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Testing for differences in benefit transfer values between state and regional frameworks

John Rolfe and Jill Windle[†]

Policy makers are often interested in transferring non-market estimates of environmental values from a 'source' study to predict economic values at a 'target' site. While most applications of the benefit transfer process involve an opportunistic search for suitable source studies, there are some examples available of more systematic approaches to developing a framework of values for benefit transfer processes. A key issue in developing such a framework is to deal with adjustment factors, where value estimates might vary systematically according to the context of the trade-offs. Previous research has identified that large differences in scope, such as between national and regional contexts, do affect values and hence benefit transfer. The research reported in this paper indicates that such differences are not significant for smaller scope variations, such as between state and regional contexts. These results provide some promise that systematic databases for benefit transfer can be developed.

Key words: benefit transfer, choice modelling, environmental valuation.

1. Introduction

Benefit transfer is the process where non-market values gained from a 'source' study can be used in some way to predict economic values at a 'target' site (Boyle and Bergstrom 1992; Desvousges *et al.* 1992; Bateman *et al.* 2002). The process typically involves transferring values across time, space, populations and sometimes from one type of environmental asset to another (Brouwer 2006; Rolfe 2006). Benefit transfer is not always viewed by practitioners as being very reliable, although it appears to work better in some contexts than others for reasons that are not well understood (Bateman *et al.* 2002; Brouwer 2006). There has been a great deal of effort by practitioners in the 1990s and early 2000s to understand where sources of bias in the benefit transfer process might be generated, and to develop more accurate ways of performing non-market valuation studies and the benefit transfer process (Wilson and Hoehn 2006).

Most applications of benefit transfer are opportunistic, involving a search for suitable source studies followed by transfer with some potential adjustment process. This 'random foraging' approach to benefit transfer is still limited for a number of reasons, including the limited number of available studies,

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the inconsistencies in the way that data has been collected and modelled, and the brevity of reporting in many academic publications (Loomis and Rosenberger 2006). Many studies are conducted and reported for specific purposes, with little consideration for subsequent use in benefit transfer applications. As a consequence, a number of study aspects such as the selection of relevant variables, attribute definition and the type of modelling conducted may not be conducive to further applications (Brouwer 2000; Wilson and Hoehn 2006).

An alternative to the 'random foraging' approach for suitable source studies for a benefit transfer exercise is to develop a specific database of benefit transfer values for subsequent case study applications. This 'systematic' approach has potential benefits in that the design of the non-market valuation exercise and data collection is conducted specifically for the purpose of ensuring accurate benefit transfer, and that any necessary adjustment factors can be explicitly modelled (van Bueren and Bennett 2004). There are often requirements for values to be adjusted for variations in site, population or other characteristics between source and target applications (Boyle and Bergstrom 1992; Desvousges *et al.* 1992; Loomis 1992; Kirchoff *et al.* 1997).

The development of stated preference techniques such as choice modelling (CM) (Adamowicz *et al.* 1998; Louviere *et al.* 2000; Rolfe *et al.* 2000; Bennett and Blamey 2001) have facilitated the use of benefit transfer values and functions because CM allows the expression of environmental values as a function of a number of site, population and other characteristics (Rolfe 2006). A CM experiment can be designed in a way so that key elements desired in a benefit transfer function are included in the choice sets as attributes or labels. The choices made by respondents from a survey population thus help to develop a benefit transfer function that can be 'mapped' across to a range of potential policy situations. Examples of the use of CM to develop a systematic benefit transfer framework have been provided by van Bueren and Bennett (2004) and Morrison and Bennett (2004).

A challenge in developing a systematic framework for benefit transfer is to address framing issues. These occur when the values for particular environmental assets are sensitive to the scope of the environmental trade-off being presented and the relevance of that scope to different population groups (Rolfe *et al.* 2002). As the focus of environmental trade-offs moves from the local to regional, state, national or international frameworks, the scope of the issues to be considered and the population of interest broadens, along with a range of substitute trade-offs. Evidence provided from Smith *et al.* (1999), van Bueren and Bennett (2004) and Morrison and Bennett (2004) indicates that these framing issues are important, and that 'adjustment factors' or 'calibration factors' need to be built into benefit transfer frameworks to reflect information about the scope of the issue being presented or the way it is being framed to a particular population group.

There are both theoretical and policy issues that are relevant to why it is important to understand the influence of scope factors on benefit transfer

processes. At the theoretical level, it is not always clear how different direct, indirect and non-use values will be combined into value estimates, and how these elements of value will be sensitive to factors such as proximity, the availability of substitutes, levels of awareness or concepts of responsibility. At a policy level, framing information may be important because most control and funding for environmental issues in Australia occurs at both state and regional or river catchment levels. While state governments are largely responsible for natural resource management, regional natural resource management or catchment groups have been established and funded in many areas to provide more regional-specific policy outcomes (Pannell *et al.* 2007).

In this paper, the sensitivity of benefit transfer values to scope and population issues at both state and regional levels are reported. A series of CM experiments were conducted across regional areas of Queensland with the specific aim of developing a benefit transfer framework. In a policy context where many natural resource management issues are being managed at both regional and state levels, key objectives were to provide value estimates for different scope and population frameworks, and to identify if value adjustments were needed between state and regional frameworks. The remainder of this paper is structured as follows. An overview of benefit transfer and the CM technique is provided in the next section. The case study characteristics as well as the design and application of the experiments are outlined in Section 3. The results are reported in Section 4, followed by a discussion and conclusions to be drawn in the final section.

2. Benefit transfer and the CM technique

The three main ways of performing benefit transfer are the transfer of point estimates, the transfer of value functions and the performance of meta analysis (Bateman *et al.* 2002). With point estimates, it is normally a per-unit value for a particular attribute that is transferred with some adjustment for site differences, although sometimes a lump sum value estimate will be transferred (Rolfe 2006). With a benefit function transfer, the equation describing the valuation function at the original site is transferred to the second site with the ability to adjust for site and population variations (Brouwer 2006). A meta-analysis can also be conducted to synthesis a series of past studies, and the results used as inputs to the benefit transfer process (Wilson and Hoehn 2006).

