Choice Modeling and Tests of Benefit Transfer

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Benefit transfer is increasingly being used by decision makers as a way of estimating environmental values suitable for use in benefit cost analysis. However, recent studies examining the validity of benefit transfer of passive use values estimated using contingent valuation have rejected the hypothesis of convergent validity. In this article, we demonstrate the usage of a form of conjoint analysis known as choice modeling for benefit transfer. Choice modeling has been touted as being particularly suitable for benefit transfer because it is possible to allow for differences in environmental quality and socioeconomic characteristics when transferring benefit estimates. We demonstrate that choice modeling is suitable for benefit transfer, particularly when the transfers involve implicit prices. Second, we examine the circumstances in which benefit transfer of choice modeling derived value estimates is likely to be most valid. Two split sample tests were undertaken to achieve this objective. The evidence from these tests indicates that transfers across different case study sites are likely to be subject to less error than those across different populations.

Key words: benefit transfer, choice modeling, passive use values, stated preference techniques.

In many situations, because of time and budget constraints, those tasked with making decisions regarding the allocation of natural resources are required to extrapolate from existing data that were collected for a different purpose. The use of existing studies in project evaluations and policy analyses is known in the resource economics literature as 'benefit transfer.'

The use of existing data is not something new to economics, or indeed many other disciplines. The novelty of 'benefit transfer' is that data believed to be sensitive to changes in the context in which they were collected, and subject to various uncertainties, are used. For instance, differences between the case study sites, or in the preferences of respondents from different regions, could lead to errors when transferring estimates. It is therefore important to determine whether benefit transfer is statistically valid, what biases might be expected, their extent, and whether they can be corrected (Boyle and Bergstrom).

Several studies have already been conducted to determine the convergent validity[1] of benefit transfer of passive use values. These studies have involved tests of the transferability of results across different sites, across different populations, and across time. The early evidence from these studies has not been supportive of the hypothesis of convergent validity for transfers across site or populations (Bergland, Magnussen, and Navrud; Kirchoff, Colby, and LaFrance).

However, these studies have, to date, been undertaken solely using the contingent valuation method. A limitation of this technique in the context of benefit transfer is that it only values discrete changes in environmental quality which may be different across sites. Bergland, Magnussen, and Navrud recommend that that convergent validity should

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[1] Convergent validity occurs when two measures of the same construct are statistically equivalent.

be tested using techniques, such as conjoint analysis, that allow for different changes in site quality in addition to differences in socioeconomic characteristics. Although preliminary evidence from some initial studies in the transportation literature of this sort is promising, these techniques have yet to be used for transferring passive use values.

In this article, tests are conducted using a conjoint[2] technique known as choice modeling to examine whether these techniques are suitable for benefit transfer. Choice modeling has been used in a small, but growing, number of nonmarket environmental valuation applications (e.g., Adamowicz, Boxall, Williams, Louviere). In choice modeling applications, goods are defined using a set of 'attributes.' By examining the relative importance people place on these attributes, it is possible to estimate their value. For example, potential car buyers typically trade-off price and features such as air-conditioning, power steering etc. In a similar vein, choice modeling surveys present respondents with several sets of resource use options defined by several attributes (e.g., price, quality), and respondents are asked to choose their preferred option in each set. The relative importance of the attributes in influencing people's choices is then estimated using discrete choice modeling techniques, such as the multinomial logit model (Ben-Akiva and Lerman). If one of the attributes involves a cost to respondents, the trade-offs that respondents make when choosing an option can be used to derive value estimates.

This article reports the results of two split-sample tests of the convergent validity of benefit transfer using choice modeling. The objective of the two tests is to determine the extent of the error that is attached to (1) transfers across different case study sites and (2) transfers across different populations given the same case study site. This is done by testing the equality of statistical models, and estimates of implicit prices and compensating surplus. By consecutively comparing two different types of transfer, it is expected that information will be produced about when benefit transfer using conjoint techniques is likely to be subject to least error.

