VALUING BOTANIC COLLECTIONS: A COMBINED TRAVEL-COST AND CONTINGENT VALUATION SURVEY IN AUSTRALIA

Paul Mwebaze,[a1]. Jeff. Bennett[a]

[a] Crawford School of Economics and Government, The Australian National University, Canberra, ACT 0200, Australia.

ABSTRACT

The economic value of biological collections in three major botanic gardens in Australia was estimated using the Travel-Cost (TC) and Contingent Valuation (CV) methods. The study used truncated count data models to control for the non-negative integer and truncation properties of the number of visits to botanic gardens in Canberra, Melbourne and Sydney. We estimate consumer surplus values of approximately $34 per trip to each botanic garden, resulting in the total social welfare estimate of approximately $96.9 million in 2010 Australian dollars. This result is relatively high compared to similar studies conducted in other countries. Willingness to pay (WTP) for entry fees and or higher parking charges for access to botanic gardens were also investigated. Results indicate a positive mean WTP of approximately $3-$4 per trip per person. These findings will be useful for resource management decisions in the botanic gardens and other biological collections in Australia.

Key words: *Economic value, botanic gardens, biological collections, willingness to pay, travel-cost method, contingent valuation method.*

A Contributed paper for the 55th Annual AARES National Conference, Melbourne-Victoria, 9th-11th February 2011.

1 Corresponding Author. Address: Environmental Economics Research Hub (EERH), Crawford School of Economics and Government, The Australian National University, Canberra, ACT 0200, Australia. Email: paul.mwebaze@anu.edu.au. Tel: +61 (2) 6125 54443 Fax: +61 (0) 6125 5448

1. INTRODUCTION

Biological collections generate benefits to society in areas as divergent as biosecurity, public health and safety, monitoring of environmental change, and traditional taxonomy and systematics (Suarez and Tsutsui, 2004). Australia's biological collections provide a resource for identifying and monitoring Australia's biodiversity, providing the knowledge needed for effective biosecurity and environmental management, and experimentation. Botanic gardens maintain collections of biological materials, ranging from preserved whole plants to DNA libraries. However, these biological resources are not optimally utilised because of the transaction costs incurred in accessing them (Bennett and Gillespie, 2008). Specifically, botanic gardens face rising costs and a decline of their traditional uses in medicine and pharmacy (Garrod *et al*., 1993). The benefits supplied by plant collections are often undervalued by policymakers, resulting in insufficient resource allocation that would allow for an improvement in the management of such collections (Whiting and Associates, 1995).

Botanic gardens also play a role as a public leisure amenity. Recent statistics indicate that the number of visitors has increased sharply over the years. Botanic gardens are now the second most popular cultural venue visited in Australia (after the cinema). Approximately 40% of the Australian population over 15 years old visit at least one botanic garden each year, according to the Botanic Gardens Trust (2010). Most botanic gardens in Australia do not charge an entry fee, and a question arises as to the magnitude of benefits generated from free public access? The aim of this paper is to assess current recreational visitor use values at three selected botanic gardens in Australia. The study employs observed and stated behaviour to make inferences about consumer preferences for the selected botanic gardens. A travel-cost model (TCM) is used to measure the values visitors place on botanic gardens. The TCM estimates non-market benefits generated from botanic gardens by identifying how much visitors are willing to pay (WTP) to gain access to such environmental goods and services. The advantages of using this technique includes its roots in consumer theory, reliance on actual market data about travel costs, and the ability to represent consumer preferences accurately (Shresha *et al*., 2002). The TCM has been widely used in the past to value recreational activities (e.g. Bennett 1996; Common *et al*., 1999; Haab and McConnell, 2002; Prayaga *et al*., 2010). However, there are relatively few papers that have assessed the recreational value of botanic gardens (e.g. Garrod *et al*., 1993).

Another objective is to use the contingent valuation method (CV) to estimate visitors' willingness to pay (WTP) for access to botanic gardens. This elicits both use and non-use values associated with botanic collections. The CVM has been used to value a change in the management of scientific collections (e.g. Provins *et al*., 2007).[2] Combining the TCM and CVM links expectations, motivations, travel costs and WTP variables for each survey respondent (Figure 1). This approach can be used to test 'convergent validity' of TC and CV methods (Garrod *et al*., 1993; Clarke, 2002; Nunes and Van den Bergh, 2004).

The paper is structured as follows. The next section describes the methodology followed and the survey instrument used in the study. The main results are reported and discussed in Section 3. Section 3.1 sets out the recreational benefits from botanic collections estimated using the TCM. Section 3.2 reports and discusses the CVM results. Section 4 provides a synthesis of the results and concludes the paper.

---

[2] Provins *et al*. (2007) give a methodological review of the use of CVM to value cultural goods. See Noonan (2003) and Throsby (2003) for an earlier review of the valuation of cultural goods such as museum collections.

2. METHODOLOGY

2.1 The Individual Travel Cost Model (TCM)

The travel-cost method (TCM) assumes that an individual must visit a botanic garden to consume its services. The non-market benefits accruing to the individual from the botanic site can be inferred from the relationship between travel-cost expenditures and the number of visits to the botanic site. Travel cost is used as a proxy for an entry price, with a change in price causing a change in consumption (Freeman, 1993). More specifically, the individual TCM stipulates that the number of visits (V_{ij}) made by an individual *i* to botanic site *j*, is a function of a number of variables including the following: the cost of travel to gain access to the site, plus any entry and parking fees; socio-economic characteristics of individual *i*; the attributes of site *j*; and the cost of accessing substitute sites (Hanley and Barbier, 2009). In this paper, the visitation model was specified as given below:

$$V_{ij} = f\left(TC_{ij}, SS_{ij}, X_{ij}, e_i\right) \quad (1)$$

where: V_{ij} = Number of visits by individual *i* to botanic site *j* in the previous 12 months,

TC_{ij} = Travel cost variables by individual *i* to gain access to botanic garden /site *j*, these include distance costs for each individual *i*, time costs (which on the whole is considered to depend on their labour market situation), and any entry/parking fee (which is charged for entrance to site *j*).