The challenge in benefit transfer is to estimate values from one or more source studies at acceptable levels of accuracy. There are two broad areas where biases and inaccuracies can develop out of a benefit transfer process (Rolfe 2006). The first is where a source study may have measurement errors, and any benefit transfer process may simply map those inaccuracies to another site (Brookshire and Neil 1992). The second is where differences between source and target sites create problems for reliability and validity. Loomis and Rosenberger (2006) categorise these differences into three groups: commodity aspects, market area aspects and welfare measure aspects,

following the categorisation of ideal transfer conditions suggested by Boyle and Bergstrom (1992).

Commodity aspects relate to differences between sites, where idealistic criteria suggest that source and target sites should be identical for valid benefit transfer (Boyle and Bergstrom 1992). A more realistic condition is that source and transfer sites should be similar across a number of key aspects (Rosenberger and Stanley 2006). Market area aspects relate to the similarities in demand for the source and target sites. This encompasses differences in the populations of relevance and the attitudes of respondents (Loomis and Rosenberger 2006) as well as policy and institutional contexts which might frame the valuation context (Rolfe 2006). Welfare measure aspects relate to differences that might emerge according to the type of analysis, including variations between willingness to pay (WTP) and willingness to accept (WTA) constructs, and differences in the models applied, collection measures and the estimation of benefits (Loomis and Rosenberger 2006).

The advantage of using CM to develop a benefit transfer framework is that many variations in commodity and market area aspects are automatically built in to the predictive function (Rolfe 2006). However, there are practical and cognitive limitations to the number of issues that can be built into a CM experiment and presented to respondents in a survey setting. Split-sample experiments are often used to identify where value differences arise from variations in the way that issues are framed or when different populations are surveyed. Differences in scope are one of the key features that distinguish some of these split-sample experiments.

van Bueren and Bennett (2004) report an explicit attempt to include scope and scale issues in a valuation study of protecting endangered species, countryside aesthetics, waterway health and country communities in Australia. They did this by conducting surveys at both national and regional levels and engaging both national and regional populations. Their results demonstrated significantly higher values at regional compared to national levels, leading to suggestions that benefit transfer between national and regional applications would need to be adjusted by scale factors. While these arguments for scale adjustments are similar to the calibration proposals of Smith *et al.* (1999), it is not clear why the scale factors should be so high (up to 26 times), and how values might vary between regional and state levels.

Morrison and Bennett (2004) report the conduct of a series of CM experiments on valuing river health in New South Wales, Australia, and the subsequent estimation of a pooled model that summarised value estimates. The pooled model demonstrated that while values were dependent on river attributes and the socio-economic characteristics of respondents, they were also influenced by whether respondents lived inside or outside catchments. However, the study may have minimised some scope and scale issues by focusing on only one river catchment at a time, and it is unclear how accurate it would be to aggregate values up to a state level where a number of river catchments would be involved.

3. Research and survey design

The key focus of the experimental study conducted was to identify if values for environmental factors varied between state and regional contexts. Two types of split-sample CM experiments were designed for the research project. One type involved regional experiments focused on a single region or catchment area. The other type involved a composite survey where several regional areas were included into each choice set. This involved a labelled model (for the regions), in comparison to the more generic unlabelled approaches of van Bueren and Bennett (2004) and Morrison and Bennett (2004). The design of the CM experiments followed the steps outlined by Bennett and Blamey (2001).

An initial challenge was to frame the split-sample experiments to be consistent with each other so that the single regional areas could be combined coherently into a composite scenario that was broadly relevant at the state level. As the survey would be completed by a range of residents across the State, it was important that the selected regions would be readily recognised and that respondents would easily comprehend the associated resource management issues.

The conduct of focus groups indicated there were two regions that were well known by most residents in Queensland: South East Queensland (the area surrounding Brisbane, the capital city) and the Murray–Darling Basin (part of the largest river system in Australia). In addition, residents were generally familiar with the coastal region adjacent to the Great Barrier Reef, as this strip was associated with many tourism locations, rainforest assets and the sugarcane industry. Widespread concerns were identified for the health of the Great Barrier Reef, with recognition that its iconic status was threatened by impacts of poor water quality from inland catchments (Productivity Commission 2003). This suggested that Queensland residents would be familiar with the concept of a larger inland region focused more around pastoral and agricultural industries that had potential environmental linkages with the health of the Great Barrier Reef.

To generate consistency between the split-samples and minimise the cognitive burden on survey respondents, these four broad regional classifications were used in the composite survey (Figure 1). The remainder of the State was not included because very low levels of population and development meant that environmental issues were not as relevant to these regions.

Four separate regional surveys were conducted in the single regional experiments. Two of these experiments (Murray–Darling and South East Queensland) were based on the same regions used in the composite survey, while two were based on smaller catchments used as proxies for the other two regions used in the composite survey (Great Barrier Reef – Coastal and Great Barrier Reef – Inland). For each regional experiment, the major population centre for each region was used as population samples for the different surveys. The broad characteristics of these catchment areas are outlined in Table 1. The composite survey was administered to three populations to identify if



Figure 1 Regional classifications in the single and composite surveys.

values for the regional areas presented together varied between the state capital (Brisbane) or regional centre (Toowoomba and Mackay) populations. Survey details for the regional and composite (statewide) surveys are presented in Table 2.