[2] Conjoint analysis refers to, broadly, any technique where a good is decomposed into its constituent attributes or characteristics, and respondents are asked to evaluate different bundles of these attributes. This includes contingent rating, contingent ranking, choice experiments, and paired comparisons techniques.

The structure of this article is as follows. The case studies are described and the questionnaire design initially reviewed. The survey logistics and the modeling results are then reported. Finally, the tests of benefit transfer are presented and conclusions are offered.

Case Studies Used in Benefit Transfer Tests

Estimates are reported in this article of the value of environmental improvements at two large ephemeral wetlands in northern New South Wales, Australia. The first wetland is the Macquarie Marshes, which were originally the largest wetlands in New South Wales with an area of about 5000 km^2. The second wetland is the Gwydir Wetlands, which were originally the third largest wetland in New South Wales, with an area of over 2000 km^2. Both wetlands have a number of significant environmental values: they are important habitats for waterbird breeding, they provide habitats for many endangered and protected waterbird species, and they produce high-quality feed for cattle grazing.

Large scale irrigation began in both the Macquarie and Gwydir Valleys in the late 1960s and early 1970s. Irrigated agriculture is now one of the largest components of total agricultural production in both valleys. A consequence of the increasing use of water for irrigation has been a reduction in the amount of water reaching both the Macquarie Marshes and Gwydir Wetlands. These wetlands and their biota have been substantially affected by changes to the flow regime caused by regulation and use of water for irrigation (Morrison and Bennett).

Questionnaire Description

The questionnaires used for the case studies were developed using the results of eight focus groups. The focus groups were used to help determine which attributes should be included in the choice sets, and to develop and refine a draft questionnaire. A pretest of 50 respondents was undertaken in June 1997 in Sydney.

Table 1. Example of a Choice Set From the Macquarie Marshes Questionnaire

Outcome	Option 1: Continue Current Situation	Option 2: Increase Water to Macquarie Marshes	Option 3: Increase Water to Macquarie Marshes
Your water rates (one-off increase)	No change	$20 increase	$50 increase
Irrigation related employment	4400 jobs	4350 jobs	4350 jobs
Wetlands area	1000 km^2	1250 km^2	1650 km^2
Waterbirds breeding	Every 4 years	Every 3 years	Every year
Endangered and protected species present	12 species	25 species	15 species
☐ I would choose Option 1			
☐ I would choose Option 2			
☐ I would choose Option 3			
☐ I would not choose any of these options because I would prefer more water to be allocated for irrigation			

The questionnaires for the Macquarie Marshes and Gwydir Wetlands were identical, except for site specific information. The questionnaires informed respondents that there were three broad options available for the management of the wetlands: to continue the current situation, to increase water for the wetlands, or to increase water for irrigation. The scenario stated that it would be possible to purchase water for the wetlands from irrigators on the existing water trading market. Respondents were told that the State Government did not have sufficient money to purchase the water from existing revenue and that it would be necessary to charge households in New South Wales a one-off levy (i.e., a levy that is only paid once) on water rates in 1998.

Respondents were then presented with an example showing them how to answer the choice sets. They were then presented with five choice sets that they had to answer (see table 1). In each choice set, there were three main options: the first option represented continuation of the "current situation" and the second and third option represented improvements in wetland quality. Respondents could also choose a fourth option, "I would not choose any of these options because I would prefer more water to be allocated for irrigation," however, the attributes for this option were not defined. This option was included to reduce perceived bias in the questionnaire. Respondents were asked for their preferred choice from each set of options.

The options in the choice sets were defined using five different attributes: water rates, irrigation related employment, wetlands area, frequency of waterbird breeding and endangered, and protected species present. The attribute levels used in the choice sets are shown in table 2. The range of these levels was set by determining the largest plausible changes for each of the attributes (Morrison and Bennett). These levels were assigned to each of the choice sets that respondents answered using a main effects L^{MN} experimental design (Louviere 1988).

