the indirect costs of surveying are often passed onto the respondent, i.e. respondents usually bear the cost of Internet connection time. Respondents may have concerns about anonymity. Inexperienced Internet users in particular may experience problems when answering web-based questionnaires. For these respondents web-based surveys can be frustrating and negatively influence their decision to participate (Manfreda, 2001).

3. EXISTING STUDIES

In this section, three bodies of literature are reviewed. The first consists of studies outside of the non-market valuation literature comparing conventional and web-based survey modes. The second consists of studies exploring the effect of survey mode on non-market valuation estimates. The third consists of the small number of existing non-market valuation studies that have been conducted using web-based surveys.

3.1 Conventional versus web-based surveys

Outside of the non-market valuation literature we are aware of only two studies that explicitly compare a conventional against a web-based survey.⁵ In the first of these, Kaplowitz *et al.* (2004), compare the results of web-based and pen and paper mail surveys of Michigan State University student's watershed knowledge, attitude and use. Potential respondents were divided into five groups. The first group received up to five contacts; a preliminary postcard, a hardcopy of the survey with attached covering letter, a reminder postcard and, for those who had not yet replied, an additional reminder postcard. The second group received two contacts; a preliminary postcard and an email containing a link to the web-based survey. The third group received three contacts; a

⁴ In Australia, 48% of households with Internet access have broadband; defined as an 'always on' Internet connection with an access speed equal to, or greater than, 256 kilobits per second (ABS, 2006).

⁵ In the mid-1990s a number of studies were published comparing conventional versus *email* survey modes. Results of these are mixed. Schuldt and Totten (1994) and Tse *et al.* (1995) both find the email survey mode to be inferior, while Bachmann *et al.* (1996), Schaefer and Dillmann (1998), and Mehta and Sivadas (1995) all report that email surveys compare favourably to conventional modes.

preliminary postcard, an email and a follow-up postcard. The fourth group received two contacts; an email and a follow-up postcard. Finally, the fifth group received only one contact; the email with a link to the survey.

Response rates ranged from 31.5% for group one to 20.7% for group five. There was no significant difference between the web-based and conventional survey modes in terms of item non-response. The most substantive difference between the two modes was in regards to the mean age of respondents (24.14 for web-based and 30.55 for pen and paper). Given that 80% of Michigan State University students were aged 24 years or under at the time of the survey, it would seem the web-based survey mode yielded a more representative sample. Further, with cost per response ranging from US\$10.97 for group one to \$1.32 for group two, the web-based survey mode proved more cost-effective.

In the second study, Cole (2005) compares responses from a web-based and a conventional pen and paper survey in terms of response rates, data quality, demographic profiles of respondents, internal consistency and responses to items among American Society of Travel Agents members. The author finds response rates to be significantly lower, and item-non response rates higher for the web-based survey than for the pen and paper survey, however they find web-based responses to be more internally consistent. Like Kaplowitz *et al.* (2004), Cole finds web-based survey respondents to be younger.

3.2 Survey mode and non-market valuation

Very few empirical studies have explored the effect survey administration mode has on nonmarket valuation estimates. In an early example, Mannesto and Loomis (1991) compare in-person and mail contingent valuation surveys of recreational boaters and anglers in the Sacramento-San Joaquin Delta of California. The in-person surveys were conducted by intercepting recreationists on-site, while mail surveys were distributed by placing a questionnaire, with pre-paid envelope attached, on vehicles parked at public boat ramps.

The authors find a significant difference in overall response rates between the two modes; 97% for in-person, 24% for mail. Item non-response rates, however, are more ambiguous; mail survey respondents are significantly less likely than in-person respondents to respond to questions relating to past behaviour, while the reverse is true for questions relating to future behaviour. A result the authors suggest may be a consequence of reduced time constraints placed on respondents under the mail survey mode and, given the forward looking nature of many contingent valuation studies, a result suggesting mail surveys may be more appropriate. Finally, willingness-to-pay (for wetland preservation) figures obtained via the mail survey are

significantly lower than those obtained via the in-person survey. A result perhaps due to either reduced social desirability bias, or a product of the additional time mail survey respondents have to consider their responses.

