Framing effects and benefit transfer in the Fitzroy basin

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Abstract.

Policy makers are often interested in how estimates of the value of an environmental asset may be disaggregated into component pieces. This is particularly the case when they are seeking to transfer benefit estimates made in one situation to related circumstances. This is the case for the environmental values of the Fitzroy River basin in Central Queensland. The basin comprises several smaller catchments that share similar development opportunities, environmental issues and water resource constraints. This paper describes an application of the choice modelling technique to estimate values for the basin as a whole and two of the smaller catchments to determine how values may be related. Comparisons are undertaken to assess the validity of the choice modelling approach to benefit transfer issues in environmental valuation studies.

Keywords: Choice modelling, framing, benefit transfer, irrigation, environment.

1. Introduction

Within the framework of environmental valuation the need often arises to apply values estimated for an environmental good in one context to another similar context. This process is called benefit transfer (BT). Boyle and Bergstrom (1992:657) state that benefit transfer is ‘the transfer of existing estimates of non-market values to a new study which is different from the study for which the values were originally estimated’. One of the major motives for partaking in a benefit transfer process is that value estimation exercises are often very expensive to perform. It can be potentially far cheaper to transfer values from previous studies or from other, similar sites than to repeat the estimation process each time a valuation is required. Interest by researchers and policy makers in the transfer of economic values for non-market resources has existed since the 1960’s (Loomis 1992). The development of non-market valuation databases such as ENVALUE are facilitating interest in benefit transfer applications (Morrison 2001).

A number of techniques are available for estimating environmental values where the information is not directly available from market information. These include related market techniques, such as the travel cost and hedonic pricing methods, and stated preference techniques such as the contingent valuation method (CVM) and choice modelling (CM). Questions about benefit transfer relate particularly to the stated preference valuation techniques, where there are concerns that any inaccuracies or biases in the values may become exacerbated in the transfer process (Brookshire and Neil 1992).

For BT to be accurate, the two main requirements are that the values estimated in the first study are free of major biases, and that the benefit transfer process does not generate substantially more. Much of the development work for techniques such as the CVM has concentrated on the first issue. The difficulty for the CVM is that because of its ‘single shot’ nature, it is difficult to identify how well values can be transferred to other locations where the circumstances may be slightly different. This can be illustrated by looking more closely at what is involved in a benefit transfer exercise.

There are three broad ways in which BT may be undertaken. The first is where values for an environmental good are transferred from one site to another that has similar bio-physical characteristics. The assumption that is made in the process is that the population will value the second site in the same way that they have valued the first. In circumstances where the sites vary according to certain bio-physical characteristics, the values for the sites might be expected to differ in proportion to the difference in characteristics. For example, if the area of two remnant vegetation sites varies, then this would be expected to impact on values. The use of the Choice Modelling (CM) technique has particular advantages here because it generates values according to underlying attributes. The results of the technique are thus particularly suitable to BT issues.

The second broad way in which BT might be undertaken is to infer that values held by a population for a particular issue might be transferred to a second population group. It may be possible that the values held by people are similar to the extent that the populations are similar. Capturing information about populations such as socioeconomic data, and relating that to the way that people make choices about environmental tradeoffs, may be an important way of allowing values to be transferred. Again, the CM technique has strengths in this area, as does the CVM.

The third broad way that values can be transferred relates to the scale of the asset in question. An example would be where values that are estimated for preserving environmental assets in a catchment need to be disaggregated down to a sub-catchment level. Alternatively, value estimates might need to be aggregated up. In practice, transfers from site A to site B will often involve a combination of these elements of site, population and scale differences. There is potential for the CM technique to be used for this purpose because of the descriptive models that are generated to describe choice behaviour. These can involve site bio-physical, sample socio-economic, and scale characteristics as determining variables of the value estimation.

These issues of benefit transfer are closely related to framing issues in valuation experiments. Framing effects occur when the respondent to a survey is sensitive to the context in which a particular tradeoff is offered, and are normal and commonplace in valuation experiments (Rolfe, Bennett and Louviere 2002). Framing problems occur when values are unduly sensitive or insensitive to the context in which they are offered. One focus of benefit transfer exercises is to determine where framing differences occur between source and target sites, so that values might be adjusted for these variations. Another focus of benefit transfer exercises is to determine where framing problems occur, because these indicate where it may not be appropriate to perform the exercise.

In this paper, the potential for benefit transfer is explored in relation to water resources and irrigation development issues. A series of CM experiments relating to potential further development of water resources in the Fitzroy basin in Central Queensland have been performed. The experiments differ according to the description of the issue, the population groups that have been surveyed, and the scale of the problem. This allows the analyst to test whether a single experiment could have been performed, and then the results extrapolated to account for site, population or scale differences.

This paper is structured as follows. In the following section, an overview of previous research relating to CM and benefit transfer is presented, together with discussion about the key issues to test. In section three, the case study is described with the key issues that frame the experiments of interest. In section four the experiments of interest are outlined, and the design and performance of the different CM surveys are described. Results and discussion are presented in section five, and conclusions drawn in section six.