Respondents were also asked a series of debrief questions to determine their sociodemographic characteristics and their attitudes toward the environment. These data were used in the models reported later in the article.

Table 2. Attribute Levels Used in the Choice Sets

Attributes	Macquarie Marshes	Gwydir Wetlands
Water rates	No change, $20, $50, $150	No change, $20, $50,$150
Irrigation related employment	4400, 4350, 4250 jobs	2800, 2780, 2700 jobs
Wetlands area	1000, 1250, 1650, 2000 km^2	400, 550, 750, 900 km^2
Frequency of waterbird breeding	4, 3, 2, every year	5, 4, 3, 2 years
Endangered and protected species present	12, 15, 20, 25 species	12, 15, 20, 25 species

Table 3. Survey Statistics

	Gwydir–Moree	Gwydir–Sydney	Macquarie–Sydney
Number of questionnaires distributed (1)	301	349	336
Final (useable) dataset (2)	233	294	250
Number of houses with nobody home (3)	606	753	547
Number of rejections (4)	162	259	184
Response rate 1	77.4%	84.2%	74.4%
Response rate 2	50.3%	48.4%	48.1%

Note: Response rate 1 is based on the number of surveys distributed i.e., $(2 \div 1)$; response rate 2 is based on the number of surveys distributed and the number of rejections i.e., $(2 \div (1+4))$.

Survey Logistics

Three separate choice modeling surveys were conducted. The first survey was conducted in Moree, a rural center close to the Gwydir Wetlands (Gwydir–Moree, i.e., GM). The second survey also focused on the Gwydir Wetlands, but was conducted in Sydney (Gwydir–Sydney, i.e., GS), the main urban center in New South Wales and over 500 km from the Gwydir Wetlands. The third survey was also conducted in Sydney, but the questionnaire was instead focused on the Macquarie Marshes (Macquarie–Sydney, i.e., MS). Sydney is a similar distance from the Macquarie Marshes as it is from the Gwydir Wetlands.

A drop-off and pick-up approach was used to distribute the questionnaires based on a cluster sampling technique. The questionnaires for the Gwydir survey in Moree were distributed on 28 and 29 June 1997 and in Sydney between 12 and 14 July. The questionnaires for the Macquarie Marshes survey were distributed three months later on the 11 and 12 October.

The response rates for the surveys are listed in table 3. The response rates from the surveys were broadly similar. With the drop-off and pick-up format, a high return rate for surveys distributed was achieved (>75%). However, when rejections are included, the response rate falls to 45–50%.

The sociodemographics of the three samples are presented in table 4. Chi-square tests indicated that the sample characteristics were the same as the population. Except for income (both Sydney samples) and age (GS sample only), the null hypothesis of no-independence could not be rejected.

Modeling Results

In this section, the results of multinomial logit models estimated using the data from the choice modeling surveys are presented. Definitions for the variables used in these models are presented in table 5.

The specification for the multinomial logit models is shown below.[3] The model includes three different types of variables. There are two alternative specific constants (C_2 and C_3). The alternative specific constants show the effect of systematic but unobserved factors on respondents' choices. These variables reflect reasons why respondents chose improved wetland quality, apart from changes in the attributes that were specified. For example, respondents may want an

[3] Respondents who chose to direct less water to the wetlands were recoded as choosing to continue the current situation. Mother Logit IIA tests were used to test for the existence of significant violations of the independence of irrelevant alternatives property. There was no significant violation once the socioeconomic variables were included.