Three studies compare telephone and mail surveys. The first of these (Loomis and King, 1994) involves a contingent valuation study of Californian household's willingness-to-pay for the improvement of wildlife habitat and fisheries resources. The authors compare a traditional Dillman (2000) repeat mailing survey to a hybrid telephone-mail survey. They find the hybrid survey to have a statistically higher overall and item response rate, furthermore, the demographic make up of respondents is significantly different between the two modes. Levels of environmental knowledge and recreational participation also differ, however environmental attitudes do not. Willingness-to-pay estimates are significantly different in three of the five cases examined, with willingness-to-pay estimates generally, although not consistently, higher for the mail than the hybrid sample. Interestingly, correcting for demographic sample biases and for variables reflecting environmental knowledge and recreational participation accounts for only one third of the differences in willingness-to-pay; suggesting the existence of other, unmeasured, differences between the samples.

In a study of visitors to Colorado state parks, Whittaker *et al.* (1998) compare a repeat mail survey with a telephone survey. Response rates and demographic characteristics, with the exception of income, do not differ between the modes. In regards to income, mail survey respondents report significantly higher incomes than respondents to the telephone survey. Despite this, Whittaker *et al.* (1998) find mail survey respondents report a significantly lower willingness-to-pay higher entrance fees than telephone respondents; a result the authors attribute to social desirability bias.

The most recent study to compare telephone and mail survey modes in a non-market valuation context involves a contingent valuation survey of New York household's willingness-to-pay for a green-electricity program (Ethier *et al.*, 2000). Here the authors find no significant difference in either response rates or respondent demographic characteristics between the two modes. A result, in contrast to both Loomis and King (1994) and Whittaker *et al.*(1998), suggesting measurable sampling and non-response bias is not a problem. They did, however, find the phone survey produced significantly higher mean responses than the mail survey to a series of questions on respondents' recent contribution to environmental organisations, rating of the service provided by the electricity company and interest in planting trees on public lands; a result the authors posit as evidence of social desirability bias in the phone survey. Nonetheless, willingness-to-pay estimates between the modes are not significantly different. The authors conclude that neither mode

dominates from the perspective of providing more valid estimates, and mode selection must, therefore, be based on other criteria.

In the only previous non-market valuation study to compare a web-based with a conventional survey administration mode, Berrens *et al.* (2003; 2004) compare a telephone sample with three web samples of a contingent valuation survey seeking U.S. household's willingness-to-pay for Senate ratification of the Kyoto Protocol. The telephone survey had an overall response rate of 45.6%, significantly higher than any of the web surveys (which had response rates ranging from 4% to 24.1%). Item non-response rates, however, were not significantly different between the two modes. Mean age and gender balance of respondents were similar, both between modes and when compared against the general U.S. population. Respondents to the telephone survey were, however, more educated and less likely to be Hispanic or African American than either web respondents or the general population. Somewhat surprisingly, web respondents reported significantly lower household incomes than either telephone respondents or the general population.

3.3 Electronic surveys and non-market Valuation

In addition to the aforementioned study by Berrens *et al.* (2003; 2004) there are a small number of non-market valuation studies employing web-based questionnaires. Tsuge and Washida (2003) use a web-based contingent valuation questionnaire to estimate the economic value of the Seto Inland Sea, Japan. Iraguen and Ortuzar (2004) use a web-based choice modelling questionnaire to estimate the willingness-to-pay of Chileans to reduce fatal accident risk in urban areas. Iraguen and Ortuzar note that their sample is predominantly male, of medium to high income and young. Despite these sample biases, the authors conclude:

...Internet surveying and, in particular, the use of a Web page encapsulated survey, offers great promise. Not only were all the expected advantages of the approach fully realised, but we believe the medium contributed in no little measure to obtain better socio-economic data, and by making the exercise more pleasurable to respondents (i.e. less of a burden), to achieve both better responses and a higher response rate than if we had used a different survey method.