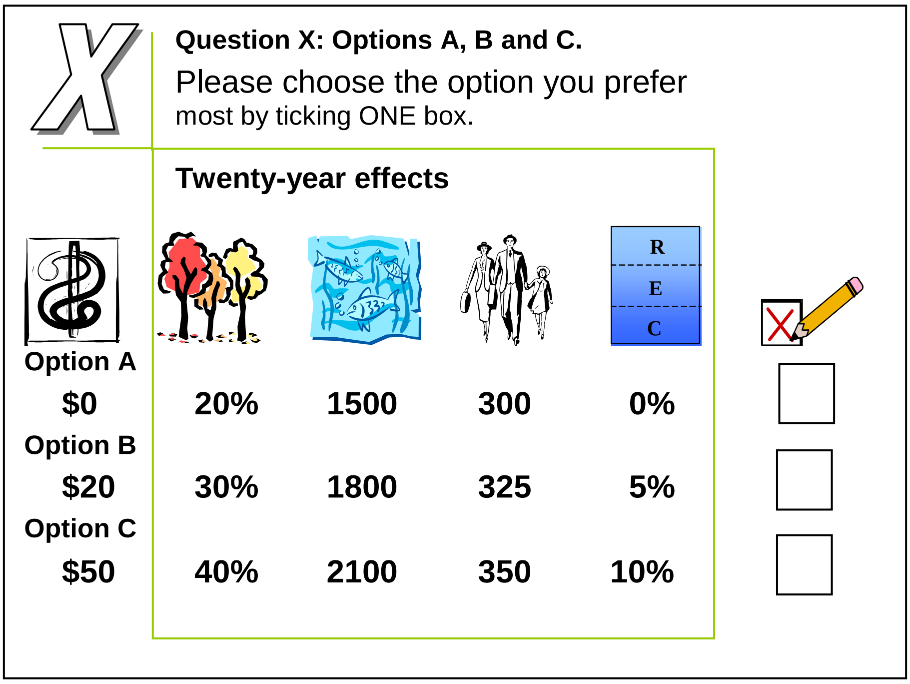
2. Choice Modelling and Benefit Transfer Issues

CM is a stated preference technique that has been adapted from conjoint analysis roots to estimate both use and non-use values. There have been a number of applications to recreational, environmental and social issues in recent years (eg Adamowicz et al 1998, Blamey et al 2000, Rolfe, Bennett and Louviere 2000, Morrison and Bennett 2000, Bennett and Blamey 2001).

CM involves asking respondents to a survey to make a series of choices about alternatives for environmental management. Each choice set involves a number of profiles describing the alternatives on offer. One of the profiles describes a current or future status quo option, and remains constant between the choice sets. The other profiles vary, so that respondents are being asked to make a series of similar, but different choices. An example of a choice set is given in Figure 1.

The profiles are made up of a number of attributes that describe the environmental issue in question. For example, profiles about environmental issues in floodplain management might be described in terms of the health of the waterways, the amount of remnant vegetation in good condition on floodplains, and the proportion of stream flows that are reserved for environmental purposes. To generate differences between profiles, these attributes are allowed to vary across a number of different levels (eg 30%, 40% or 50% of healthy vegetation in floodplains). These profiles then represent different options for future development and protection of the issue in question.

Figure 1 – Example Choice Set used in the Survey



The choice information is analysed using a logistic regression model. The probability that a respondent would choose a particular can be related to the levels of each attribute making up the profile (and the alternative profiles on offer), the socio-economic characteristics of the respondent, and other factors. The latter might include the ways in which the choices are framed to respondents through background information and structure of the survey, and the way in which the surveys are collected (Bennett and Blamey 2001, Rolfe, Bennett and Louviere 2002).

The logistic regression function can be used to generate probabilities of choice, and estimates of compensating surplus between different choice profiles. Most interest usually lies in finding the difference in compensating surplus between the status quo option and specific policy relevant profiles. As well as these estimates of consumer surplus, the models can also be used to generate estimates of marginal value changes for each attribute. Known as part-worths, implicit prices, or attribute values, these provide an indication of the value to respondents of each one unit change in the provision of an attribute. Both the part worth and the compensating surplus estimates can be used for testing the equivalence of different models. They may also be used for benefit transfer purposes (Morrison and Bennett 2000, Rolfe, Bennett and Louviere 2000).

Guidelines have been suggested for benefit transfer applications involving non-use values. Boyle & Bergstrom (1992) suggest 'idealistic' technical criteria such as:

- the non-market commodity valued at the study site must be identical to the non-market commodity to be valued at the policy site, (both in the characteristics of the good and the nature and extent of the change being valued),
- the populations affected by the non-market commodity at the study site and the policy site hold identical characteristics, and
- the assignment of property rights at both sites must lead to the same theoretically appropriate welfare measurement (e.g. willingness to pay versus willingness to accept).

Some development work has already occurred in relation to using CM for potential benefit transfer applications (Morrison, Bennett, Blamey and Louviere 1998, Rolfe and Bennett 2000, Van Bueren and Bennett 2000, Morrison and Bennett 2000. The richness of data from CM experiments allows analysts to test where differences might be between values for two sites when two separate valuation experiments have been performed. If the values for one experiment could be successfully used to replicate the second experiment and estimate values for the other site, then it appears that potential for benefit transfer exists.

Bennett and Blamey (2001) discuss this in more detail, identifying several justifications for the use of choice modelling as the basis for successful BT, which include:

- Whereas other techniques may produce estimates of demand for one or two potential goods, CM produces estimates that can be modelled for any scenario alternative that falls within the range of attributes and label space of the experiment. This provides obvious cost advantages, which is relevant to the normal justification for using BT.
- The decomposition of value into component parts (attributes) also assists in the process of BT. Often, BT is inhibited by differences between the original and transfer sites. Where sites share similar descriptive attributes, but the proposed changes differ, CM allows the flexibility for the transfer to proceed. In addition, such detailed descriptive (attribute) information assists researchers to identify where site and study similarities may exist or if attributes can be safely removed from the proposed BT study.
- CM also allows the inclusion of attributes to capture values for socioeconomic issues. Such socioeconomic attribute values (e.g. a concern for possible unemployment as a result of choices made), which may form part of respondent’s value statements in other methodologies yet remain hidden in an amalgam of environmental and social contributions, can be drawn out in the CM experiment. This enables more confidence among policy makers as to the nature of the values held and offers further depth to BT site comparisons.
- The nature of CM, like other stated preference techniques, requires greater public participation than alternate valuation methodologies. This both engenders a perception of transparency amongst respondents and may lead them to think they are being included in the decision making process at an early stage.
- CM, through its rich data set, provides a suitable platform for structuring experiments for inclusion in research databases. These databases allow for the centralised collection of BT value estimation experiment objectives, site characteristics, the study methodology, data sets and results. In turn, this makes it much easier for researchers and policy makers to undertake the process of BT.