Table 4. Sociodemographics of the Survey Respondents

Variable	Gwydir–Moree	Gwydir–Sydney	Macquarie–Sydney
Age (>17 years)	41.7 years	44.1 years	44.3 years
Sex (% male)	59.4%	55.0%	55.8%
Children (%)	74.6%	76.7%	72.1%
Income (household)	$48,127	$51,978	$54,680
% Proenvironment	23.9%	39.5%	35.5%
% Prodevelopment	26.7%	10.0%	10.3%

Table 5. Definitions of Variables

Variable	
C_2, C_3	Alternative specific constants for options 2 and 3
INCOME	Respondent's household income
INCOMEDUMMY	Dummy variable showing if respondents have not reported their income
CHILD	Dummy variable showing whether respondents have children
VISIT	Dummy variable representing whether a respondent is intending to visit the wetland in the future
PRODEV	Dummy variable showing that a respondent is prodevelopment
PROGRE	Dummy variable showing that a respondent is proenvironment
UNDER	Likert scale showing whether respondents understood the information in the questionnaire (1 = strongly agree,5 = strongly disagree)
WORK	Likert scale showing whether respondents believed the scenario would work (1 = strongly agree, 5 = strongly disagree)
ONE-OFF	Likert scale showing whether respondents believed that payment would be one-off (1 = strongly agree, 5 = strongly disagree)
RATE	Water rates
JOBS	Irrigation related employment
AREA	Wetlands area
BREED	Frequency of waterbird breeding
SPECIES	Number of endangered and protected species present

increase in an attribute that was not specified (e.g., nonendangered or nonprotected species). The next variable type involves interactions with the socioeconomic and attitudinal variables ($C_{\text{CHILD}}, C_{\text{INCOME}}$, etc). These interactions show the effect of various attitudes and socioeconomic characteristics on the probability that a respondent will choose either option 2 or 3. The final type is the design variables, which are the choice set attributes. $V1, V2$, and $V3$ represent the indirect utility of each of the options.

$$\begin{aligned}
V_1 &= \beta_{12}\cdot \text{RATE} + \beta_{13}\cdot \text{RATES} \\
&\quad + \beta_{14}\cdot \text{JOBS} + \beta_{15}\cdot \text{AREA} \\
&\quad + \beta_{16}\cdot \text{BREED} + \beta_{17}\cdot \text{SPECIES} \\
V_2 &= \beta_1\cdot C_2 + \beta_3\cdot C_{\text{CHILD}} + \beta_4\cdot C_{\text{INCOME}} \\
&\quad + \beta_5\cdot C_{\text{INCOMEDUMMY}} + \beta_6\cdot C_{\text{VISIT}} \\
&\quad + \beta_7\cdot C_{\text{PRODEV}} + \beta_8\cdot C_{\text{PROGRE}} \\
&\quad + \beta_9\cdot C_{\text{UNDER}} + \beta_{10}\cdot C_{\text{WORK}} \\
&\quad + \beta_{11}\cdot C_{\text{ONEOFF}} + \beta_{12}\cdot \text{RATE} \\
&\quad + \beta_{13}\cdot \text{RATES} + \beta_{14}\cdot \text{JOBS} \\
&\quad + \beta_{15}\cdot \text{AREA} + \beta_{16}\cdot \text{BREED} \\
&\quad + \beta_{17}\cdot \text{SPECIES} \\
V_3 &= \beta_1\cdot C_3 + \beta_3\cdot C_{\text{CHILD}} + \beta_4\cdot C_{\text{INCOME}^+} \\
&\quad + \beta_5\cdot C_{\text{INCOMEDUMMY}} + \beta_6\cdot C_{\text{VISIT}} \\
&\quad + \beta_7\cdot C_{\text{PRODEV}} + \beta_8\cdot C_{\text{PROGRE}} \\
&\quad + \beta_9\cdot C_{\text{UNDER}} + \beta_{10}\cdot C_{\text{WORK}} \\
&\quad + \beta_{11}\cdot C_{\text{ONEOFF}} + \beta_{12}\cdot \text{RATE} \\
&\quad + \beta_{13}\cdot \text{RATES} + \beta_{14}\cdot \text{JOBS} \\
&\quad + \beta_{15}\cdot \text{AREA} + \beta_{16}\cdot \text{BREED} \\
&\quad + \beta_{17}\cdot \text{SPECIES}.
\end{aligned}$$

The results of the multinomial logit models for each of the three surveys are presented in table 6. In each model, the coefficients for RATES, BREED, and SPECIES are significant at the 5% level or higher and have *a priori* expected signs. The coefficient for AREA has the expected sign and is significant at the 10% level or higher in both Sydney models. The coefficient for JOBS[4] is only significant in the GS model. However, it is significant in the Macquarie Marshes model if a one-tailed t-test is used, given that there are *a priori* expectations about the sign. Neither the coefficients for JOBS nor AREA are significant in the GM model. This demonstrates a difference in the preferences of urban and rural populations. It indicates that changes in wetlands area and irrigation employment are more important to people in Sydney than to people living in proximity to the wetland.