SS_{ij} = A dummy variable to capture whether individual *i* visited a substitute site to *j*, (it takes on the value 1 for substitute sites and zero otherwise),

X_{ij} = Vector of socio-economic characteristics of individual *i* (income, education, age),

e_i = Error term assumed to be normally distributed with constant variance and zero mean.

An important statistical feature of the TCM given by Eq. (1) is that the dependent variable (V_{ij}) can only take integer values. This kind of data is known as 'count data' and using the standard ordinary least squares (OLS) regression to estimate Eq. (1) is not appropriate. A Poisson or negative binomial regression method was used instead. The Poisson model has the property that the conditional mean (expected value) should be equal to the variance. However, if this condition is not met, implying some overdispersion problem, then a negative binomial regression should be used instead (Cameron and Trivedi, 1986; 1988). Other problems associated with the application of count data models for estimating recreation site demand using onsite surveys arise from two sources (Chakraborty and Keith, 2000): (1) the probability of being surveyed depend on the frequency of visits (endogenous stratification); and (2) non-users are often not sampled (truncation). The standard Poisson and negative binomial estimators will be biased and inconsistent if applied to a truncated sample. In view of the issues involved in modelling recreational demand data, we used the zero truncated Poisson (ZTP) and zero truncated negative binomial (ZTNB) regressions to estimate Eq. (1). These count data models have been used in numerous studies (Creel and Loomis, 1990; Coupal *et al*., 2002; Shrestha *et al*., 2002; Prayaga *et al*., 2010).

A count data model which assumes a semi-log functional form, has the simple and convenient property of allowing the estimation of consumer surplus per visit as the inverse of the travel cost coefficient (Englin and Shonkwiler, 1995; Creel and Loomis, 1996; Shrestha *et al*., 2002; Prayaga *et al*., 2010). The demand for recreational visits is set out in Eq. (2), where *Vr* is the expected number of visits, *TC* is travel costs per trip, and X_n is a vector of explanatory variables affecting demand.

$$\ln V_r = \beta_0 - \beta_1 TC + \beta_2 X_2 + \beta_3 X_3 + ...\beta_n X_n + e_i \quad (2)$$

$$CS = -\frac{1}{\beta_{TC}} \quad (3)$$

2.2 The Survey Instrument

The survey questionnaire developed for this study consists of two parts (Figure 1). The first part was designed to collect information on trip motivation, travel costs, travel time and on-site expenditures. This information is used to estimate the recreational use benefits generated by individuals visiting botanic sites. The second part is the CV exercise. This is designed to measure user's WTP for a change in the management of botanical collections. The NOAA guidelines were followed to ensure the payment vehicle was appropriate to the context and was regarded to be fair (Arrow *et al*., 1993). The payment vehicle used for this CV exercise is 'entry fee' to gain access to a botanic garden. The dichotomous choice (DC) format was used. This type of question is favoured because it gives the respondent no incentive not to answer truthfully: i.e. the format is incentive compatible (Bateman *et al*., 2002).[3]

Before administering the survey, a first draft of the questionnaire was pretested in a number of pilot interviews. The study opted for an in-person survey because it generally yields the highest survey response, as well as allowing the use of the dichotomous choice WTP question format in the CV (Bateman *et al*., 2002). The final revised questionnaires were administered at three selected botanic gardens. The three sites chosen are representative of the different settings (types) in existence. They are the Australian National Botanical Garden (ANBG), the Royal Botanic Garden Melbourne (RBGM) and the Royal Botanic Garden Sydney (RBGS). The data for the study were collected over the 4-month period from July through November, 2010. This period was chosen to maximise the number of visitors to be surveyed for minimum cost. Potential participants were intercepted at random and an in-person written survey was conducted while visitors were relaxing in the visitor centre, cafe, gardens, parking places etc. Visitors were queried regarding their travel costs of the visit, reasons for choosing

[3] Note that incentive compatibility also requires the stipulation of a provision rule; for example if 50% of respondents agree to pay, then an entry fee should be established.

the selected site as a travel destination, their whole site experiences and appreciation of the visit, and some demographic information. Interviewers were instructed to target individuals, avoiding participation of others from the same group, although several members of a group could be interviewed together. Only adult members were interviewed, and interviewers were instructed to question the head-of-household responsible for expenditure decisions if family groups were encountered. A systematic random sampling procedure was applied to the data collection process.[4] One problem with on-site surveys is that they are conducted when a trip is still in progress and respondents may not be able to provide reliable data on total costs (Upneja *et al*., 2001). For this survey, visitors were intercepted at the end of their trip as they prepared to leave, by which time they had incurred the costs and had data to report. During the sampled periods, every fourth individual who arrived at the site was intercepted.

2.3 Descriptive Statistics

Descriptive statistics from the survey data used in this paper are summarised in Table 1. A total of 1500 visitors were interviewed at the three selected botanic sites. Visitors sampled at the three sites were more likely to be female (57-64%). On average, respondents were 36 years old, with a relatively high average annual income of $77,000. Of the total responses, 1139 were usable for the travel-cost demand estimation, with incomplete essential information being the main reason for excluding observations. However, the remaining sample is representative of the profile of visitors to botanic gardens.

On average, respondents visited the selected botanic gardens between six and eight times a year, with each trip lasting over two hours, depending on the site. Figure 2, 3 and 4 give the

[4] Since there may be more than one access points on some sites (entrance, exit etc), more people visit at some times than others, and the composition of visitors may also differ substantially at different times of the year (e.g. school holidays vs term times, winter vs. summer). The surveys were stratified in order to be representative of the distribution or spread of the visits (e.g. weekend vs. week days). We sampled at different hours of the day. Visitors were intercepted at every access point.

stated principal motivating factors for the trips. Note that the recreational experience not only includes learning about plant collections but also other potentially valued joint products such as relaxation, meeting and spending time with friends, natural beauty and scenic view, and nature walk. A number of these motivating reasons given above, for example natural beauty and scenic view, highlight the value of plant collections for the visitors.