Previous research has raised a number of issues that are important to the application of CM in attempts at BT of environmental values. The process of BT can only ever be as methodologically sound as the estimation technique on which the previous study is based (Atkinson et al 1992, Smith 1992). Boyle & Bergstrom (1992), Desvouges et al (1992) and Garrod and Willis (1999) suggest a range of criteria for conducting successful BT. These focus on site and population equivalence as important prerequisites of benefit transfers.

Site Equivalence

As discussed above, for successful BT to take place there must be a high degree of similarity between the source and the target sites. Site equivalence focuses upon whether or not one population holds the same values for similar sites. With the CM technique, this can be tested by ascertaining if the values for particular components (attributes) are equivalent, and if similar conservation profiles have the same consumer surplus value.

Morrison, Bennett, Blamey and Louviere (1998) focussed upon estimating values held by the Sydney population for the Gwydir Wetlands (Site 1) and the Macquarie Marshes (Site 2) in New South Wales. The objective of the study was to examine the validity of BT using CM to transfer values between sites. The researchers tentatively concluded that although the derived value estimates from the populations were not equivalent across the two sites, there was some equivalence in the compensating surplus values for similar profile changes. The test results are thus inconclusive (Morrison and Bennett 2000).

Rolfe and Bennett (2000) explored how two different population groups (respondents from Queensland and the Northern Territory) valued the preservation of native vegetation in the Desert Uplands of Queensland (Site 1) and the Daly-Sturt region in the Northern Territory (Site 2). The key objective was to understand how factors such as state boundaries and geographic distance—defined in the study as parochial effects—impacted on value formulation and future BT processes. The researchers concluded that there was little significant difference between the part worth values for the two sites in question across the two population groups. The same conclusions were supported when compensating surplus values for protection scenarios were compared. These conclusions remain somewhat limited however, due to the number of insignificant attributes in the models that were generated.

Population Equivalence

Tests of population equivalence can also be carried out in CM studies by comparing values for component changes and scenario profiles. Morrison, Bennett, Blamey and Louviere (1998) also tested for equivalence in their study for values of the Gwydir Wetlands between populations in Sydney and Moree. The authors found that the results were significantly different with implicit price estimates and compensating surplus figures diverging substantially. Accordingly they stated that BT between rural and urban populations should be treated with caution.

On the other hand, Rolfe and Bennett (2000) included between population tests in their CM study across values for the Daly-Sturt region. While inconclusive owing to the limited number of significant attributes, the researchers reported little significant difference between the two respondent groups (populations from Queensland and the Northern Territory). There were however significant differences in value within a state population. Queenslanders from the south-east corner of the state (grouped as an 'urban' population), had significantly different values for vegetation preservation in the Desert Uplands to the 'regional' population in the rest of the state.

Testing the issue of population equivalence was also part of the work undertaken in the National Land and Water Audit project into the non-market costs of land and water degradation in Australia (Van Bueren and Bennett 2000). Two of the tests conducted in that study compared the values held by a regional population and a capital city population for land and water protection in a regional area. The regional areas of interest were the Fitzroy basin in central Queensland and the Great Southern Basin in Western Australia. The populations surveyed were Rockhampton and Brisbane for the Fitzroy, and Albany and Perth for the Great Southern Basin. In both cases, little difference in values could be ascertained between the capital city and the regional populations. The one exception was in the Fitzroy study where the Rockhampton population had a much higher part-worth value for one attribute (the viability of country communities) than did the Brisbane population.

Another test reported in Van Bueren and Bennett (2000) compared the values for land and water protection at the national level held by two regional populations (Albany and Rockhampton) as well as the national population. No difference existed between the values held by the Albany and Rockhampton populations, indicating that these two regional populations viewed the issues in a similar light. However, regional respondents have significantly higher values for landscape aesthetics and lower values for species protection when compared to the national sample. This suggests that urban/regional population differences do exist.

Bennett and Morrison (2001) analysed value differences for five rivers across NSW. They concluded that the environmental attribute of different rivers were valued differently both by respondents resident in each river catchment and by people living outside the catchment. Specifically, non-use values for outside catchment residents were greater than for in-catchment residents. The opposite result was found for the user value attributes of rivers.

Scale equivalence

The issue of whether responses to valuation experiments are insensitive to the scale of the issue is related to concepts of embedding and scope. Embedding effects are held to occur when values for a particular item are embedded within another (Kahneman and Knetsch 1992). Scope effects occur when values for a particular item are insensitive to the quantity of the item on offer. CM has particular strengths in minimising and testing for scope issues (Rolfe et al 2000). However, the issue of scale is not just about differences in the amount of the items involved, but also in how respondents view and frame the problem. This may be because when environmental issues are presented at different levels of scale, respondents automatically consider different substitutes for framing purposes (Rolfe et al 2000). The results therefore might vary.