(Iraguen and Ortuzar, 2004 p.523)

Using both face-to-face interviews and a web-based survey, van der Heide *et al.* (2005) use contingent valuation to estimate respondents' willingness-to-pay for two habitat de-fragmentation scenarios in the Veluwe region of the Netherlands. Unlike the face-to-face sample, who are interviewed on-site; the web-based sample is taken from a representative panel that are not assumed to have any prior knowledge of, or affinity with, the region. It is not surprising,

therefore, that the Internet sample consistently reports a lower median willingness-to-pay than the face-to-face sample.

In a study of preferences for priority setting among alternative health programs, Schwappach and Strasmann (2006) seek to test the reliability of web-based stated preference (conjoint analysis) surveys. The authors were particularly concerned that a web-based survey may not encourage as careful deliberation as either, pen and paper- or interviewer-based survey modes. The authors, however, conclude that there was no evidence of respondents making easy choices or arbitrarily 'clicking' their way through the web-based survey.

Finally, Ready *et al.* (2006) use an interactive computer survey to trial a new continuous attribute based stated choice method. Although the results upon which the article is based are from a computer installation at an exhibition on global climate change at the Marian Koshland Museum of Science, Washington DC, the survey has subsequently been placed on the Internet.⁶

4. THIS STUDY

4.1 Fraser Island

Situated less than five kilometres off the Queensland coast, at the southern end of the Great Barrier Reef and some 250 kilometres north of Brisbane (see Figure 2), Fraser Island is the largest sand island in the world (166,283 hectares) and one of Australia's iconic natural attractions. Inscribed on the World Heritage List in 1992, the Island attracts approximately 300,000 visitors per year. This level of visitation poses some significant environmental threats to the long-term preservation of the Island, with visitors contributing to a range of environmental problems including erosion, litter disposal, human-wildlife interactions and contamination of the Island's freshwater resources.

A recent report commissioned by the Queensland Environmental Protection Agency highlights the fact that many sites on Fraser Island are being used well beyond their capacity, suggesting that intervention may be required to ensure the Island's long-term sustainability (Edaw, 2002). This has prompted the Queensland Parks and Wildlife Service to consider access restrictions to Fraser Island.

To gain an appreciation of the potential welfare effects of any move to restrict access to the Island, it is useful to estimate the consumer surplus associated with current visitation. While organised tours already face access restrictions, and in the short- to medium-term are unlikely to

⁶ See <u>www.koshland-science-museum.org</u>. Click on 'Global Warming Facts and Our Future' and then on 'Consider the Alternatives' to start the program.

be restricted further, independent visitors currently face no restrictions and are thus the group most likely to have some form of restriction imposed upon them in the future. This paper, therefore, using the zonal travel cost method, attempts to estimate the current (unrestricted) consumer surplus attributable to visiting Fraser Island by this group of visitors. This surplus, or at least some portion of it, is that most likely to be affected by future management interventions.

Figure 2: Location of Fraser Island, featuring main townships, lakes and unsealed roads.



Source: Hadwen and Arthington (2003)

It is possible to estimate consumer surplus using a stated preference method, such as contingent valuation. However, the survey instrument used in this study contained questions relating to another stated preference method (choice modelling) investigating visitor preference for alternative management actions. Discussion with practitioners and our own judgement lead us to believe the cognitive burden of answering two sets of stated preference questions was too great. Furthermore, controversy surrounding a previous study that attempted to place a monetary value on the preservation of Fraser Island (Hundloe *et al.*, 1990) increased our reluctance to use the contingent valuation method. Thus, the travel cost method was deemed the most appropriate non-market valuation technique to employ.