3 RESULTS AND DISCUSSION

The results of the analyses are presented in two parts. First, we present and discuss the estimated travel cost models and the visitation benefits associated with botanic collections (Section 3.1). Then we present and discuss the contingent valuation results (Section 3.2).

3.1 TC RESULTS

3.1.1 Estimated TC Models

Travel costs can be estimated in a number of different ways by changing the definition and inclusion of variables used in the model. Historically, three methods have been used for estimating travel costs (Bateman, 1993; Common *et al*., 1999). The first method uses only estimated fuel costs as a function of distance while the second method captures estimated full car costs that include fuel, insurance, maintenance and depreciation as a function of distance. The third method uses ‘perceived’ costs as reported by the respondents. This study used reported costs because it is most likely to represent the opportunity costs that respondents considered when making their trip decision (Bennett, 1996; Prayaga *et al*., 2010). Results for the estimated models using reported costs are summarised in Table 2. Based on superior performance of the models, only the ZTNB models are reported for discussion. Also, to maintain consistency in comparing results across the three sites, all the variables were retained across the models regardless of the statistical significance of their estimated coefficients. In general, the signs and significance of the variables included in the models are consistent with economic theory and the valuation literature. The likelihood ratio test for alpha (the overdispersion parameter) was statistically significant across the three estimated models, indicating that the ZTNB models are preferred over a more standard ZTP model.

The results demonstrate that the travel-cost variables have negative signs and are statistically significant ($P \leq 0.05$) across all the models. This is consistent with Creel and Loomis (1990), and Grogger and Carson (1991). Transport cost, as a price variable with negative sign is the main result of the recreation demand model, indicating a downward sloping demand curve. This implies that visitors to botanic gardens will take fewer trips as transport costs increase. This would suggest that the price elasticity of demand for trips (measured in terms of transport costs), is highly significant in explaining consumer behaviour, in determining the number of annual trips to botanic sites. This result might be relevant for policy guidance since any measures that targets directly transport related expenditures (e.g. taxes on fuel, parking fees etc) will influence the quantity demanded of annual trips to botanic gardens. For example, a policy option that is characterised by changing the pricing rates of parking fees might well change consumer recreational behaviour.

The coefficient of the duration of the visit variable is statistically significant ($P \leq 0.05$) with a negative sign in all the estimated models, consistent with Creel and Loomis (1990). In general, the longer trip duration is likely to reduce frequency of visits to the selected botanic gardens. This is a similar finding to that reported by Shrestha *et al*. (2002) who looked at recreational fishing in the Brazilian pantanal. The mean duration of the trip to the selected botanic sites is approximately 2.5 hours, averaged for the 3 sites (from Table 1).

The dummy variable for substitute sites is also negative and statistically significant ($P \leq 0.05$) across all the models. This variable captures whether or not respondents visited any other sites on their trip. The result confirms that the availability of substitute sites reduces the demand for trips to the botanic gardens, consistent with economic theory. Note the number of respondents who visited substitute sites on their trip to the botanic sites varies among the three sites; it was highest in Sydney (48.6%) and least in Canberra (28.3%).

Our results also show that the demand for visits to botanic gardens is sensitive to income, with the coefficient of income elasticity being positive and statistically different from zero ($P \leq 0.05$). With respect to the personal characteristics, both age and gender were negative and statistically significant ($P \leq 0.05$) in all the models estimated. This means that the annual number of trips is expected to be higher for younger, female visitors than for the other respondents.

3.1.2 Estimating Visitation Benefits Derived From Botanic Gardens

The economic values of visits to botanic gardens were derived using the trip generation functions reported in Table 2. Following Creel and Loomis (1990), the mean consumer surplus (CS) estimates for these demand models were obtained using the negative inverse of the travel-cost coefficient ($-\frac{1}{\hat{\beta}}$). The CS values per trip for the ANBG, RBGM and RBGS were \$47.49, \$135.49 and \$75.45, respectively. The 95% confidence intervals of the mean CS estimates per trip are given in Table 2.

Multi-purpose trips can be a problem for the TCM. It has been shown that excluding the costs of visiting substitute sites can biase the estimate of CS per visit upwards on average (Smith and Kaoru, 1990). For the round trips involving several sites, travel costs can be allocated between each site in a *pro rata* procedure (OECD, 2002). In this paper, travel costs were allocated between each site using the proportion of time spent on each site: using the mean length of the trip in hours (1.92-2.84) and adjusting for the proportion of travel costs that can be allocated to each botanic site , we obtained an approximate CS estimate per hour of $15.83, $27.19 and $13.30 for the ANBG, RBGM and RBGS respectively. The social welfare value of recreational opportunities in the selected botanic gardens can then be estimated using the total number of annual visitors to each site. Based on 2010 visitor statistics, the total social welfare values are approximately $6.3 million, $44.1 and $46.6 million for the ANBG, RBGM and RBGS respectively, in 2010 Australian dollars (Table 3).

3.2 CONTINGENT VALUATION RESULTS

3.2.1 *Results from Payment Principle Question*

In addition to questions about travel behaviour, the questionnaire asked respondents whether they would be willing to pay an entry fee (or higher parking charge) to gain access to the botanic gardens. Questions of this nature are often used in recreation demand surveys in order to elicit some measure of respondents' WTP to use or to gain access to a specific site (Garrod *et al.*, 1993; Nunes and Van den Bergh, 2004). As well as using a dichotomous choice (DC) question a follow-up open-ended WTP question was included to improve the statistical efficiency of the WTP estimates (Bateman *et al.*, 2002). If the response to the open-ended question was a zero willingness to pay, then the respondent was asked to indicate his or her main reason for this choice.