Van Bueren and Bennett (2000) tested the issue of how values might change according to the scale of the issue presented to respondents. In that study, surveys were run across the same population group to test if values for land and water conservation differed according to whether the issues were presented in a regional or a national context. The test was carried out across two population groups, Rockhampton and Albany, with the Fitzroy basin and the Great Southern Basin being the respective regional contexts presented. The conclusion drawn was that implicit prices were significantly lower when issues were presented in the national context.

Bennett and Morrison (2001) sought estimates for the environmental values of individual rivers and for all the rivers of NSW. They found that the implicit prices estimated for all the rivers were larger than for individual rivers, but that the simple aggregation of the individual river value estimates would exceed the state wide estimates.

This suggests that point estimates of value are dependent on the scale of the issue presented, and that they may not be suitable for all benefit transfer applications. A point value estimate (such as a part-worth value from a CM application) might be described as the average "per person" value of gaining an additional unit of one aspect of the environmental good in question, e.g. an additional kilometer of healthy waterways. In contrast, a value function derived by a CM application yields estimates of the respondent’s willingness to pay (WTP) for that additional unit as a function of biophysical, socioeconomic, demographic and other explanatory variables. Transferring the value function has been suggested by some researchers (eg Loomis 1992, Brouwer 2000) as preferable to transferring point values.

Van Bueren and Bennett (2000) tested the application of value functions to different scale contexts. For example, a value function derived from surveys focused at the national context was applied to estimate values for the Fitzroy and Great Southern Region, while value functions estimated at the regional level were used to predict national values for protecting land and water resources. These value function transfers were not very successful. The national value function was not effective at predicting regional level values, while the regional value functions were only partly successful at predicting values at the national level.

Bennett and Morrison (2001) estimated a meta-analytic model to transfer benefit estimates from their survey of four rivers to other rivers in NSW. The value function estimated included environmental attributes, socio-economic characteristics, location of the river and location of the respondent relative to the river as independent variables. The model was tested by comparing values from the initial CM estimates against the values from the meta-analytic model estimates. Three of the 14 implicit prices estimated by the BT model were significantly different from the original estimates.

These difficulties in transferring values across different scales are important because the cost of estimating non-use values in valuation experiments is so high. Even if non-use values associated with water resources could be estimated for the Fitzroy basin, can they be logically apportioned down to the sub-catchment level, or even further down to the project level? If differences in scale do exist, then they need to be accounted for in any apportionment of values within the catchment. Scale differences may also be important in any transfer of values to other catchments.

3. The Case Study Areas

The Fitzroy Basin, encompassing 142,000 km2, is the second largest externally draining basin in Australia. Beef cattle, grain, irrigated crops and coal are key primary products in the region. The Fitzroy Basin has two major irrigation centres; the Emerald irrigation area located on the Comet/Nogoa/Mackenzie river systems and the Dawson Valley irrigation area located along the Dawson river. These irrigation areas are approximately the same size and produce mostly cotton, peanuts, citrus and grains. The basin is described in more detail in Loch and Rolfe (2000).

These two sub-catchments are similar in resource and environmental conditions. About 50% of vegetation has been cleared from the floodplains in both areas, although there are much higher levels of clearing in some soil and vegetation types. Each of the sub-catchment's river systems comprise around 1000 kilometers of waterways and there is only a slight variance in river health between the two areas. The Comet/Nogoa/Mackenzie has about 50% of its river systems in a healthy condition and the Dawson River has 40%. In addition, if the proposal to build a major storage dam along the Dawson River is approved, there will be little or no water left in reserve for future environment or development purposes in the two areas.

There are however, some important social differences. The Emerald irrigation area is advantaged by the Fairbairn Dam, providing a greater system yield to irrigation farmers and somewhat greater security of supply. In addition, the Emerald district is home to other major industries such as coal mining and horticulture (which employs many seasonal workers). As a direct result, the population in the Emerald irrigation area is larger and more stable than that of the Dawson irrigation area. The Dawson Valley is serviced by a number of smaller towns which appear more susceptible to population losses and/or economic stagnation.

When compared to the Fitzroy Basin, these sub-catchments appear to be good indicators of the larger picture. In terms of environmental conditions, around 50% of floodplain vegetation has been cleared from the Fitzroy River basin and it has about 60% of its 2800 kilometers of waterways rated in good health. While the population of the basin is quite stable, there is an underlying pattern of people shifting from rural areas and small townships into the larger centres. However, in contrast to the sub-catchments where approximately 50,000 megalitres remain in reserve, there is a greater amount of potential reserve water available in the lower Fitzroy area—some 300,000 megalitres—although this is largely situated along or around land unsuitable for major irrigated agriculture.

Demands for irrigation water are very high in the basin where land suitable for cotton and/or horticulture is available. When additional supplies from the raising of the Bedford weir were auctioned in 1997, medium security water averaged $909/megalitre, and high security water averaged $1600/megalitre. There is substantial interest in developing more irrigation in the

Dawson and Comet/Nogoa/Mackenzie sub-catchments, where there is land suitable for irrigation purposes.

Proposals for further development include a major storage on the Dawson (the Nathan Dam), smaller weirs or other instream diversions, and offstream storages. Offstream storages are typically built by irrigators on their own land, and used to capture overland flows and water harvested from rivers in floodtimes. One advantage of developing off-stream storages is that they are privately funded. In contrast, instream storages tend to be funded from the public purse, although the costs can be recouped from subsequent sales of water to industry and agriculture.