4.2 Survey procedure

Following the method of Wilson and Tisdell (2004), visitors to Fraser Island were given surveys with pre-paid self addressed enveloped attached. This was to give respondents the opportunity to carefully consider replies in their own time. A total of two sampling occasions during 2006 were undertaken, the first in April and the second in August. In April 800 surveys were distributed over a period of seven days, in August 560 surveys were distributed over a period of eight days; reflecting the fact that August is a much quieter time of year on the Island. In both cases, surveys were distributed at a range of locations, predominantly in the lower third of the Island.

The web-based survey was constructed using Macromedia Dreamweaver MX for Windows. To ensure the validity of any comparison between the two modes, the web-based survey was constructed to look as similar as possible to the pen and paper survey.⁷ A link to the web-site was then placed on both the School of Economics website, and a number of other Fraser Island tourism information websites, with the simple invitation 'Visited Fraser Island recently? Click here to fill in a survey on the future management of the Island'.

5. RESULTS

5.1 Response rates

Out of the 1,360 pen and paper surveys distributed over both sampling periods a total of 463 surveys were returned, of which 33 (7.1%) were unusable due to key questions (often relating to respondent's income and education) being left unanswered. Thus the pen and paper survey mode yielded a response rate of 31.6%.

Calculating response rates for web-based surveys presents some difficulties, there is no way of knowing how many individuals might have seen the survey, or links to the survey, but declined to participate. One way to deal with this is to use a visitation counter that keeps track of the number of times that a site has been accessed. The response rate can then be estimated by dividing the number of returned surveys by the visitation count. However, this is sure to underestimate response rates as the same individual may visit a site a number of times before submitting a completed questionnaire (Kay and Johnson, 1999). In this case, the survey site registered 442 'hits', and 173 surveys were submitted, of which 27 (15.6%) were unusable due to unanswered questions. Thus, while item non-response was higher, the web-based survey mode yielded a slightly higher overall response rate of 33.0% than the pen and paper survey.

⁷ A copy of the web-based survey can be found on <u>www.uq.edu.au/economics/survey</u>.

5.2 Cost comparison

As noted in Section 2, one of the key potential advantages of web-based over other survey administration modes is reduced cost. Excluding researcher time, out-of-pocket expenses for the pen and paper survey include vehicle hire and fuel (\$1,730.50), accommodation (\$445.46), pre-paid envelopes and postage (\$274.18), and printing (\$1,047.20); a total of \$3,497.34 or \$8.13 per usable response. The web-based survey had no out-of-pocket expenses due to the fact that the School of Economics had an existing site license for Macromedia Dreamweaver. Nonetheless, the academic price for the software is only \$283.00.

Including researcher time widens the cost-gap between the two survey administration modes, to distribute surveys the researcher spent a total of 15 days on Fraser Island; to develop the web version of the survey took approximately 6 days.

5.3 Socio-demographics

A key concern for those considering the use of web-based surveys is whether or not this survey administration mode introduces sample frame or sample non-response bias. This section, therefore, seeks to address this issue by comparing and contrasting the socio-demographic makeup of respondents to both survey modes.

As seen in Table 1, there is very little difference between the gender and mean age of respondents to each survey mode, while respondents to the pen and paper survey report a higher mean household income; a result consistent with that of Berrens *et al.* (2003; 2004). In regards to educational attainment, each of the four categories were coded 1 (less than year 12) to 4 (degree) and a mean score calculated. Again there is very little difference between the two survey modes.

As also reported in Table 1, chi-square tests on the equality of distributions with respect to gender, age, income and education suggest that none of these variables differ significantly between modes at the 1, 5 or 10% level of certainty. The distributions of age, income and highest educational attainment are illustrated in Figures 3 to 5 below.