Respondents who stated 'No' to the principle WTP question represented, on average about 50% of the survey sample at the three selected botanic gardens (Table 4). We explored why this number of respondents opted to stay 'out of the market'. The primary stated motive for not being willing to pay anything was that the Australian Government should cover the costs, and a secondary reason was that changing entry or parking fees may be a deterrent for some visitors (Table 5). Some respondents preferred to give a voluntary donation while other reasons were not disclosed. However, a well known reason might have been the strategic behaviour to 'free ride'. Dealing with protest zero bidders is a critical issue in CV studies. As these reasons suggest a zero valuation of the proposed change (or reflect a disapproval of the payment vehicle), we used the strategy of considering them as real zero bids. This results in conservative estimates of the visitors' WTP (Santagata and Signorello, 2000).

3.2.2 WTP estimation from single bounded DC valuation question

Table 6 and Table 7 summarise the basic dataset derived from the single bounded DC valuation question for the survey sample. For each bid price, the tables show the number of respondents facing that bid, the number of 'yes' responses and the proportion of 'yes' responses. The discrete choice dataset was analysed using (i) a logit regression model, and (ii) a Turnbull estimator (Haab and McConnell, 1997). The logit model is parametric since it is based on the assumption that in the population the latent true variable WTP follows a logistic distribution. The Turnbull estimator is a non-parametric approach (Turnbull, 1976). The results of the logit model estimation are presented in Table 8. In all the three estimated models the coefficients have the expected signs and are statistically significant ($P \leq 0.05$).

From the estimated logit equations, the expected value of the mean WTP, $E(WTP)$, was calculated using the formula developed for a WTP distribution truncated at zero in the left side (Haneman, 1984), as given below:

$$\ln[1+\exp(\alpha)]/\beta \qquad (3)$$

A similar procedure was followed when applying the Turnbull estimator to estimate a lower-bound for the mean WTP. The equation for the Turnbull estimator is (Turnbull, 1976):

$$E(WTP) = \sum \pi_j B_j \qquad (4)$$

where $\pi_j = [\Pr(Yes * B_j) - \Pr(Yes * B_{j+1})]$.

Table 9 reports the mean WTP estimates for the three selected botanic gardens. As expected *a priori*, all parametric mean WTP values are bounded from below by the estimated lower-bound Turnbull mean.

3.2.3 WTP Estimation from the Open-Ended Valuation Question

Table 10 reports summary statistics for the open-ended WTP question, by location. The skewness and kurtosis measures reveal that WTP open-ended distribution is positively skewed and leptokurtic. The open-ended mean WTP values are smaller than the single bounded DC mean. There are a number of possible explanations for this disparity. One argument could be 'strategic bias' leading to understatement of the true WTP. Another explanation may be that answering an open-ended question is a more difficult task as quantitative information is required (Hanley and Barbier, 2009). Where cognitive difficulty and preference uncertainty are present, it is more likely that individuals will give lower values. On the contrary, DC data may also be affected by a certain degree of yea-saying (Bateman *et al*, 2002). This could bias discrete choice estimates of mean WTP upward.

A number of authors have documented a particular bias in CV surveys where an open-ended valuation question format followed a discrete choice question format (e.g. Santagata and Signorello, 2000). This anomaly is called the 'anchoring effect', whereby the open-ended WTP values are not independent of the bids that were randomly distributed among the respondents . Anchoring effect can be regarded as a more general type of starting point bias.

It can be explained by using the psychological prospect theory of economic behaviour, whereby individuals identify a reference point and then frame deviations from this reference point as either losses or gains (Kahneman and Tversky, 1979).[5] The presence of the anchoring effect was tested by regressing the open-ended WTP values on the bid price used in the previous stage of the questionnaire. These linear regression models indicated that the coefficient estimate of the bid price was not statistically different from zero in all the estimated models. Hence our dataset does not exhibit the anchoring effect. Further inspection of the dataset supports this conclusion. The percentage of cases in which the stated WTP was equal to the randomly distributed bid price averaged 14% for the three surveys.

3.2.4 WTP Valuation Functions

It is common practice in CV studies to estimate a valuation function that relates discrete choice or WTP to variables that are expected to have an influence on the choice or on the stated WTP amount. This explorative estimation allows us to perform a test of construct and theoretical validity by determining whether choices or WTP amounts are significantly related to variables suggested by economic theory. A large number of variables were available for inclusion in the valuation functions. Table 11 gives the estimated logit models that best fitted the data. The coefficients on the bid price, travel costs, distance, number of previous visits, age and income were statistically significant ($P \leq 0.05$) and of the expected signs, consistent across the three models. The results indicate that the relative probability of a 'yes' decreases with increases in the 'cost' asked of a respondent and increases with income, consistent with economic theory. The age of respondent influenced negatively the attitude towards the contribution for entry fees or higher parking charges. Note that respondents with a high

[5] When a respondent gives a 'yes' answer to the single-bounded DC question, she adopts a reference point equal to the distance between the suggested bid price and her equivalent surplus. If the answer was 'no', the respondent does not form a reference point (Santagata and Signorello, 2000).

visitation frequency have a lower WTP than the average respondent. Respondents who travel longer distances or who incurred higher travel costs also have a lower WTP. This indicates that the values obtained with the TCM and CVM are consistent. Hence the TC exercise has helped to capture other value categories than the CV exercise.

The open-ended valuation functions are reported in Table 12. Following Greene (1987) and Santagata and Signorello (2000), the multivariate linear equations were estimated using a Tobit regression model, as data are censored at zero. Tobit models confirmed the signs and significance already observed in the logit functions reported. The signs and significance are consistent across all the estimated models. Thus, the WTP was higher for individuals with higher income and less for respondents who travel longer distances and incur higher travel costs. The age variable shows a negative significant coefficient revealing that older respondents were willing to pay less than younger respondents. The gender variable also shows a negative coefficient implying that male visitors were willing to pay less than female respondents but this variable is not highly significant. Finally, respondents with a high visitation frequency have a lower WTP than the average respondent.