The diversion of further water for irrigation purposes is likely to have some social and environmental consequences. Social consequences include increased regional spending and employment prospects that flow from increasing production, although the scale economies of most irrigation developments limit the job creation potential. Environmental consequences include biophysical effects of the interruption to natural flows in watercourses, the development of land for farming, and potential for runoff to impact on water quality in the system.

Concerns about the potential for overallocation of water resources and subsequent environmental impacts, together with the 1994 Council of Australian Governments Water Reform Agreement has prompted the Queensland Government to establish where the limits between development and protection should lie. The framework chosen for this is the Water Allocation and Management Plan (WAMP) developed for the Fitzroy catchment. This has effectively capped the level of potential extractions from the system at approximately 50% of median flow levels, together with rules for not harvesting the first spring floods.

Although the Fitzroy WAMP sets limits for water extraction in the basin, a number of questions remain about where balance between production and environmental protection should be struck. For economists, these include questions such as:

- Whether the current WAMP limits reflect the weight of community values for production versus protection outcomes,
- whether some water should be retained in reserve to guard against unforeseen outcomes,
- should more development should be allowed in some catchments in return for increased protection in others, and
- how proposals for competing developments within a catchment with different environmental and social outcomes should be evaluated.

To be able to evaluate these issues in economic terms, it is important to be able to estimate values for both production and non-production outcomes. While the former (such as the value of additional cotton production) can be estimated from market data, the latter (such as community values for protecting vegetation in floodplains) are more difficult to estimate. CM can be employed to estimate these non-use values.

4. Design and performance of the experiments

A series of CM surveys was designed to estimate values for environmental and social tradeoffs associated with irrigation development in the Fitzroy basin. It was important that the valuation information could be applied in various formats, particularly at the sub-catchment or project level. For these reasons, the surveys were designed to test a number of hypotheses about benefit transfer issues. The first test was about whether different populations held the same values for environmental and social tradeoffs in the Fitzroy basin. The second test was about whether the same population group held the equivalent values for similar sub-catchments within the Fitzroy basin, while the third test was about whether values in the Fitzroy could be accurately disaggregated into sub-catchments. The tests are outlined in more detail in Table 1.

Table 1: Tests to be performed

Test	Test to be Performed*	Description
A – population equivalence	FTZ Bne = FTZ Rok = FTZ Emd	Test whether values for the Fitzroy are equivalent across population groups
B – site equivalence	CNM Bne = DAW Bne	Test whether values for the two sub-catchments are equivalent across one population
C – scale equivalence	FTZ = CNM + DAW	Test whether values for changes across the Fitzroy system are equivalent to values for changes estimated separately in the Dawson and Comet/Nogoa/Mackenzie subcatchments

*FTZ = Fitzroy, CNM = Comet/Nogoa/Mackenzie, DAW = Dawson, Bne = Brisbane population, Rok = Rockhampton population and Emd = Emerald population.

The main case study focus was on the Comet/Nogoa/Mackenzie and the Dawson rivers and the whole Fitzroy River basin. The populations of interest included Brisbane as a major capital city centre, Rockhampton as a regional centre and Emerald as a likely impacted local center. To capture the required data, three versions of the survey were devised (Loch, Rolfe and Windle 2001). The application of the three versions to the relevant population groups is depicted in Table 2.

Table 2: Experiment Plan for Survey Round

Version No.	Survey Version Description	Population to be Sampled		
		Brisbane	Rockhampton	Emerald
1	Floodplain development (Fitzroy)	√	√	√
2	Floodplain development (Comet/Nogoa/Mackenzie)	√		
3	Floodplain development (Dawson)	√		

The objective of the CM experiment was to estimate respondent's preferences for tradeoffs between further floodplain development in the Fitzroy Basin and environmental and social tradeoffs. To present survey respondents with development and protection alternatives, the issues had to be described in several concise attributes. These were selected with the aid of scientific and policy experts in the basin, and the conduct of a series of focus groups in the towns to be surveyed (Loch, Rolfe and Windle 2001).

For consistency, the same attributes were used as the basis for the choice scenarios generated for the three case study areas. These attributes were:

- Payment levy (an annual levy collected through local government rates over 20 years)
- The amount of healthy vegetation left on floodplains
- The kilometers of waterways that remain in good health
- The number of people leaving rural or country areas every year, and
- The amount of water kept in reserve for future use.

The base was selected as the likely level in twenty years time for each attribute if current trends continued. The other levels for each attribute to be used in the alternative scenarios were set between the current level and the expected future level. This allowed for a variety of different outcomes if various protection measures were implemented. In the case of the reserve attribute, a negative level was used for both the Dawson and Comet-Nogoa-Mackenzie basins to indicate that water could potentially be allocated below the WAMP limits (the median flow level). The base and alternative levels for each version of the survey are set out in the following table.

Table 3 – WTP Base and Attribute Levels for the Case Study Areas

Attribute	Fitzroy Levels		CNM Levels		Dawson Levels	
	Base	Alternatives	Base	Alternatives	Base	Alternatives
Payment	0	20, 50, 100	0	10, 20, 50	0	10, 20, 50
Healthy Vegetation in floodplains	20%	30%, 40%, 50%	25%	30%, 40%, 50%	10%	20%, 30%, 40%
Kilometers of Healthy Waterways	1500	1800, 2100, 2400	400	500, 650, 800	300	400, 550, 700
People leaving country areas	300	275, 325, 350	0	0, 25, 50	300	275, 325, 350
Amount of water in reserve	0%	5%, 10%, 15%	0%	-2%, 2%, 4%	0%	-5%, 5%, 10%

Each of the choice sets presented to respondents involved a status quo or base option (the expected position in twenty years time), together with two alternative scenarios that involved some annual payment for increased protection measures. The experimental design resulted in a series of 25 choice sets. These were blocked into five versions of the survey, so that five choice sets within a version were presented to respondents. An example of the choice sets presented to respondents is provided below.