[4] Employment is not typically considered to be a utility producing characteristic. However, Portney has suggested and Morrison, Bennett, and Blamey have empirically demonstrated that nonuse values can accrue to the preservation of rural employment.

Table 6. Multinomial Logit Models

Variable	Macquarie–Sydney	Gwydir–Sydney	Gwydir–Moree
ASC2	−1.001**	1.606***	0.878*
	(−2.256)	(3.535)	(1.814)
ASC3	−0.757*	1.897***	1.180***
	(−1.704)	(4.148)	(2.440)
Interactions with			
CHILD	0.395**	−0.447**	1.157***
	(2.296)	(−2.421)	(5.738)
INCOME	0.529E−5**	0.545E−5**	−0.492E−5*
	(2.006)	(2.237)	(−1.786)
INCOMEDUMMY	−0.334	0.573**	−0.766***
	(−1.292)	(2.377)	(−2.865)
VISIT	0.552***	0.558***	0.614***
	(0.162)	(0.163)	(2.674)
PROGRE	1.149***	0.576***	0.856***
	(6.102)	(3.359)	(3.619)
PRODEV	−1.120***	−1.103***	−1.356***
	(−4.876)	(−4.533)	(−4.279)
UNDER	−0.284***	−0.521***	−0.404***
	(−2.883)	(−5.146)	(−3.681)
WORK	−0.225***	−0.364***	−0.546***
	(−2.706)	(−4.314)	(−7.075)
ONE-OFF	0.343***	0.287***	0.258***
	(4.624)	(4.009)	(2.905)
Design variables			
RATES	−0.145E−1***	−0.136E−1***	−0.106E−1***
	(−12.084)	(−12.109)	(−7.830)
JOBS	0.155E−2	0.291E−2**	−0.700E−3
	(1.591)	(2.209)	(−0.444)
AREA	0.484E−3***	0.527E−3*	−0.480E−3
	(2.936)	(1.640)	(−1.173)
BREED	−0.350***	−0.128**	−0.163**
	(−5.784)	(−2.306)	(−2.322)
SPECIES	0.614E−1***	0.437E−1***	0.410E−1***
	(5.156)	(4.026)	(2.911)
Summary statistics			
Log-likelihood	−944.204	−1041.689	−703.209
Chi-squared (constants only)	406.128	361.570	219.618
Rho-squared adjusted	0.171	0.148	0.128
Number of observations	1045 (178 skipped)	1121 (308 skipped)	742 (367 skipped)

Note: ***significant at 1%, **significant at 5%, *significant at 10% *t*-statistics are in brackets.

The coefficients for most of the remaining variable were significant at the 1% level and have *a priori* expected signs. However, the signs of several variables differ from expectations and are worth noting. The sign of the coefficient for CHILD was positive in the Macquarie Marshes and GM models but negative in the GS model. This may reflect different affects that having children has on willingness to pay. One would expect bequest motives to induce higher willingness to pay, yielding a positive coefficient; however, households with children may have lower disposable income, thereby, lowering willingness to pay. Hence, one explanation for this result is that, in the first two surveys, the bequest motives had a relatively greater effect than reduced disposable income. The sign of INCOME also differed across the first three surveys. In the two Sydney surveys INCOME, as expected from theory, had a positive sign. In the Moree survey, it had a negative sign. To some extent, the negative sign could reflect the fact that many higher income people in Moree are involved in the cotton industry, and therefore have a vested interest in seeing less water going to the Gwydir Wetlands.