4 CONCLUSIONS

Recreational trips to botanic gardens are an important activity in Australia. Recreational trips to the three surveyed botanic gardens are largely influenced by transport costs, proximity of substitute sites, and visitors' socio-economic characteristics such as age, gender and income. Their average consumer surplus (CS) estimate per trip of approximately $34 is higher than the average CS figures revealed from a synthesis of the past recreational studies in botanic gardens around the world. This study shows the total welfare measure due to recreational visits to the three botanic gardens in Australia is $96.9 million annually. A paper by Garrod *et* *al*. (1993) estimated the recreational value of four botanic gardens in the UK to be £41,700 annually. However, the values reported in this paper are of the same order of magnitude with other recreational activities such as fishing. Prayaga *et al*. (2010) estimated the value of recreational fishing in the Great Barrier Reef to be approximately $167 per trip per angler.

The CV exercise undertaken in this paper queried visitors for their WTP for entry or parking fees to gain access to the three botanic gardens. The analysis resulted in a positive mean WTP of between $4.0 and $5 per trip for entry fees and approximately $3.0 per hour in higher parking fees to the botanic gardens. The CV estimates are significantly smaller than the TC values. These CV estimates include individuals' valuations of their option to visit the botanic gardens at some point in the future (option value); their valuations of the knowledge that the collections continue to exist (existence value); and their valuations of the botanic gardens (and collections therein) as an asset for future generations (bequest value). Respondents perceive botanic gardens as safe haven of plant biodiversity and as valuable gene banks, coupled with their use as a resource for education and scientific research.

The combination of TCM and CVM estimation results indicate that respondents with relatively higher travel costs have a low WTP for a policy change. This suggests that some budget constraint is active, and that TCM and CVM estimates are complementary in terms of obtaining a complete picture of the overall monetary values associated with the botanic gardens. The big difference between the CVM and TCM estimation results requires additional explanation. The two models are not measuring the same thing-The CVM is estimating WTP for entry in the form of a per unit price while the TCM is estimating a consumer surplus. Hence one wouldn't expect them to be the same.

ACKNOWLEDGEMENT

This study was funded by the Department of Sustainability, Environment, Water, population and Communities. We would like to thank management and staff from the botanic gardens in Canberra, Melbourne and Sydney for helping to facilitate the visitor survey. We are grateful to the three Research assistants from ANU who helped interview visitors.

REFERENCES

Arrow, K., Solow, R., Portney, P., Leamer, E., Radner, R., Schuman, H. (1993). Report of the NOAA panel on contingent valuation. *Federal Register* 58 (10):4602–4614.

Bateman, I.J. (1993).Valuation of the environment methods and techniques: revealed preference methods. In: Turner, R. K, editor. Sustainable environmental economics and management—principles and practice. London: Belhaven Press;1993.p.192–233.

Bateman, I.J., Carson, R. T., Day, B., Hanemann, M. W., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R., Swanson, J. (2002). Economic Valuation with Stated Preference Techniques: A Manual. Edward Elgar, Cheltenham, UK, pp.458.

Bateman, I.J., Langford, I.H. (1997). Non-Users Willingness to Pay for a National Park: An Application and Critique of the Contingent Valuation Method. *Regional Studies* 31 (6):571-582.

Bennett, J. (1996). Estimating the recreational use values of national parks. Tourism Economics 1996;2(4):303–20.

Bennett, J., Gillespie, R. (2008). Bio-resources for Biotechnology in Australia: An Economic Perspective. A Report Prepared for the Commonwealth Department of the Environment, Water, Heritage and the Arts, pp.47.

Cameron, A.C., Trivedi, P.K. (1986). Econometric models based on count data: comparisons and applications of some estimators and tests. *Journal of Applied Econometrics* 1: 29–53.

Cameron, A.C., Trivedi, P.K. (1998). Regression Analysis of Count Data. Cambridge University Press, Cambridge, UK.

Chakraborty, K., Keith, J.E. (2000). Estimating the Recreation Demand and Economic Value of Mountain Biking in Moab, Utah: An Application of Count Data Models. *Journal of Environmental Planning and Management* 43(4):461-469.

Clarke, P.M. (2002). Testing the convergent validity of the contingent valuation and travel cost methods in valuing the benefits of health care. *Health Economics* 11:117-127.

Coupal, R.H., Bastian, C.T. Taylor, D.T. (2002). Economic Benefits of Sport Fishing and Angler Wildlife Watching in Pennsylvania: A Comment. *Journal of Travel Research* 41:210-211.

Creel, M.D., Loomis, J.B. (1990). Theoretical and empirical advantages of truncated count estimators for analysis of deer hunting in California. *American Journal of Agricultural Economics* 72 (1990):434–441.

Dalrymple, G., Hanley N. (2005). Using economic valuation to guide the management of outdoor recreational resources. *Tourism* 53(2):105-114

Englin, J.E., Shonkwiler, J.S. (1995). Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation. *The Review of Economics and Statistics* 77:104–112.

Freeman, A.M., (1993). The measurement of environmental and resource values: theory and methods. Resources for the Future, Washington DC.

Garrod, G., Pickering, A., Willis, K. (1993). The Economic Value of Botanic Gardens: a Recreational Perspective. *Geoforum* 24 (2):215-224.

Greene, W. (1997) Econometric Analysis, 3rd Edition. Prentice Hall, U.S.A.

Grogger, J.T., Carson, R.T. (1991). Models for truncated counts. *Journal of Applied Econometrics* 6: 225–238.

Haab T, McConnell K (2002) Valuing environmental and natural resources: the econometrics of non-market valuation. Edward Elgar, Cheltenham.