A drop-off and pick-up approach was used to collect the surveys. Respondents were sampled at random in Emerald, Rockhampton and Brisbane based on a cluster sampling technique. Each survey collector was provided with a set of instructions incorporating an outline of respondent selection in each node and how to verbally introduce the survey itself. Collectors made a minimum of two attempts to collect the survey. The surveys were collected at the three locations in November and December 2000.

In Brisbane, 340 completed surveys were collected for the three versions collected three. In Rockhampton, 122 surveys were completed, and there was 149 completed in Emerald. 50.5% of all people approached gave back a fully completed survey. 41.5% of all people approached declined to complete the survey, and 9% of people approached took a survey form and either did not return it to the collector or did not complete it fully.

Survey Statistics

The socio-demographics of the respondents who completed the surveys are summarised in Table 5 below.

It is interesting to note from these figures that the three populations felt that the state of the environment had generally declined, and ranked highly their concern for the environment, (in both cases higher than the state average). However, the numbers of respondents either donating or belonging to environmental organisations significantly declines the closer the population is to the specific tradeoffs involved between environmental concerns and further development. This is particularly noticeable in the Emerald population, where membership drops to less than 2%, as would be expected given the probable lack of representative organisations and a likely focus on employment and further development.

Table 4 – Socio-Demographics of the Survey Respondents

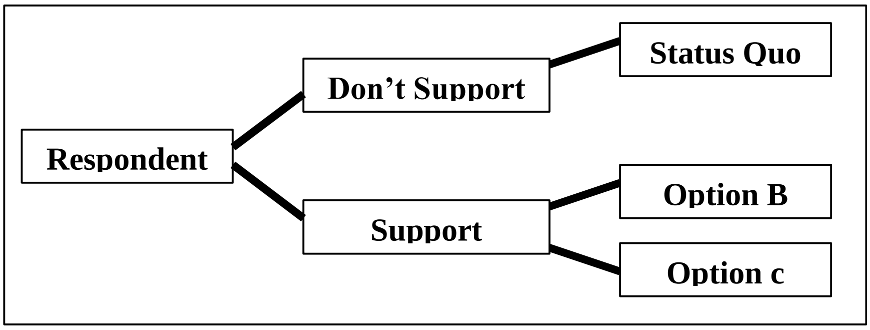
Variable	Brisbane	Rockhampton	Emerald	State Average
Age (> 17 years)	43.00 years	43.82 years	39.43 years	42.2 years †
Gender (% Male)	43.65%	51.69%	44.51%	49.72%†
Education (%>year 12)	50.78%	58.96%	50.08%	45.62%†
Income (household)	$43,125	$37,57	$41,399	$27,500†#
Employed full or part time	60.14%	60.66%	65.73%	59.71%†
% that agree environ. Declined	56.07%	57.24%	54.89%	41.7%*
% concern for environ. Problems	19.94%	21.87%	20.55%	8.1%*
% donated to environment	51.16%	35.50%	30.05%	n/a^
% environmental group member	10.75%	9.84%	1.53%	n/a^

* - Figures for Qld. from March 1999 ABS Environmental Issues Paper 4602.0.
† - Figures obtained and estimated from 1996 Census data.
# - Mean disposable income (i.e. after tax). Population figures quoted include tax component.
^ - Comparable state figures not available from Census or other data, however if they were available the actual numbers would be most probably overstated. This is likely the case with the population figures also.

5. Results and Analysis

The choice data from each version of the CM surveys were analysed and modelled using the LIMDEP program. To minimise potential violations of the IIA/IID conditions associated with linear regression models, a two level (nested) choice model was estimated. Respondents were assumed to firstly make a choice about whether they would support increased protection measures against continuation of the current trends. This choice was modelled against the socio-economic characteristics of respondents. In the second stage, respondents were assumed to choose between the alternatives presented according to the levels of each attribute. The choice model is depicted in figure 2.

Figure 2. Nested choice structure



Generating nested models involved three different types of variables. The branch choice equation (explaining the support/don’t support choice) involves attributes that represent the socio-demographic characteristics of the survey respondents. The utility functions that predict choices between different protection alternatives involve the choice set attributes. The third variable is an inclusive value parameter which specifies the link between the two levels of the model. Each of the variables used in the nested model are specified in the following table.

Table 5 – Variables used in the CM Application

Attributes of branch choice equations	*Indicates why people choose between the support/no support branches in the models*
Age	Age of respondent (in years)
Income	Income of household in dollar terms
Education	Education (ranges from 1=primary to 5=tertiary degree)
Occupation	Occupation (ranges from 1=employed to 5=othercatagories)
ASC	Constant value – reflects the influence of all other factors on choice between support/no support branches of the model.
Attributes in the utility functions	*Indicates why people choose between the two alternatives*
Cost	Amount that households would pay in extra rates (or rent) each year to fund improvements
Vegetation	% of healthy vegetation remaining in floodplains
Waterways	Kilometers of waterways in catchment remaining in good health
People leaving	Number off people leaving country areas each year
Reserve	% of water resources in catchment not committed to the environment or allocated to industry/urban/irrigation uses
ASC_1	Alternate specific constant which reflects the influence of all other factors on choice between different choice profiles.
IV Parameter	*Provides statistical link between the two levels of the nested model*

The models that could be generated from these data were used to test the three specific framing issues of interest relating to site, population and scale factors. These issues are discussed in turn.