The explanatory power of all models is satisfactory, with adjusted rho-squared of 13–17%. The chi-squared statistics indicate that each model is significant overall.

Benefit Transfer Tests

One of the questions addressed in this article is whether conjoint techniques such as choice modeling are suited to benefit transfer. Hence in this section, several convergent validity tests are reported. These are for benefit transfers of passive use values across (1) sites given the same population, and (2) populations given the same case study site. Three tests are conducted for each type of transfer. In the first test, the equality of the two models is examined. Second, the equality of implicit prices is tested. Last, the equality of estimates of compensating surplus is tested.

Test 1: The Models are Equivalent

As discussed in Swait and Louviere, multinomial logit models have a scale parameter which is inversely proportional to the variance of the error terms, but is confounded with the $\boldsymbol{\beta}$ vector. By rescaling the data, it is possible to test the null hypothesis that the parameter vectors for the two datasets are equivalent, except for differences in variance.

The test statistic for the across sites transfer (MS/GS) is 43.22, and for the across populations transfer (GM/GS) is 70.38. The critical value at the 5% level is 27.59 with 17 degrees of freedom. Therefore, in each case, the null hypothesis is rejected and it can be concluded that for both transfers, the parameter vectors are not equivalent. Overall, however, it appears that the difference between parameter vectors is greater for transfers across populations.

Test 2: The Equivalence of Implicit Prices

The second test focuses on the equality of implicit prices. Implicit prices, or part-worths, are point estimates of the value of a unit change in a nonmonetary attribute. They provide information about the value respondents place on a particular aspect of a resource *ceteris paribus*. Implicit prices are often useful for decision makers who need to evaluate the benefits or costs of small changes in single aspects of environmental quality. Implicit prices are calculated as follows, if utility is a linear function of all attributes:

$$(1) \qquad IP = \beta_A/\beta_M$$

where IP is the implicit price, β_A represents the coefficient of the Ath nonmonetary attribute, and β_M represents a monetary attribute coefficient.

The null hypotheses for the second test are that the implicit prices are equivalent first across sites and second across population. For this test, the Krinsky and Robb bootstrapping procedure was used to generate standard errors for the implicit prices. This procedure involves randomly drawing a large number of parameter vector estimates from a multivariate normal distribution with mean and variance equal to the $\boldsymbol{\beta}$ vector and a variance-covariance matrix from the estimated multinomial logit model (Park, Loomis, and Creel).

Implicit prices and 95% confidence intervals for the three models are shown in table 7. In both transfers, the confidence intervals overlap for each of the implicit prices, indicating a degree of similarity.

Poe, Severance-Lossin, and Welsch have, however, demonstrated that overlapping confidence intervals, generated using the Krinsky–Robb procedure, provides an inaccurate test of the equality of mean estimates. They show that the actual significance given by overlapping confidence intervals does not correspond to the stated level of significance implied, and is more conservative.

One alternative that Poe, Severance-Lossin, and Welsch propose for testing the equality of means is to calculate differences between the two random distributions developed using the Krinsky–Robb procedure. A one-sided approximate significance level is calculated by the proportion of negative values in the distribution of differences, depending on which mean is thought to be greater (Poe, Welsch, and Champ). The results from this test are reported in the last two rows of table 7. The implicit price for BREED is significantly different at the 1% level for the Macquarie Marshes/Gwydir Sydney transfer, while the implicit price for AREA is significantly different at the 5% level for the GM/GS transfer. It should be noted that the implicit price for JOBS is close to be significantly different in the GM/GS transfer, and may have been if it were possible to measure more accurately the implicit price for JOBS