The purpose of the choice experiment was to assess community values for key environmental assets that would help to guide resource allocation decisions at a regional level. Drawing on the priorities set by regional NRM bodies (Pannell *et al.* 2007), the key attributes were summarised as *healthy soil*, *healthy waterways* and *healthy vegetation*. Scenarios were framed to respondents in terms of a 15-year future base with a decline in resource condition. This decline in potential condition, with no additional cost implications, was presented as a consistent ‘constant base’ option. Choice alternatives offered improvements from that base, but at some annual cost to respondents over the 15-year period. In order to avoid any payment vehicle bias, several potential payment options were described with no specific method being specified. Respondents were informed that financial contributions might be made through increased taxes, higher rate payments or through an increase in prices for some related goods and services.

In the single regional surveys each choice set involved a constant base option as well as two improvement scenarios, while each choice set in the composite survey involved the constant base option and four improvement scenarios (one for each region). Example choice sets for the two types of surveys are presented in Appendix 1a and 1b.

Once the experiment had been appropriately framed, the next step was to select the attributes, levels and labels used to specify the choice sets. Four attributes were used to describe the choice scenario in each region; three environmental attributes (soil water and vegetation) and a cost attribute to represent the payment vehicle. Each attribute could vary over three levels in the improvement options, for example, annual levels for the payment vehicle were \$20, \$50 and \$100. Full details of the attributes and levels used are outlined in Table 3.

Table 1 Main characteristics of the four regional catchments

| | Murray–Darling | South East Queensland | Mackay–Whitsunday* | Fitzroy Basin† |
|-------------------------|-----------------------------|------------------------------|--|--|
| Main town | Toowoomba | Brisbane | Mackay | Rockhampton |
| Main land use | Agriculture Western grazing | Urban development | Sugarcane (cropping) | Cattle grazing |
| Catchment size | Large | Small | Small | Large |
| Catchment outlet | Not Queensland | Not Great Barrier Reef (GBR) | GBR Intensive agriculture | GBR Extensive grazing |
| Tourism | Some – not important | Important – coastal tourism | Very important–coastal and GBR tourism | Low importance – coastal and GBR tourism |
| Residential development | Some growth | Strong growth | Growing | Recent growth |

*Information from this catchment was used to represent the broader GBR – Coastal classification.

†Information from this catchment was used to represent the broader GBR – Inland classification.

Table 2 Survey details

| Survey | Region/catchment area | Population sampled | Environmental attributes | Comment |
|--|---|--|-----------------------------|--|
| Regional survey | | | | |
| Four separate regional surveys | S.E. Queensland Murray–Darling Mackay–Whitsunday Fitzroy Basin | Brisbane Toowoomba Mackay Rockhampton | Soil Water Vegetation | Each population sample completed a survey specific to their region |
| Statewide survey | | | | |
| Four regional areas included in one survey | S.E Queensland Murray–Darling GBR – Coastal areas GBR – Inland areas | Brisbane Toowoomba Mackay | Soil Water Vegetation | All populations completed the same survey |

Table 3 Current condition, future base and attribute levels

| | Soils in good condition | Waterways in good health | Healthy Vegetation |
|--|----------------------------|-----------------------------|-----------------------|
| Murray–Darling | | | |
| Area: 314 000 sq km, River length: 20 000 km | | | |
| <i>Current condition</i> | 65% | 60% | 45% |
| Base level in 15 years | 50% | 40% | 25% |
| Attribute levels | 55%, 60%, 65% | 45%, 50%, 55% | 30%, 35%, 40% |
| South East Queensland | | | |
| Area: 23 000 sq km, River length: 2000 km | | | |
| <i>Current condition</i> | 60% | 55% | 45% |
| Base level in 15 years | 45% | 35% | 25% |
| Attribute levels | 50%, 55%, 60% | 40%, 45%, 50% | 30%, 35%, 40% |
| Mackay–Whitsunday | | | |
| Area: 9000 sq km, River length: 700 km | | | |
| <i>Current condition</i> | 65% | 60% | 65% |
| Base level in 15 years | 50% | 40% | 45% |
| Attribute levels | 55%, 60%, 65% | 45%, 50%, 55% | 50%, 55%, 60% |
| Fitzroy Basin | | | |
| Area: 143 000 sq km, River length: 15 000 km | | | |
| <i>Current condition</i> | 65% | 50% | 45% |
| Base level in 15 years | 50% | 30% | 25% |
| Attribute levels | 55%, 60%, 65% | 35%, 40%, 45% | 30%, 35%, 40% |
| GBR-coast* | | | |
| Area: 90 000 sq km, River length: 7000 km | | | |
| <i>Current condition</i> | 65% | 60% | 65% |
| Base level in 15 years | 50% | 40% | 45% |
| Attribute levels | 55%, 60%, 65% | 45%, 50%, 55% | 50%, 55%, 60% |
| GBR-inland† | | | |
| Area: 430 000 sq km, River length: 34 000 km | | | |
| <i>Current condition</i> | 65% | 50% | 45% |
| Base level in 15 years | 50% | 30% | 25% |
| Attribute levels | 55%, 60%, 65% | 35%, 40%, 45% | 30%, 35%, 40% |

*The area and river lengths of the GBR Coastal region were estimated to be approximately 10 times larger than Mackay–Whitsunday (MW) region. The MW proportions were used to represent this region.

†The area and river lengths of the GBR Inland region were estimated to be approximately three times and two and a quarter times the size of the Fitzroy Basin, respectively. The Fitzroy Basin proportions were used to represent this region.

Presentation issues for the choice experiment were tested in focus group settings. Participants indicated that they preferred simple presentation formats where the changes in attributes were summarised in terms of percentages rather than amounts, particularly for the composite survey where four different alternatives were involved. To ‘ground’ the choice sets with the actual amounts of each asset, the current level of each attribute was reported in both physical and percentage terms in each choice set. The changes were then reported in percentage terms.

Two experimental designs were developed for the surveys. In the regional model where each choice set had two unlabelled alternatives plus a constant base option, the design involved 24 choice profiles. These were 'blocked' into four versions of the survey involving six choice sets per version. In the composite state model where each choice set had four labelled alternatives (one for each region) plus a constant base option, the design involved 78 choice profiles. These were 'blocked' into 13 versions of the survey involving six choice sets per version.