Haab, T.C., McConnell, K.E. (1997). Referendum Models and Negative Willingness to Pay: Alternative Solutions. *Journal of Environmental Economics and Management* 32: 251–270.

Hanemann, M. (1984). Welfare Evaluations in Contingent Valuation Experiments with Discrete Response Data. *American Journal of Agricultural Economics* 66: 332–341.

Hanley, N., Barbier, E.B. (2009). Pricing Nature: Cost-Benefit Analysis and Environmental Policy. Edward Elgar, USA, pp.353.

Kahneman, D. Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica* 47: 263–291.

Long, J.S., Freese, J. (2006). Regression Models for Categorical Dependent Variables Using Stata. Second edition, Stata Press Publication, StataCorp LP, College Station, Texas, USA, pp.527.

Loomis, J.B., Walsh, R.G. (1997). Recreation Economic Decisions: Comparing Benefits and Costs, 2nd ed. Venture Publishing, Inc, Pennsylvania.

Loomis, J.B., Walsh, R.G. (1997). Recreation Economic Decisions: Comparing Benefits and Costs, 2nd ed. Venture Publishing, Inc, Pennsylvania.

Menkhaus, S. Lober, D.J. (1996). International ecotourism and the valuation of tropical rainforests in Costa Rica. *Journal of Environmental Management* 47:1-10.

Noonan, D. (2003). Contingent valuation and cultural resources: a meta-analytic review of the literature. *Journal of Cultural Economics* 27:159-176.

Nunes, P.A.L.D, Van den Bergh, C.J.M. (2004). Can people value protection against invasive marine species? Evidence from a joint TC-CV survey in the Netherlands. *Environmental and Resource Economics* 28:517-532.

P.G. Whiting and Associates (1995). The social and economic value of scientific collections. Federal Biosystematics Group, Canada. Unpublished Report, pp.67.

Pearce, D.W. Turner, R.K. (1990). Economics of Natural Resources and the Environment. New York: Harvester Wheatsheaf.

Pendleton, L.H. (1995), .Valuing Coral Reef Protection. *Ocean & Coastal Management* 26 (2):119-131.

Perman, R., Ma, Y., McGilvray, J. M. Common (2003). *Natural Resource and Environmental Economics*, Third Edition, Harlow: Pearson Education Ltd.

Prayaga, P., Rolfe, J., Stoeckl, N. (2010). The Value of Recreational Fishing in The Great Barrier Reef, Australia: A Pooled Revealed Preference and Contingent Behaviour Model. *Marine Policy* 34 (2010):244-251.

Santagata, W., Signorello, G. (2000). Contingent Valuation of a Cultural Public Good and Policy Design: The Case of 'Napoli Musei Aperti'. *Journal of Cultural Economics* 24: 181-204.

Shrestha, R.K., Seidl, A.F., Moraes, A.S. (2002). Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models. *Ecological Economics* 42 (1-2):289-299

Throsby, D. (2003). Determining the value of cultural goods: how much (or how little) does contingent valuation tell us? *Journal of Cultural Economics* 27:275-285.

Turnbull, B.W. (1976). The Empirical Distribution Function with Arbitrarily Grouped, Censored and Truncated Data. *Journal of the Royal Statistical Society* 38: 290–295.

Upneja, A., E. L. Shafer, W. Seo, and J. Yoon (2001). Economic Benefits of Sport Fishing and Angler Wildlife Watching in Pennsylvania. *Journal of Travel Research* 40 (1):68-78.

Table 1: Descriptive statistics of variables used in regression models, by selected locations

Parameters	**Australian National Botanic Garden (ANBG)**	**Royal Botanic Garden Melbourne (RBGM)**	**Royal Botanic Garden Sydney (RBGS)**
Trip demand (visits/year)	7.49	8.48	6.82
Travel-cost ($)	45.34	32.43	20.94
Travel time (hours)	2.39 -	0.85	0.75 -
Length of trip (hours)	1.92	2.84	2.61
Substitute sites (yes=1, no=0)	0.28	0.34	0.49
Annual Income (‘000 $)	94.64	70.35	83.88
Age (years)	43.89	36.13	30.87
Gender (Male=1; Female=0)	0.38	0.33	0.43

Note: Gender coding: Male=1; Female=0

Table 2: Estimated TC models of recreational visits to selected botanic sites

Parameter estimates	ANBG	RBGM	RBGS
Travel cost	-0.0211 (-4.23)***	-0.0075 (-5.59)***	-0.0133 (-9.38)***
Duration	-0.0739 (2.89)***	-0.1056 (-2.59)**	-0.1272 (-10.56)***
Substitute sites	-0.0578 (-0.62)***	-0.3048 (-3.67)***	-0.5713 (-17.24)***
Age	-0.0060 (-2.43)***	-0.0012 (-2.44)**	-0.0197 (-2.59)**
Gender	-0.3036 (4.20)***	-0.5086 (-5.98)***	0.2422 (7.68)***
Income	0.0010 (2.68)***	0.0126 (6.11)***	0.0002 (5.07)***
Constant	2.1529 (16.33)***	1.7889 (10.30)***	2.4846 (48.35)***
Alpha	1.1305***	1.32***	1.85***
Log-likelihood	-579.70	-881.38	-663.10
Chi-2	163.62	372.90	803.35
No. of Obs.	529	152	614
Consumer surplus/trip ($)	47.49	135.49	75.45
95% confidence interval ($)	32.46-88.47	99.02-206.07	62.41-95.37

Notes: Coefficients are given with *t*-statistics in parentheses. **P<0.05; ***P<0.01

Table 3: Aggregate annual consumer surplus estimates

Site	Consumer surplus per trip ($)	Proportion of travel-costs per site	Total visitors per year(#)	Total surplus ($ millions)
ANBG	24.73	0.64	395,559	6.26
RBGM	47.71	0.57	1,619,950	44.06
RBGS	28.91	0.46	3,500,000	46.55

Notes: (i) Proportion of travel costs allocated per site is based on time spent on each site. (ii) Visitor statistics for the year 2010.