Table 7. Implicit Prices and Confidence Intervals

	Jobs	Area	Breed	Species
Macquarie–Sydney	10.7 cents	3.4 cents	$24.15	$4.27
	(−2.7, 23.8)	(1.1, 5.7)	($15.83, $33.72)	($2.69, $5.98)
Gwydir–Sydney	21.8 cents	3.9 cents	$9.81	$3.21
	(5.1, 40.1)	(0.9, 8.4)	($2.40, $17.42)	($1.50, $4.71)
Gwydir–Moree	−7.7 cents[a]	−4.7 cents[a]	$15.18	$3.86
	(−42.9, 21.7)	(−12.6, 3.5)	($2.00, $29.95)	($1.15, $6.73)
P-values—MS/GS	0.142	0.400	0.006	0.198
P-values—GM/GS	0.056	0.030	0.260	0.348

[a] Insignificant coefficients in GM model.

using the Moree model. Hence, the hypothesis of convergent validity is rejected for two out of the eight implicit prices. These results are generally supportive of the use of implicit prices for benefit transfer.

Test 3: The Equivalence of Estimates of Compensating Surplus

The final test focuses on the equivalence of estimates of compensating surplus. This is second type of value estimate that can be derived using choice modeling. Compensating surplus is the value of a discrete change in environmental quality. This can be different from the sum of the changes in the implicit prices if the value that respondents have for an environmental improvement is not totally explained by the changes in the attributes. These value estimates are more appropriate for use in cost-benefit analysis. Compensating surplus (CS) can be derived from the multinomial model using the following formula when a single good is modeled (Boxall et al.).

$$(2) \qquad CS = -\frac{1}{\beta_M}(V_0 - V_1)$$

where β_M is the coefficient for the monetary attribute and is interpreted as the marginal utility of income, V_0 represents the utility of the initial state, and V_1 represents the utility of the subsequent state.

This is an important test because deriving welfare estimates is one of the primary objectives of benefit transfer and cost-benefit analysis. The null hypothesis for this test is that there is convergence between the compensating surplus estimates across sites and populations. The results from testing this hypothesis for the GS/GM transfer are not reported here. This is because only three of the five design variables are signed as predicted and significant in the Moree model, hence, the outcome of the hypothesis tests is self-evident.

This hypothesis is difficult to test with choice modeling because it is possible to derive numerous compensating surplus estimates from the models, depending on the levels of the attributes selected. One way of performing this test is to specify one or more policy relevant alternatives and compare estimates of compensating surplus. A limitation of this approach is that the magnitude of difference may diverge depending on the improvement chosen, therefore, limited information is provided about the transferability of welfare estimates. Some systematic way is needed to sample from the myriad of possible environmental improvements that can be valued using a choice model.

For this article, an experimental design was used to sample from the set of possible environmental improvements. Three levels were selected for each of the four nonmonetary attributes (JOBS, AREA, BREED, and SPECIES), based on the changes defined in the Gwydir Wetlands questionnaire. A one-ninth fraction of the 3^4 full factorial was taken, resulting in the selection of nine representative alternatives (see table 8). Estimates of CS and 95% confidence intervals are also reported in Table 8 for each model. Confidence intervals were again calculated using the Krinsky and Robb procedure and Poe, Severance-Lossin, and Welsch tests were conducted. The socioeconomic characteristics were set at the population mean levels when estimating compensating surplus. Compensating surplus was estimated using the approach followed by Boxall et al.

Alternative specific constants have been included when estimating compensating surplus. There is some debate in the literature about whether they should be included because of concerns that they may represent symbolic (yea-saying) responses. However, given that they reflect part of the reason that