As well as the choice sets, the survey questionnaires included:

- Background material on environmental issues and some framing questions,
- Questions about the attitudes of respondents to environmental issues,
- Rating tasks about different reasons for protecting environmental assets,
- Descriptions of the trade-offs involved and the attributes selected to represent the case studies,
- Follow-up questions to understand how the choice sets had been completed, and
- Questions about the socio-demographic characteristics of respondents.

3.1 Survey collection and respondent characteristics

All surveys were collected between October and December 2005. Households were selected at random based on a cluster sampling technique and surveys were collected using a drop-off/pick-up format. Any household member over the age of 15 was eligible to participate. A total of 1095 surveys were collected, with response rates of 50 per cent or higher. Details are provided in Table 4.

Table 4 Survey response details

| | Survey version | Returned completed | Approximate response rate (%) |
|-------------|------------------------------|--------------------|-------------------------------|
| Brisbane | Regional – S.E. Queensland | 180 | 50 |
| | Statewide composite | 171 | |
| Toowoomba | Regional – Murray–Darling | 162 | 50 |
| | Statewide composite | 140 | |
| Mackay | Regional – Mackay–Whitsunday | 154 | 61 |
| | Statewide composite | 141 | |
| Rockhampton | Regional – Fitzroy Basin | 147 | 72 |
| | Total | 1095 | |

There was a similar spread in the age and gender of respondents across population samples, but differences in other characteristics. In terms of age, education and income, the sample populations were broadly similar to that of the wider population (Table 5).

Table 5 Socio-demographic characteristics of respondents

| | Brisbane | Toowoomba | Mackay | Rockhampton |
|---|-----------------|-----------------|-----------------|-----------------|
| Average age | 42 years | 37 years | 43 years | 47 years |
| (Range) | (17–89) | (18–82) | (15–81) | (19–86) |
| <i>ABS 2001 Census*</i> † | <i>43 years</i> | <i>44 years</i> | <i>42 years</i> | <i>45 years</i> |
| Gender (% female) | 56% | 54% | 51% | 50% |
| Have dependent children | 72% | 59% | 80% | 77% |
| Education | | | | |
| Have non-school qualification | 46.9% | 56% | 42.7% | 46% |
| <i>ABS 2001 Census*</i> | <i>46%</i> | <i>43%</i> | <i>40%</i> | <i>41%</i> |
| Annual income (pre tax) | | | | |
| Missing values | 13% | 23% | 14% | 10% |
| Less than \$70 000 | 77% | 80% | 60% | 72% |
| <i>ABS 2001 Census</i> | <i>63%</i> | <i>72%</i> | <i>66%</i> | <i>71%</i> |
| Member of an environmental organisation | 7% | 6% | 9% | 7% |
| Family associated with farming industry | 19% | 34% | 33% | 23% |

*The ABS figures were based on the same age range as participants in each sample population.

† χ^2 -tests were conducted to compare the sample data with ABS figures. The only significant difference between the ABS and the sample data was *age* in Toowoomba.

4. Results

To analyse the results, conditional logit models were developed for all the split samples using LIMDEP software. The welfare of each choice alternative was modelled to be a function of the attributes, with the choice of the improvement alternatives relative to the status quo option also modelled to be conditional on non-attribute factors and an Alternative Specific Constant (ASC). A description of the variables used in the models is presented in Appendix 2. For the regional surveys, a separate model was developed for each of the four catchment areas and then all samples were combined to provide a pooled model (Appendix 3). For the statewide composite surveys, three separate models were developed for each population sample as well as a pooled model for the combined data (Appendix 4).

The model results provide value functions that are dependent on site and population characteristics. There is some evidence that populations have higher values for protecting environmental assets in their own region. In the pooled model for the statewide composite surveys (Appendix 4), the dummy variable for the Brisbane sample registers a positive ASC for their regional area (South East Queensland) compared to negative ASCs for the other regions. This provides some support for the findings of Morrison and Bennett (2004) that populations have higher protection values for assets within their own catchment.

To help understand if there are differences between the models from the various split-sample applications relating to scope and scale issues, it is convenient to focus on a comparison of point estimates. These values for marginal trade-offs between a single attribute and the cost variable were

estimated from the models by taking the ratio of each attribute coefficient and the cost coefficient. Confidence intervals were estimated with a Krinsky and Robb (1986) procedure, where a matrix of 1000 sets of parameters was drawn for each model. The vectors of estimates for each marginal value were then ordered and truncated to produce an estimate of the 95 per cent confidence intervals. The results are presented in Table 6.

Table 6 Marginal values and 95% confidence intervals for the different models

| | Soil | Water | Vegetation |
|----------------------------------|---------------------------------|----------------------------|----------------------------|
| | \$ value of each 1% improvement | | |
| Brisbane – South East Queensland | | | |
| Regional model | \$3.05 (\$1.79–\$4.59) | \$3.42 (\$2.26–\$4.88) | \$3.01 (\$1.77–\$4.40) |
| Statewide model* | \$5.34 (\$0.68–\$17.4) | \$4.99 (\$0.55–\$16.93) | \$7.69 (\$3.19–\$21.03) |
| Toowoomba – Murray–Darling | | | |
| Regional model | \$4.02 (\$2.51–\$5.91) | \$6.28 (\$4.77–\$8.80) | \$2.35 (\$0.94–\$4.01) |
| Mackay – Mackay–Whitsunday | | | |
| Regional model | \$4.60 (\$2.87–\$6.75) | \$7.82 (\$5.84–\$10.88) | \$2.42 (\$0.86–\$4.37) |
| Rockhampton – Fitzroy Basin | | | |
| Regional model | \$3.70 (\$1.96–\$6.23) | \$6.69 (\$4.70–\$10.01) | \$4.48 (\$2.53–\$7.18) |
| Pooled models | | | |
| Regional model | \$3.72 (\$2.94–\$4.57) | \$5.80 (\$4.98–\$6.88) | \$2.88 (\$2.10–\$3.71) |
| Statewide model† | \$4.64 (\$2.64–\$7.09) | \$6.62 (\$4.68–\$9.43) | \$4.54 (\$2.66–\$7.03) |

*There were insufficient responses to calculate significant marginal values for each regional classification from each sample in the statewide survey. The only sample where significant results were calculated was for Brisbane and South East Queensland. Full details of the underlying model are presented in Windle and Rolfe (2006).