Table 4: Results from the payment principle question, by site and payment vehicle.

Response	ANBG (Parking Fee)	RBGM (Entry Fee)	RBGS (Entry Fee)
Yes	308 (50.74)	103 (42.9)	263 (42.35)
No	299 (49.26)	137 (57.1)	358 (57.65)
Total	607 (100)	240 (100)	621 (100)

Note: Figures in brackets are percentages of responses.

Table 5: What is the main reason you are not willing to pay higher entry/parking fees?

Reasons	ANBG (parking fees)	RBGM (entry fees)	RBGS (entry fees)
Government should provide support	39.1	23.9	27.1
No need for higher parking/entry fees	18.5	14.5	16.8
I prefer to give a donation	1.7	25.6	15.2
Other reason	15.0	11.97	13.1
I don't want additional financial burden	9.4	-	6.1
I am not able to afford to pay for it	8.6	6.8	7. 1
Don't have to pay elsewhere	3.9	5.98	8.8
Don't know or refused	3.9	-	

Table 6: Proportion of 'yes' responses to parking fee increases (ANBG)

Bid price ($)	No. of respondents	No. of 'yes' respondents	% yes
2	24	19	0.79
2.4	66	39	0.59
2.6	59	33	0.56
3.8	335	176	0.53
4	64	22	0.34
5	59	19	0.32
Total	607	308	

Note: Some neighbouring price bands have been merged together.

Table 7: Distribution of 'yes' responses to entry fees question, by location

	RBGM			RBGS		
Bid price ($)	**No. of respondents**	**No. of 'yes' responses**	**% yes**	**No. of respondents**	**No. of 'yes' responses**	**% yes**
1	30	26	0.87	99	78	0.79
3	39	21	0.54	96	47	0.50
4	35	17	0.49	85	45	0.53
5	39	14	0.36	87	41	0.47
7	40	11	0.28	88	17	0.19
9	25	7	0.28	71	16	0.23
10	32	7	0.22	95	19	0.20
Total	240	103		621	263	

Table 8: Estimated Logit Models

Parameters	ANBG	RBGM	RBGS
Bid price	-0.6794 (-5.84)***	-0.2841 (-5.34)***	-0.2931 (-9.25)***
Constant	-2.2644 (-5.81)***	-1.2096 (-3.98)***	-1.2141 (-6.74)***
Log likelihood	-402.12	-147.26	-372.22
Chi-2 value	37.11	33.35	101.85
No. Of Obs.	607	240	621

Notes: Coefficients are given with *t*-statistics in parentheses. **P<0.05; ***P<0.01

Table 9: Single-bounded discrete choice estimates of mean WTP ($)

Parameters	**ANBG**		**RBGM**		**RBGS**	
Model	Logit	Turnbull	Logit	Turnbull	Logit	Turnbull
E (WTP)	3.48	2.97	5.18	4.11	5.03	3.81

Notes: Conventional logit model used to estimate mean WTP. Formulas and procedures are given in the text.

Table 10: Statistics of open-ended WTP question ($)

Statistics	ANBG (Parking Fee)	RBGM (Entry Fee)	RBGS (Entry Fee)
Mean	3.21	4.20	4.18
Median	3.00	4.00	4.00
Maximum	30.00	20.00	40.00
Minimum	0.00	0.00	0.00
Standard deviation	2.53	3.36	3.78
Skewness coefficient	3.39	1.09	2.56
Kurtosis coefficient	29.94	4.81	18.64
Sample size	542	221	578

Table 11: Logit Valuation Functions

Parameters	Model 1 (ANBG)	Model 2 (RBGM)	Model 3 (RBGS)
Bid price	-0.0173 (5.44)***	-0.1077 (-2.61)***	-0.0288 (7.860)***
Travel cost	-0.0164 (-2.38)**	-0.0037 (-2.63)**	-0.0248 (-2.70)**
Distance	-0.0920 (-2.44)**	-	-0.1172 (-2.69)**
No. of Visits	-0.0251 (-2.27)**	-0.0225 (-2.15)**	-0.0368 (3.50)**
Age	-0.0095 (-2.70)**	-0.0797 (-2.07)**	-0.0258 (-3.14)***
Gender	0.4393 (1.08)	-0.1599 (-2.18)**	0.3601 (1.69)
Income	0.0063 (2.06)**	0.0086 (2.84)**	0.0634 (2.25)**
Constant	-2.6992 (-2.94)***	2.9685 (2.64)**	-0.3709 (-1.23)
Log likelihood	-373.62	-125.26	-278.78
Chi-squared (6)	118.64	40.80	118.64
No. of obs.	563	213	501

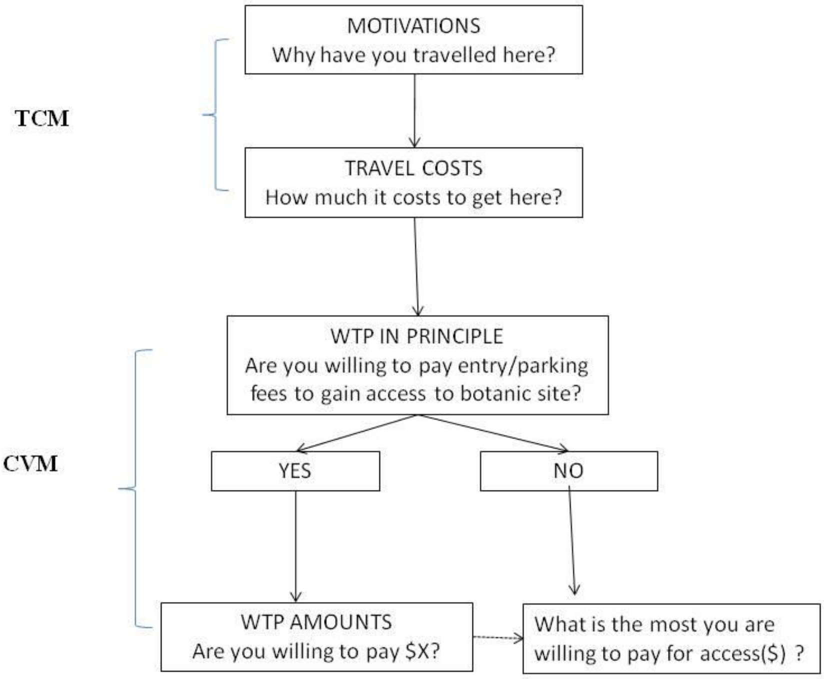
Notes: Coefficients are given with *t*-statistics in parentheses. **P<0.05; ***P<0.01

Table 12: Tobit Valuation Functions.