5.1 Site Equivalence Results

The site test was aimed at finding whether the values of two similar catchments (Comet/Nogoa/Mackenzie and the Dawson) held by the same population (Brisbane) were identical. The hypothesis can be stated as follows:

Ho: β CNM = β DAW

H1: β CNM $\neq$ β DAW

where β CNM and β DAW are the parameter vectors corresponding to the Comet/Nogoa/Mackenzie and the Dawson data sets respectively.

Model results for the two data sets are shown in Table 6 below. The models appear robust, with most attributes significant and signed as expected[1].

There are several ways of testing the hypothesis that the models generated are equivalent. These include log-likelihood tests, comparison of part-worth values, comparison of compensating surplus values. Each of the tests are described in turn.

5.1.1 Site significance test

The first test for this site hypothesis is examine the significance of a location variable. Likelihood ratio tests can be used to identify whether significant differences exist between

[1] The exceptions are that the income coefficient is negative in both models, and the education coefficient is negative in the CNM model.

models with and without an additional variable (Whitten and Bennett 2000). The test statistic is -2 x ($LL_1 - LL_2$), where LL_1 is the log-likelihood of the first model, and LL_2 is the log-likelihood of a second model with additional parameters added. The test statistic is approximately chi-square distributed with the degrees of freedom equivalent to the number of parameters added. If the test statistic is larger than the appropriate chi-square statistic, the added parameters create a significantly different model (Louviere et al 2000).

Table 6. Results of Nested Multinomial Logit Models for CNM and Dawson Sites

Variables	CNM Site		Dawson Site	
	Coeff.	St. Error	Coeff.	St. Error
Utility Variables				
ASC_1	.0585	.1192	-.3567***	.1283
Cost	-.0234***	.0046	-.0406***	.0058
Vegetation	.0333***	.0116	.0488***	.0105
Waterways	.0020***	.0007	.0036***	.0007
People	-.0156***	.0037	-.0057**	.0023
Reserve	.1544***	.0337	.1018***	.0152
Branch Choice Equations				
ASC	.9776	.9819	-1.6137**	.8210
Age	-.0069	.0080	.0128*	.0068
Education	-.2777***	.1051	.3481***	.0945
Income	-.0001***	.0001	-.0001***	.0001
Inclusive Value Parameters				
Pay	.8903***	.3196	.2425**	.1204
No Pay (Fixed Para.)	1		1	
Model Statistics				
N (Choice Sets)	435	(0 skip'd)	615	(10 skip'd)
Log L	-378.20		-538.29	
Adj. rho-square	.31182		.27164	
Chi-square (DoF = 12)	356.80		415.06	

*** - P<0.001
** - P<0.01
* - P<0.05

The test is performed by combining data sets and estimating a model, but without specifying a location attribute. Then a model is calculated where a dummy variable is included for one of the locations. The log-likelihood of the joint CNM/Dawson model is –956.93, while the log-likelihood of a model with a dummy variable for the Dawson sample added is -938.92. The test statistic is therefore:

$$= -2 \times (-956.93 - -938.92)$$
$$= 36.02$$

The appropriate chi-square statistic with one degree of freedom is 3.84. Therefore it can be concluded that a significant difference does exist when the location is taken into account.

5.1.2 Part-Worth (Implicit Price) Site Test

The part-worth tests involve the comparison of confidence intervals for the part-worth values calculated from the models. The part-worths, also known as implicit prices, are the point estimates of the value of a unit of change in a non-monetary attribute. Because standard errors are not calculated in the nested multi-nomial models it is necessary to use the Krinskey and Robb (1986) procedure for this purpose. The simulation involves the random draw of a number of parameter vectors from a multivariate normal distribution with mean and variance equal to the β vector and a variance-covariance matrix from the estimated nested multinomial logit model (Morrison, Bennett, Blamey and Louviere 1998). Confidence intervals can be estimated from the upper and lower tails of the simultation exercise. The part-worths and the 95% confidence intervals for the two models are shown below in Table 7[2].

Table 7: Part Worth & Confidence Interval Estimates for the CNM and Dawson sites.

	Comet/Nogoa/Mackenzie			Dawson		
Attribute	P Worth	Lower	Upper	P Worth	Lower	Upper
Vegetation	1.43	0.33	2.53	1.20	0.63	1.77
Water	0.09	0.02	0.18	0.09	0.05	0.13
People	-0.67	-1.22	-0.35	-0.14	-0.28	-0.05
Reserve	6.61	3.32	12.36	2.50	1.81	3.46
ASC 1		Not significant		-8.78	-13.81	-2.55

Comparison of the results shows that there is overlap of confidence intervals between three of the four part-worths for the two sites. There is no overlap for the *People leaving* attribute. This may be because the levels for *People leaving* were very different in the two sub-catchments (see Table 3), indicating that the part-worths are sensitive to the absolute values of the levels involved. The results indicate that the models are equivalent in the areas where the case studies were similar, but vary when the attributes have very different levels in the different case studies.

5.1.3 Compensating Surplus Site Test

The third test involves a comparison of compensating surplus values for the three populations. This involves estimation and comparison of compensating surplus for specific alternatives. Because a very large number of scenarios could be described from the attributes and levels used in the experiment, an experimental design process was used to select a representative sample of nine scenarios. The models reported in Table 6 were used to generate compensating surplus measures for each, and upper and lower confidence intervals were estimated utilising the Krinsky and Robb (1986) bootstrapping procedure. In the final formulae, the mean levels for the relevant socio-economic characteristics were used for estimation purposes.