†The 'population' variable was omitted for comparative purposes.

A key test for benefit transfer was to test if the models generated similar values for the same environmental improvements, particularly when differences in scope were involved. The results demonstrate little difference in marginal values across regions and populations. The confidence intervals for attribute part-worths almost always overlap between the regional models, suggesting that values held by regional populations for regional environmental issues are very consistent.

A Poe *et al.* (2001) procedure provides a more robust test of differences in part-worths than testing for overlapping confidence intervals. The Poe *et al.* (2001) procedure involves comparing differences in parameter estimates between two 1000-draws of the relevant part-worths. The procedure is repeated 100 times by randomly re-ordering one vector of estimates, with significance differences in values given by the proportion of differences that fall below zero.

The key focus of the survey was to test if values for environmental assets varied according to whether they were presented in a regional context (single regional survey) or a statewide context (composite survey). The results from van Bueren and Bennett (2004) and Morrison and Bennett (2004) suggest that extending the scope in which a survey is framed will tend to reduce the marginal values for the environmental assets involved. In this case study, the Poe *et al.* (2001) procedure was used to identify if only a small scope variation between regional and state levels would lead to significant reductions in marginal values.

Three main tests were available from the statistical models generated (Table 7). The first was a test of whether the values held by a regional population for environmental assets were the same across the narrowly scoped and the widely scoped formats. Poe *et al.* tests indicated that marginal values for healthy soils and waterways were the same between the Brisbane regional model and the Brisbane statewide model, but values were higher for healthy vegetation in the statewide model, contrary to expectations.

Table 7 Similarities in marginal values at the 95% level of significance

| Composite survey | Regional surveys | Vegetation | Waterways | Soil |
|--|--|------------|-----------|------|
| Statewide – Brisbane State – S.E. Qld | Regional – Brisbane Regional S.E. Qld | ✗ | ✓ | ✓ |
| Statewide – pooled South east Qld | Regional South East Qld | ✓ | ✓ | ✓ |
| Murray–Darling | Murray–Darling | ✓ | ✓ | ✓ |
| GBR – Coastal | Mackay–Whitsunday | ✓ | ✓ | ✓ |
| GBR – Inland | Fitzroy | ✓ | ✓ | ✓ |
| Statewide – pooled All regions | Regional Regional – pooled | ✓ | ✓ | ✓ |

The second test available was to pool the data for the composite survey and generate a combined statewide model. Values for the different regional areas were then estimated from this model and compared to the separate regional models. Poe *et al.* tests revealed no significant differences for any of the three attributes (Table 7).

The third test available was to compare the marginal values for the attributes between the pooled data for the composite surveys and the pooled data for the regional surveys. This is a more powerful test for whether the way the survey was framed affected the values estimated. No significant differences were identified between the two types of survey format, indicating that value estimates were consistent whether choices were framed in a regional or wider statewide context.

The similarity in results outlined above indicates that marginal values are quite robust to changes in scope. However, use of the values is more problematic when changes in scale are considered and changes are translated from percentage

terms into physical amounts. For example, while there are similar values for marginal percentage changes in attribute levels across the regions, the different sizes of the regions mean that extrapolating those marginal values for percentage changes into physical changes would result in very different values by region. These scale differences may help to explain why van Bueren and Bennett (2004) and Morrison and Bennett (2004) generated significant variations in marginal values across varying frames.

While the use of percentage changes for variations in levels provided a convenient way of presenting complex information in the composite choice sets and focusing on scope differences, the ambiguity about whether the data should be analysed in percentage change or physical amounts suggests that the use of this format is problematic. In terms of extrapolating these amounts into a policy context, the most conservative approach would be present values as proportional to the sum of regional areas rather than by regional area. Given that the pooled regional models provide the stronger model fits and the more conservative value estimates, the following values could be applied across the regions of interest:

- \$3.70 per household for a 1 per cent improvement in soil condition;
- \$2.90 per household for a 1 per cent improvement in healthy vegetation; and
- \$5.80 per household for a 1 per cent improvement in healthy waterways.

5. Discussion and conclusions

The survey results raise some questions about the appropriateness of using percentage changes to represent variations in attribute levels. While the results indicated little difference in values between regional areas in terms of percentage change, much larger differences emerge if those changes are translated into quantities. It seems likely that respondents have focused on the relative changes rather than the actual amounts when making their choices, reducing the potential accuracy of estimated values. In this case study, the percentage change format was selected to reduce the complexity of presenting the composite choice sets. The results indicate that it may be safer to avoid this style of format.

Despite these questions about how the influence of presentation aspects may translate to values for actual rather than relative changes, the consistency of the presentation approach allows other key methodological issues to be reported. The results of this study confirm that the potential to transfer benefit estimates seems robust. In Queensland, there appears to be a considerable degree of consistency in the marginal values for improvements in soil, water and vegetation condition across populations and across regions where different NRM issues are of concern.

A key conclusion to be drawn from the results of this study is that values for environmental factors did not vary between state and regional contexts. This may be consistent with the institutional setting, where responsibilities

for environmental protection are normally perceived to lie at the state rather than the regional level. It suggests that for benefit transfer purposes there is no need to use adjustment factors when the scope only varies between state and regional contexts.