Variable	Pen and paper	Web-based	Chi-squared	df
Gender (proportion of sample male)	51.40	51.01	0.0081	1
Mean age (years) ^a	40.91	40.79	0.6279	4
Mean income (gross weekly household A\$) ^b	1,523.86	1,441.06	4.3298	10
Mean highest educational attainment ^c	3.23	3.28	2.3925	3

Table 1: Gender, Mean age and income of respondents

Categories used can be seen in Figure 3 below. Because of the small number of respondents (< 5), the two lowest (0-19, 20-29) and the two highest (60-69, 70-79) categories were pooled for the Chi-square test. Mean response values were calculated from the mid-points of category values and no respondent selected the 80+ category.

а

^b Categories used can be seen in Figure 4 below. Mean response values were calculated from the mid-points of category value. For those who selected the highest category (\$2,000 +) a figure of \$2,500 was used.

^c Categories used were: completed less than year 12 or equivalent (coded 1), completed year 12 or equivalent (coded 2), trade certificate or equivalent (coded 3) and Bachelor or higher degree or equivalent (coded 4).



Figure 3: Age distribution of respondents to each survey



Figure 4: Income distribution of respondents to each survey

Figure 5: Highest educational attainment of respondents to each survey



In regards to the respondent's place of residence, as seen in Figures 6 and 7, 82% of respondents to the pen and paper survey where residents of Australia, compared with 73% of web-based survey respondents. As seen in Table 2, however, chi-square tests suggest the distribution of respondent's country of residence between survey modes is not significantly different at the 1, 5 or 10% level.

As seen in Figures 8 and 9, 70% of Australian resident pen and paper survey respondents were from Queensland, compared to only 51% of respondents to the web-based survey. As reported in Table 2, chi-square tests suggest the distribution of Australian respondent's state of residence between survey modes *is* significantly different at the 1% level. As Internet use in Queensland is not significantly lower than in the other States (ABS, 2006), it seems likely that this result is driven by respondent recruitment, that is, Queenslanders, being more familiar with Fraser Island and its surrounds, are possibly less likely to visit promotional web-sites of the type used to recruit respondents to this survey.

Table 2: Place of residence of respondents

Variable	Chi-squared	df
Country of residence ^a	6.0892	3
State of residence (Australian residents only) ^b	18.2354*	3

^a Categories used can be seen in Figure 6 below. Because of the small number of respondents (< 5), the categories of 'North America' and 'Other' were pooled for the Chi-square test.

* Significant at the 1% level.

b Categories used can be seen in Figure 7 below. Because of the small number of respondents (, 5), the categories of 'South Australia' and 'Western Australia' were pooled for the Chi-square test.



Figure 6: Country of residence – pen and paper survey respondents

Figure 7: Country of residence - web-based survey respondents





Figure 8: State of residence (Australian residents) - pen and paper survey respondents

Figure 9: State of residence (Australian residents) - web-based survey respondents



6. TRAVEL COST ESTIMATES

While the preceding analysis suggests there is reason to believe web-based surveying is as valid as the more conventional pen and paper mode, the ultimate test is to see whether the two modes yield similar consumer surplus estimates. This section reports the results from a zonal travel cost model used to estimate the consumer surplus associated with independent visitors' recreational use of Fraser Island.⁸

There are two approaches that may be taken when estimating a zonal travel cost model, the traditional Clawson-Knetsch two-stage methodology (Clawson and Knetsch, 1966) and the gravity model, often used in geography and transport studies to model commuting decisions. The methodology and theoretical underpinnings of these two models are extensively discussed elsewhere (see for example, Hanley and Spash (1993) and Garrod and Willis (1999)) and will not be revisited here. It is sufficient to note that the gravity model 'short-cuts' the two-stage method and has been shown to produce the same consumer surplus estimates as the more cumbersome Clawson-Knetsch method. In all, the gravity approach is more elegant and has become increasingly popular with practitioners in recent times and is subsequently the approach taken in this paper.

The first step in employing the gravity model is to determine a travel demand function (known as a 'trip generating function') based on the cost of travel and any other variables that may contribute to the explanation of visitation rates. The second step involves integrating this function for each zone using the respective zonal choke price (i.e. that price at which visitation falls to zero) as the upper limit for integration, and the current cost of travel from that zone as the lower limit. The integrals provide a measure of consumer surplus for each zone, which may then be summed to obtain the aggregate consumer surplus or recreational value of the site.