Table 8. Estimates of Compensating Surplus

Alternative	Change in Attributes	Macquarie–Sydney	Gwydir–Sydney	*P*-value
1	Jobs-nochange; Area +150 km^2; Breed +1 year; Species +4	\$27.83 (\$6.64, \$48.55)	\$80.96 (\$63.27, \$101.81)	0.000
2	Jobs-no change; Area +350 km^2; Breed +2 years; Species +13	\$97.20 (\$79.60, \$113.64)	\$127.57 (\$111.08, \$146.06)	0.010
3	Jobs-no change; Area +500 km^2; Breed +3 years; Species +8	\$105.13 (\$90.27, \$121.76)	\$127.25 (\$106.27, \$147.57)	0.056
4	Jobs −20; Area +150 km^2; Breed +2 years; Species +8	\$66.90 (\$51.62, \$82.79)	\$99.25 (\$85.28, \$116.62)	0.000
5	Jobs −20; Area +350 km^2; Breed +3 years; Species +4	\$80.81 (\$65.22, \$98.40)	\$104.11 (\$87.21, \$120.00)	0.026
6	Jobs −20; Area +500 km^2; Breed +1 year; Species +13	\$76.03 (\$59.07, \$92.77)	\$119.31 (\$100.69, \$139.18)	0.000
7	Jobs −100; Area +150 km^2; Breed +3 years; Species +13	\$103.80 (\$85.98, \$123.02)	\$107.63 (\$89.10, \$128.82)	0.414
8	Jobs −100; Area +350 km^2; Breed +1 year; Species +8	\$41.00 (\$26.22, \$58.01)	\$79.86 (\$62.67, \$97.42)	0.000
9	Jobs −100; Area +500 km^2; Breed +2 years; Species +4	\$53.20 (\$38.63, \$67.07)	\$82.75 (\$64.84, \$102.15)	0.004

Note: 95% confidence interval is in brackets.

respondents chose to improve environmental quality, there is an argument for using them in welfare estimation. There are also pragmatic reasons for including alternative specific constants when estimating compensating surplus. For instance, Blamey, Bennett, Louviere, Morrison, and Rolfe have demonstrated that including alternative specific constants is needed to ensure that surplus estimates are not affected by the inclusion or exclusion of any policy labels on choice sets. However, the inclusion of constants does require the assumption that unobserved aspects of improved wetland quality (i.e., those aspects not measured by the attributes) are the same across wetlands if surplus estimates are to be used for benefit transfer. In contexts where wetlands are likely to differ substantially in the unobserved aspects, it may be prudent to rely solely on implicit prices when using benefit transfer.

The results in table 8 are mixed. The confidence intervals overlap for five out of the nine alternatives, but the Poe, Severance-Lossin, and Welsch test shows that only two of the mean estimates are equivalent at the 5% significance level, and three at the 1% level. Thus the results from this test are less supportive of the hypothesis of convergent validity. This contrasts with the earlier findings regarding implicit prices. The differences in the estimates of compensating surplus appear to be driven by differences in the magnitude of the alternative specific constants and the attribute representing the frequency of waterbird breeding.

Information about the magnitude of errors likely to be experienced when using benefit transfer is provided by determining the percentage mean difference in the estimates of compensating surplus. For these nine alternatives, the differences in mean estimates range from 4% to 66% , with a mean of 32% . This provides some information for decision makers about the errors that may be experienced when transferring estimates of compensating surplus generated using choice modeling. For many decisions, errors of this magnitude may be considered acceptable, especially where the benefits so estimated clearly exceed, or are exceeded by, the costs.

Conclusion

Benefit transfer has been increasingly used for decision making despite evidence indicating that the transfer of estimates derived using contingent valuation is subject to error. In this article, the suitability of a conjoint technique known as choice modeling for benefit transfer has been trialed. The suitability of conjoint techniques arises from their capacity to allow for different changes in environmental quality as well as differences in socioeconomic characteristics when transferring benefit estimates. It has been shown in this article that the transfer of implicit prices

generated using choice modeling is valid the majority of the time. However, the transfer of estimates of compensating surplus was found to be valid less often. Thus, these results indicate that use of conjoint techniques is most suitable for benefit transfer when the objective is the extrapolation of implicit prices.

The second objective of this article has been to determine in what contexts the benefit transfer of passive use values estimated using choice modeling is likely to be most accurate. Two different contexts have been examined: transfers across different case study sites, and transfers across different populations given the same case study site. The transfers across sites showed greater evidence of convergent validity than across population transfers. The greater validity of across site transfers can be explained by the capacity of choice modeling to allow for different changes in environmental equality across sites.

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