Care should be taken not to ignore the need for adjustment factors altogether. The results of van Bueren and Bennett (2004) suggests that adjustment factors would be required for benefit transfer between regional and national contexts, while the results of Morrison and Bennett (2004) suggest that adjustment may be needed between state and subregional or local contexts. However, an implication of this study is that adjustment may only be required for larger changes in context or framing.

In terms of methodology, the results demonstrate that changing the frame of a CM survey to make substitute possibilities more explicit did not significantly change the resulting value estimates. It is possible that respondents to the narrowly framed regional surveys implicitly considered the same trade-offs that were made explicit to respondents in the composite surveys. The implication for CM practitioners is that where a target survey population is aware of the relevant issues, it makes little difference whether a survey is narrowly or broadly scoped. Given the complexities of presenting broadly scoped surveys, such as with the composite survey reported above, this is an important finding. It suggests that instead of presenting broader, and by implication less well defined choices sets, it is preferable to present more narrowly scoped and precisely defined trade-offs.






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Appendix 1 Example choice sets. (a) Example choice set for the regional model. (b) Example choice set for the statewide model






(a)

| | | | | |
|--|--|--|---|--|
| 5 | Question 5: Carefully consider each of the following three options. Suppose options A, B and C were the only options available, which would you choose? | | | |
| <p>How much I pay each year</p>  <p>Current condition</p> | <p>Soils in good condition</p>  <p>6,000 sq km 65%</p> | <p>Waterways in good health</p>  <p>420 km 60%</p> | <p>Healthy vegetation</p>  <p>6,000 sq km 65%</p> | <p>I would choose</p>  |
| Condition in 15 years time – Options A,B, and C | | | | |
| Option A | | | | |
| \$0 | 50% | 40% | 45% | <input type="checkbox"/> |
| Option B | | | | |
| \$100 | 65% (15% better) | 55% (15% better) | 55% (10% better) | <input type="checkbox"/> |
| Option C | | | | |
| \$100 | 55% (5% better) | 55% (15% better) | 60% (15% better) | <input type="checkbox"/> |

(b)

Qu 4. Carefully consider each of the following 5 options. Suppose these were the only options available, which would you choose?

Please indicate which option you prefer  mark one box only

| | | | | | | | |
|---|---|---------------|--|---|---|---------------|--|
| <input type="checkbox"/> I prefer this option | Murray Darling | | | <input type="checkbox"/> I prefer this option | Great Barrier Reef – Coastal | | |
| In 15 years time | Expected | Option | | In 15 years time | Expected | Option | |
| Soils in good condition | 50% or 157,000sq km | 5% better | | Soils in good condition | 50% or 45,000 sq km | 5% better | |
| Waterways in good health | 40% or 8,000 km | 5% better | | Waterways in good health | 40% or 2,800 km | 10% better | |
| Healthy vegetation | 25% or 78,500sq km | 10% better | | Healthy vegetation | 45% or 40,500 sq km | 5% better | |
| How much I pay each year |  | \$100 | | How much I pay each year |  | \$100 | |
| <input type="checkbox"/> I prefer this option | South East Queensland | | | <input type="checkbox"/> I prefer this option | Great Barrier Reef – Inland | | |
| In 15 years time | Expected | Option | | In 15 years time | Expected | Option | |
| Soils in good condition | 45% or 10,500 sq km | 5% better | | Soils in good condition | 50% or 215,000 sq km | 15% better | |
| Waterways in good health | 35% or 700 km | 10% better | | Waterways in good health | 30% or 10,200 km | 10% better | |
| Healthy vegetation | 25% or 6,000s q km | 5% better | | Healthy vegetation | 25% or 107,500 sq km | 10% better | |
| How much I pay each year |  | \$20 | | How much I pay each year |  | \$50 | |
| <input type="checkbox"/> I prefer this option | Keep current situation | | | How much I pay each year |  | \$0 | |

Appendix 2 Description of the variables used in the MNL models

| Variable | Description |
|---|--|
| Cost | The annual amount that households would pay to fund improvements over a 15-year period |
| Soil | Area of soil in good condition |
| Waterways | Kilometres of waterways in good health |
| Vegetation | Area of vegetation in good health |
| ASC | Alternate Specific Constant which reflects the influence of all other factors on choice of improvement options |
| Socio-demographic variables | |
| Age | Age of respondent (in years) |
| Gender | Male (1) Female (2) |
| Children | Has dependent children (1) Does not have dependent children (2) |
| Education* | Education ranges from – primary education (1) to tertiary degree (5) |
| Income* | Ranges from ‘under \$6000 (1) to ‘more than \$100 000 (7) |
| Brisbane | Brisbane (state capital) = 1; Toowoomba and Mackay (regional centres) = 0 |
| Environmental opinions | |
| Environmental condition | Think environmental condition in last 10 years has ‘declined’ (–1); ‘improved’ (1); ‘stayed same/don’t know’ (0) |
| Environmental favour | In project proposals – ‘favour environment more often’ (1); ‘favour development more often’ (–1); ‘favour environmental and development equally’ (0) |
| Environmental knowledge | Knowledge of the issues addressed in the survey. Self rating from 1 (low) to 10 (high) |
| Choice selection variables | |
| Confidence | Confidence that made the correct choice – from ‘very confident’ (1) to ‘not very confident’ (4) |
| Preference | Did respondent have a preference for the different attributes? Yes (1); No (–1); not sure (0) |
| Understood | Understood the information in the survey: ‘strongly agree’ (1) to ‘strongly disagree’ (5) |
| More information | Needed more information than was provided: ‘strongly agree’ (1) to ‘strongly disagree’ (5) |
| Confused | Found answering the choice ques confusing: ‘strongly agree’ (1) to ‘strongly disagree’ (5) |
| GBR values variables: Reasons for supporting more environmental protection of the GBR | |
| If ranked 1 or 2 (most) important | (1); If ranked 3, 4 or 5 (least) important (0) |
| Use | I want to use them for recreation |
| Option | I may want to use them in the future |
| Bequest | We should protect them for future generations |
| Existence | We need to protect plants, birds, and water life |
| Quasi option | We should be careful because the impacts of current practices may be poorly understood |

*Variables coded to match response categories in the questionnaire survey.