Parameters	Model 1 (ANBG)	Model 2 (RBGM)	Model 3 (RBGS)
Travel cost	-0.0137 (3.04)***	-0.0016 (1.97)**	-0.0034 (-2.10)**
Distance	-0.0051 (-3.89)***	-	-0.0005 (-2.47)**
No. of visits	-0.0404 (-2.59)***	-0.0224 (-2.71)**	-0.0109 (-1.78)*
Age	0.0303 (1.74)*	-0.0021 (-2.11)**	- 0.0374 (-2.41)**
Gender	-0.1083 (-1.25)	-0.5264 (-1.95)	-0.2395 (-1.64)
Income	0.0002 (2.66)***		0.0041 (2.06)**
Constant	1.8229 (2.13)**	4.3314 (5.63)***	2.2960 (4.28)***
Log likelihood	-168.22	-499.46	-1112.72
Chi-squared (7)	119.19	100.00	126.95
No. Of obs.	312	213	442

Notes: Coefficients are given with *t*-statistics in parentheses. **P<0.05; ***P<0.01

Figure 1: Linking motivation to visit botanic sites to WTP amounts



Source: Based on Garrod *et al*. (1993)

Figure 2: What were the most important reasons for your trip to the ANBG?

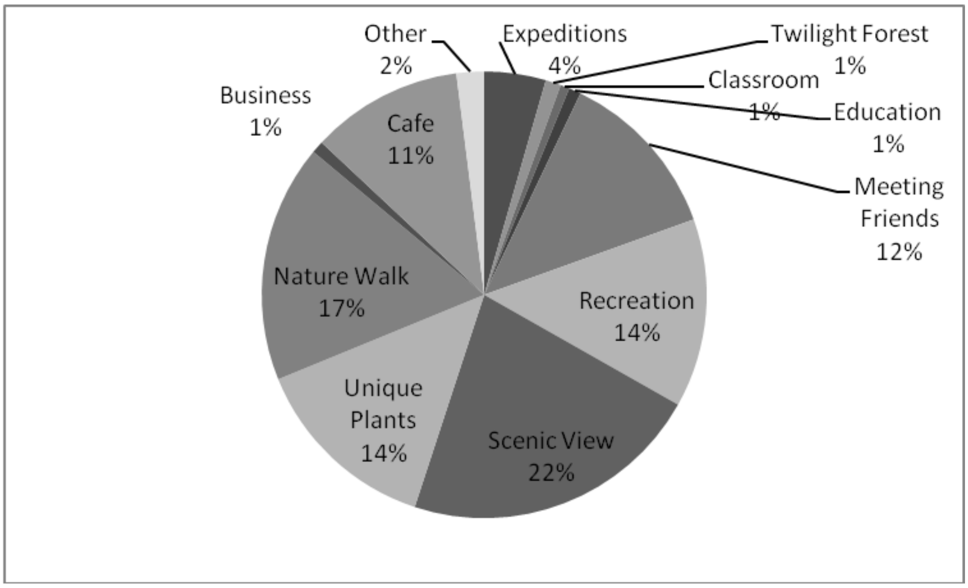


Figure 3: What were the most important reasons for your trip to the RBGM?

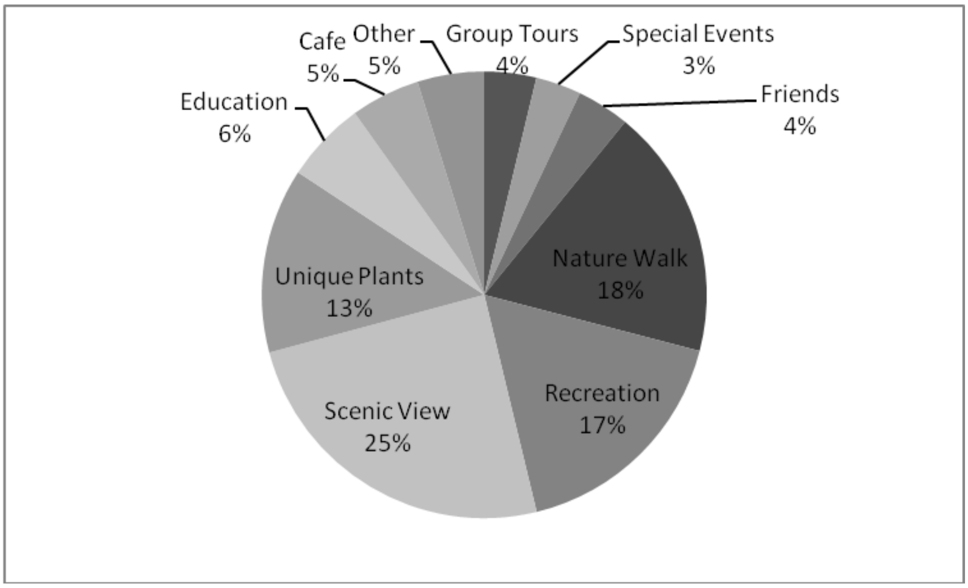


Figure 4: What were the most important reasons for your trip to the RBGS?