To obtain the trip generating function, zonal visitation rate was regressed against average zonal travel cost (TC) and three socio-demographic variables (age, income and education). As there is no theoretical reason for choosing one functional form over another, the linear, linear-log, log-linear, log-log and equations using the reciprocal of travel cost were all estimated. Equations were assessed using F and t-tests, adjusted R^2 values, and consideration of autocorrelation and heteroskedasticity problems. Of the full set of estimated equations, the preferred equation for each

⁸ More information on the travel cost analysis, including definition of the dependent variable, travel costs and the treatment of the cost of time etc. can be found in Fleming and Cook (2007).

administration mode is given in Table 3.⁹ In both cases, the functional form of the preferred equation was log-log.

Survey mode	Dependent Variable	Constant (t-statistic)	Independent Variable (t-statistic)	adjR ²	F statistic (p-value)
Pen and paper	Ln(VR)	11.22568 (17.1717)	-1.067552 Ln(TC) (-10.6931)	0.8253	114.3424 (0.0000)
Web-based	Ln(VR)	12.62543 (19.1754)	-1.088471 Ln(TC) (-8.4567)	0.7986	94.8025 (0.0000)

Table 3: Preferred first-stage estimation equations

Substituting in current average zonal travel cost and multiplying by zonal population, these models yield an estimated number of annual visits of 130,909 for the pen and paper model and 111,655 for the web-based model. Given there are approximately 300,000 visitors annually, and the model estimates only Australian residents traveling independently,¹⁰ both of these figures seem within the bounds of plausibility.

With the assumption that people will respond to increases in price in a similar way to increases in travel cost, the visitation levels corresponding to a schedule of travel costs was derived. As noted above, in theory this involves incrementing the travel cost variable until visitation falls to zero. However, due to the nature of a logarithmic function, it is not possible to obtain a zero level of visitation. Instead choke prices were identified at that point where the level of visitation in each zone reached one. For each zone the level of visitation V_i was calculated using equation (1), along with equation (2) for the pen and paper survey and equation (3) for the web-based survey.

$$V_i = VR_i \times \frac{N_i}{10,000} \tag{1}$$

$$Ln(VR) = 11.22568 - 1.067552\ln(TC) \tag{2}$$

$$Ln(VR) = 12.62543 - 1.088471\ln(TC) \tag{3}$$

Where VR_i is the visitation rate from zone *i*, N_i is the population of zone *i* and V_i , thus, represents the scaled number of visits per 10,000 population from each zone for the year.

Hence, for the pen and paper survey:

⁹ In all estimated equations, none of the socio-demographic variables were found to be significant at the 1, 5 or 10% level.

¹⁰ When considered from an Australian perspective, the expenditure of overseas visitors associated with visiting Fraser Island might more appropriately be considered as contributing to producer surplus, and not to consumer surplus (which is measured by the travel cost procedure). For this reason, overseas visitors are excluded from the analysis. See Fleming and Cook (2007) for further details.

$$V_i = \frac{N_i}{10,000} e^{11.22568} \times TC^{-1.067552}$$
(4)

And for the web-based survey:

$$V_i = \frac{N_i}{10,000} e^{12.62543} \times TC^{-1.088471}$$
(5)

In both cases, the trip generating function was integrated for each zone between the actual travel cost and the zonal choke price travel cost. This estimates consumer surplus for each zone. Consumer surplus for the pen and paper survey is thus:

$$CS_{i} = \frac{N_{i}}{10,000} e^{11.22568} \times \left[\frac{TC^{-0.067552}}{-0.067552}\right]_{TC_{i}}^{TC_{i}+\Delta C_{\max}}$$
(6)

And for the web-based survey is thus:

$$CS_{i} = \frac{N_{i}}{10,000} e^{12.62543} \times \left[\frac{TC^{-0.088471}}{-0.088471}\right]_{TC_{i}}^{TC_{i} + \Delta C_{\max}}$$
(7)

All the zonal answers were added to obtain the estimate of total consumer surplus. This yields a surplus of \$417,494,101 and \$486,456,234 per annum for the pen and paper and web-based surveys respectively. These figures correspond to per-person per-visit estimates of \$3,189.20 (pen and paper) and \$4,356.78 (web-based).