Appendix 3 Regional multinomial logit models

| Population Region | Pooled model All combined | | Brisbane South East Queensland | | Toowoomba Murray–Darling | | Mackay Mackay–Whitsunday | | Rockhampton Fitzroy | |
|---------------------------------|------------------------------|--------|-----------------------------------|--------|-----------------------------|--------|-----------------------------|--------|------------------------|--------|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| Cost | -0.0178*** | 0.0012 | -0.0214*** | 0.0024 | -0.0186*** | 0.0024 | -0.0182*** | 0.0026 | -0.0155*** | 0.0025 |
| Soil | 0.0663*** | 0.0070 | 0.0652*** | 0.0132 | 0.0746*** | 0.0141 | 0.0839*** | 0.0154 | 0.0575*** | 0.0147 |
| Water | 0.1032*** | 0.0064 | 0.0730*** | 0.0121 | 0.1167*** | 0.0167 | 0.1427*** | 0.0141 | 0.1038*** | 0.0139 |
| Vegetation | 0.0512*** | 0.0067 | 0.0642*** | 0.0130 | 0.0437*** | 0.0133 | 0.0441*** | 0.0146 | 0.0695*** | 0.0147 |
| ASC | -0.7455*** | 0.0749 | -0.9516*** | 0.1441 | -0.8223*** | 0.1489 | -0.6147*** | 0.1597 | -0.7403*** | 0.1628 |
| Socio-demographic variables | | | | | | | | | | |
| Ag | 0.0008 | 0.0030 | 0.0073 | 0.0060 | 0.0039 | 0.0071 | -0.0033 | 0.0075 | -0.0116 | 0.0079 |
| Gender | -0.2554*** | 0.0853 | -0.6083*** | 0.1662 | -0.5642*** | 0.1992 | -0.9260*** | 0.2179 | 0.5829*** | 0.2110 |
| Children | -0.6280*** | 0.1005 | 0.2639 | 0.1925 | -1.3254*** | 0.2177 | -1.0454*** | 0.2971 | -0.7478*** | 0.2585 |
| Education | 0.2746*** | 0.0404 | 0.1541* | 0.0849 | 0.4457*** | 0.0947 | 0.3924*** | 0.0947 | 0.1741* | 0.0892 |
| Environmental opinions | | | | | | | | | | |
| Environmental condition | -0.0834 | 0.0621 | 0.1115 | 0.1272 | 0.0896 | 0.1413 | -0.1279 | 0.1488 | -0.0789 | 0.1447 |
| Environmental favour | 0.4094*** | 0.0736 | 0.7605*** | 0.1662 | 0.5813*** | 0.1603 | -0.0210 | 0.1747 | 0.9614*** | 0.1911 |
| Environmental knowledge | -0.0328 | 0.0244 | -0.1108** | 0.0488 | 0.0445 | 0.0536 | -0.2189*** | 0.0697 | 0.0587 | 0.0670 |
| Choice selection variables | | | | | | | | | | |
| Confidence | -0.2946*** | 0.0553 | -0.1272 | 0.1116 | -0.0174 | 0.1274 | -0.2264 | 0.1436 | -0.9050*** | 0.1317 |
| Preference | 0.5410*** | 0.0493 | 0.9243*** | 0.0983 | 0.4013*** | 0.1132 | 0.7600*** | 0.1303 | 0.3115*** | 0.1179 |
| Understand | -0.0868** | 0.0420 | -0.3129*** | 0.0776 | -0.0601 | 0.0926 | 0.3411** | 0.1335 | -0.0599 | 0.1120 |
| More information | 0.0379 | 0.0474 | -0.1408 | 0.0969 | 0.1206 | 0.0984 | 0.3675*** | 0.1284 | 0.1627 | 0.1183 |
| Confused | -0.0913* | 0.0482 | 0.1698* | 0.1002 | -0.2284** | 0.1122 | -0.3419*** | 0.1207 | 0.1539 | 0.1166 |
| Land and water values variables | | | | | | | | | | |
| Use | -0.1049 | 0.1032 | 0.0866 | 0.1933 | -0.8129*** | 0.2528 | 0.6499** | 0.2568 | 0.3437 | 0.2635 |
| Option | -0.3754*** | 0.1144 | -0.4223** | 0.2110 | 0.1465 | 0.3018 | -0.8124*** | 0.2868 | -1.1272*** | 0.2889 |
| Bequest | 0.7605*** | 0.1396 | 1.0504*** | 0.2176 | -0.6159 | 0.4635 | 1.1207*** | 0.4011 | 0.8009** | 0.4036 |
| Existence | -0.1026 | 0.1404 | -0.4926* | 0.2640 | 1.6826*** | 0.2888 | -0.4598 | 0.3991 | -1.5023*** | 0.3988 |
| Quasi option | 0.2642*** | 0.1012 | 0.2425 | 0.2099 | 0.1097 | 0.2211 | 0.8885*** | 0.2647 | 0.8820*** | 0.2549 |
| Model statistics | | | | | | | | | | |
| Log-likelihood | -3246.92 | | -914.14 | | -790.85 | | -683.16 | | -682.48 | |
| Adj R^2 | 0.15097 | | 0.15007 | | 0.19025 | | 0.23324 | | 0.19218 | |
| Observations | 3492 | | 990 | | 900 | | 822 | | 780 | |

***significant at the 1% level; **significant at the 5% level; *significant at the 10% level.

Note: When 'Income' was included as a variable in the models it was only significant in the Toowoomba and Mackay samples and only at the 5% level.

Appendix 4 Multinomial logit models for the statewide survey

| | POOLED | | BRISBANE | | TOOWOOMBA | | MACKAY | |
|------------------------------|-------------|--------|-------------|--------|-------------|--------|-------------|--------|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| All regions | | | | | | | | |
| COST | -0.0073*** | 0.0009 | -0.0081*** | 0.0015 | -0.0064*** | 0.0016 | -0.0074*** | 0.0015 |
| SOIL | 0.0333*** | 0.0068 | 0.0448*** | 0.0116 | 0.0306** | 0.0127 | 0.0276** | 0.0119 |
| WATER | 0.0485*** | 0.0067 | 0.0595*** | 0.0114 | 0.0445*** | 0.0126 | 0.0481*** | 0.0118 |
| VEG | 0.0332*** | 0.0068 | 0.0537*** | 0.0114 | 0.0232* | 0.0128 | 0.0228* | 0.0120 |
| Murray–Darling | | | | | | | | |
| ASC-MD | -4.2335*** | 0.6010 | -2.8042*** | 0.7350 | -2.2914*** | 0.7190 | -2.4449*** | 0.7718 |
| AGE | 0.0079 | 0.0060 | 0.0053 | 0.0098 | 0.0161 | 0.0139 | 0.0087 | 0.0111 |
| GENDER | 0.3884*** | 0.1381 | -0.6601** | 0.2595 | -0.7705*** | 0.2224 | 0.6314** | 0.2764 |
| CHILD | 0.5776*** | 0.1707 | -0.5507 | 0.3545 | -0.4928* | 0.2817 | -0.4977 | 0.3359 |
| EDUCAT | 0.3494*** | 0.0660 | 0.2693** | 0.1184 | 0.4318*** | 0.1231 | 0.3659*** | 0.1263 |
| INCOME | 0.0868* | 0.0517 | 0.0948 | 0.0877 | 0.0143 | 0.1167 | -0.0040 | 0.0972 |
| BRISBANE | -0.5729*** | 0.1540 | | | | | | |
| Great Barrier Reef – Coastal | | | | | | | | |
| ASC-GBRC | -2.7213*** | 0.5689 | -2.4926*** | 0.6668 | -1.0885 | 0.8059 | -0.7852 | 0.6323 |
| AGE | 0.0037 | 0.0056 | 0.0047 | 0.0089 | 0.0056 | 0.0160 | -0.0019 | 0.0091 |
| GENDER | 0.2728** | 0.1287 | -0.5219** | 0.2283 | -0.1721 | 0.2631 | 0.0244 | 0.2195 |
| CHILD | 0.2258 | 0.1632 | -0.6632** | 0.3155 | 0.1358 | 0.3333 | -0.5058* | 0.2796 |
| EDUCAT | 0.1334** | 0.0608 | 0.2516** | 0.1065 | 0.2600* | 0.1404 | 0.2965*** | 0.1026 |
| INCOME | 0.1433*** | 0.0483 | 0.1432* | 0.0787 | -0.3162** | 0.1433 | 0.0442 | 0.0772 |
| BRISBANE | -0.3703*** | 0.1398 | | | | | | |
| South East Queensland | | | | | | | | |
| ASC-SEQ | -2.9981*** | 0.5820 | -2.5684*** | 0.6089 | -1.0477 | 0.7305 | 0.4271 | 0.7881 |
| AGE | -0.0007 | 0.0056 | 0.0105 | 0.0079 | 0.0279* | 0.0135 | -0.0289** | 0.0133 |
| GENDER | 0.3456*** | 0.1308 | -0.0864 | 0.1987 | -0.8036*** | 0.2369 | -0.1708 | 0.3034 |
| CHILD | 0.2635 | 0.1662 | -0.9222*** | 0.2807 | 0.2221 | 0.3010 | -0.3449 | 0.3639 |
| EDUCAT | 0.2325*** | 0.0622 | 0.1272 | 0.0939 | 0.4933*** | 0.1266 | 0.2148 | 0.1451 |
| INCOME | 0.0299 | 0.0483 | 0.3227*** | 0.0711 | -0.5612*** | 0.1294 | -0.2010* | 0.1078 |
| BRISBANE | 0.6404*** | 0.1365 | | | | | | |

Appendix 4 *Continued*

| | POOLED | | BRISBANE | | TOOWOOMBA | | MACKAY | |
|-----------------------------|--------------|--------|--------------|--------|--------------|--------|--------------|--------|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| Great Barrier Reef – Inland | | | | | | | | |
| ASC-GBRI | -3.8512*** | 0.6077 | -2.4703*** | 0.6958 | -1.8323** | 0.8705 | -0.7778*** | 0.6683 |
| AGE | -0.0023 | 0.0062 | 0.0018 | 0.0095 | 0.0142 | 0.0177 | -0.0125*** | 0.0102 |
| GENDER | 0.4214*** | 0.1387 | -0.3462 | 0.2398 | -0.7627*** | 0.2848 | -0.1113*** | 0.2354 |
| CHILD | 0.5637*** | 0.1717 | -1.2891*** | 0.3175 | -0.5354 | 0.3646 | -0.5724* | 0.2940 |
| EDUCAT | 0.1388** | 0.0656 | 0.1556 | 0.1141 | 0.3020** | 0.1536 | 0.3227*** | 0.1104 |
| INCOME | 0.2088*** | 0.0521 | 0.2833*** | 0.0840 | -0.1554 | 0.1479 | 0.0549 | 0.0839 |
| BRISBANE | -0.1458 | 0.1490 | | | | | | |
| Model statistics | | | | | | | | |
| No. of observations | 2256 | | 834 | | 690 | | 732 | |
| Log <i>L</i> | -3439.850 | | -1222.041 | | -1009.745 | | -1069.557 | |
| Adj <i>R</i> ² | 0.04924 | | 0.08187 | | 0.08142 | | 0.08337 | |
| X ² (dof) | 396.230 (28) | | 152.716 (24) | | 123.172 (24) | | 100.036 (24) | |

***significant at 1%; **significant at 5%; *significant at 10%.