To account for multiple-site visitors,¹¹ each zonal estimate of consumer surplus was adjusted according to the average zonal proportion of time spent on Fraser Island, relative to the time spent away from home on the trip, as given by equation (8):

Proportion of consumer surplus allocated to Fraser Island =
$$\frac{NI_x}{TN_x}$$
 (8)

Where, NI_x is the number of nights spent on Fraser Island by visitor x and TN_x is the total number of nights spent away from home by visitor x. If this proportion is greater than or equal to 1, or if TN_x is zero (signifying a day trip), then 100% of the consumer surplus is allocated to the Island.

¹¹ One of the assumptions of the travel cost methodology is that only one site is visited per trip. That is, all the travel costs are incurred exclusively to obtain access to the particular recreation site being valued (Haspel and Johnson, 1982). If a trip has multiple objectives, it implies the full cost of the trip is not an implicit price for the particular recreation site under consideration. In this paper, the total travel costs of all (multiple- and single-site) visitors are used and the resulting estimates adjusted as discussed above; a method first suggested by Clough and Meister (1991).

This yields adjusted consumer surplus estimates for the pen and paper survey of \$191,353,287 (\$1,461.73 per-person per-visit) and for the web-based survey of \$206,192,787 (\$1,853.14 per-person per-visit). These results are summarized in Table 4 below.

	Unadjusted	Adjusted for multiple-site visitors
Pen and Paper		
Total	\$417,494,101	\$191,353,287
Per-person per-visit	\$3,189.20	\$1,461.73
Web-based		
Total	\$486,456,234	\$206,192,787
Per-person per-visit	\$4,356.78	\$1,853.14

Table 4: Summary of consumer surplus estimates (\$A per annum)

7. CONCLUSION

This paper compares results obtained from a non-market valuation questionnaire conducted via two alternate survey administration modes; conventional pen and paper and the Internet. It was thought the web-based survey mode may offer several advantages over more conventional modes, particularly in the area of surveying costs. However, there was concern that web-based surveying would result in sample frame and/or non-response bias.

In fact, in addition to yielding similar overall response and item non-response rates, respondents to the alternate modes did not differ significantly in terms of age, education, household income or country of residence. Among Australian residents, however, a significant difference was found between respondents to the alternate modes in terms of their State of residence, with respondents to the web-based survey less likely to have come from Queensland. As Internet use in Queensland is not significantly lower than in the other States (ABS, 2006), it seems likely that this result is driven by respondent recruitment, based as it is, on catching the attention of visitors to primarily tourism-related websites. It may be that Queenslanders, being more familiar with Fraser Island and its surrounds, are less likely to visit promotional web-sites of the type used to recruit respondents to this survey. Certainly the issue of respondent recruitment to web-based non-market valuation questionnaires deserves further consideration. This difference in State of residence is the most likely driver behind the larger consumer surplus estimates seen in the web-based model, reflecting the fact that web-based respondents, on average, have to travel further to visit Fraser Island.

Nonetheless, estimates of consumer surplus between the alternate modes are not substantially different, moreover, as expected, the web-based survey cost substantially less to implement than the pen and paper survey, both in terms of out-of-pocket expenses and researcher time.

In all, there is reason to believe the Internet has potential to become a valuable tool for nonmarket valuation practitioners, either in replacing, or supplementing, conventional survey administration modes. This is particularly true when the site under consideration, or the population being surveyed, is in a remote location, or, as is the case for most graduate students, the research budget is limited.

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