The compensating surplus values provide an estimate of value for the scenario of interest relative to the base option used in the survey. However, the models have generated negative values for those base options, so that even though the different alternatives may be preferred over the base, the overall estimate of value remains negative. The negative values for the status quo options are likely to be because this was the future base depicted in twenty years time, reflecting large potential environmental losses from the current situation. Respondents may not have not have viewed this status quo base as a preferred choice, thus creating the negative values.

In the CNM basin, the value of the status quo option can be estimated at -$80.70. Where the scenario values are higher than this level (see Table 8), it indicates the scenario is preferred to the base option. In cases where the scenario value is lower than this amount, it means that some negative attribute changes (eg more people leaving country areas) are outweighing any other positive attribute changes. It is a similar story in the Dawson catchment, where the

[2] The part-worth for the ASC 1 for the CNM model is not included because this parameter was not significant (see Table 6).

value of the status quo option in twenty years time is -$11.07. Scenarios that have higher values than this (see Table 8) are preferred to the base.

Table 8: Compensating Surplus Estimates for CNM and Dawson sites

Scenario	Attribute Changes from Base	CNM	Dawson
1	Veg +5%, Water +100k 's, People 0 change, Reserve -2%	-81.30 (-142.55, -33.78)	-8.04 (-59.48, 50.92)
2	Veg +5%, Water +250k 's, People +25, Reserve +4%	-76.81 (-165.84, -35.86)	-6.39 (-55.98, 50.31)
3	Veg +5%, Water +400k 's, People +50, Reserve +2%	-80.37 (-166.47, -34.69)	-4.00 (-52.35, 51.60)
4	Veg +15%, Water +100k 's, People+25, Reserve +2%	-88.25 (-161.16, -47.28	-9.65 (-59.88, 46.89)
5	Veg +15%, Water +250k 's, People+50, Reserve -2%	-91.93 (-168.97, -50.22)	-7.30 (-56.28, 48.13)
6	Veg +15%, Water +400k 's, People 0 change, Reserve +4%	-50.33 (-132.32, 6.72)	-1.39 (-51.53, 56.69)
7	Veg +25%, Water +100k 's, People+50, Reserve +4%	-102.90 (-188.27, -59.15)	-10.45 (-60.05, 44.85)
8	Veg +25%, Water +250k 's, People 0 change, Reserve +2%	-61.77 (-147.06, -11.76)	-4.66 (-55.42, 53.41)
9	Veg +25%, Water +400k 's, People+25, Reserve +2%	-65.45 (-158.72, -12.91)	-3.15 (-52.08, 53.65)

The comparisons of compensating surplus values between the different sites indicate that little difference exists between values for the Comet/Nogoa/Mackenzie and Dawson basins. This suggests that the null hypothesis should be accepted.

In conclusion, the log-likelihood test indicates that a significant difference does exist between the models generated for the CNM and Dawson catchments. The part-worth tests indicate that the difference is centered on the *People leaving* attribute, and care should be taken in any extrapolation of these values for benefit transfer purposes. The automatic transfer of point values is not appropriate in this case. The compensating surplus tests indicate that the model differences are not significant enough to cause significant differences in the value of a representative sample of alternative profiles. The conclusion to be drawn is that while model differences do exist, they do not invalidate the use of benefit transfer. However, benefit transfer is appropriate for a value function, but not for point estimates.

5.2 Population Equivalence Results

The population test was aimed at finding whether the values of the local population, the regional city (in the catchment) population and the capital city (out of the catchment) population were identical. The hypothesis can be stated as follows:

Ho: β BNE = β ROK = β EMD

H1: β BNE $\neq$ β ROK $\neq$ β EMD

where β BNE, β ROK and β EMD are the parameter vectors corresponding to the Brisbane, Rockhampton and Emerald population data sets respectively.

The models generated from the three populations (Table 9) appear to be robust[3]. Most attributes are significant and signed as expected. The results indicate that the Rockhampton

[3] The use of nested models did not generate a significant IV parameter for the Rockhampton population. This was due to the smaller sample size collected for that city. To facilitate comparisons, simple multinomial logit (MNL) models have been calculated for each sample.

population did not consider *People leaving* to be significant, and the Brisbane population did not consider *Reserve* to be significant. In the socio-economic section there is far greater variance between the models, with none of the attributes appearing as significant across all three populations. *Occupation* seems unrelated to choice across each of the populations while *Age* appears to be significant only for the Emerald and Rockhampton respondents. *Education* and *Income* appear to be significant factors of support for the no-choice option in Rockhampton and Brisbane only.

Table 9: Results of the Multinomial Logit Models for Population

Variables	**Emerald Population**		Rocky Population		Brisbane Population	
	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error
Cost	-0.018***	0.002	-0.012***	0.002	-.0203***	.0021
Vegetation	0.031***	0.008	0.025***	0.008	.0354***	.0080
Waterways	0.001***	0.000	0.001***	0.000	.0005**	.0002
People	-0.005***	0.002	-0.003	0.002	-.0060***	.0019
Reserve	0.035**	0.017	0.035**	0.016	.0094	.0163
Alt. Specific Constant	0.944	0.659	0.910	0.690	-1.3674	.5969
Age	-0.027***	0.010	-0.028***	0.009	-.0053	.0112
Occupation	-0.023	0.075	-0.075	0.074	.1283	.0812
Education	-0.022	0.085	-0.175*	0.088	.3153***	.0884
Income	0.0001	0.0001	0.0001**	0.0001	.0001***	.0001
Model Statistics						
Number of Choice Sets		630		605		650
Log Likelihood		-579.29		-611.70		-601.27
Adjusted rho-square		.13911		.06813		.14818
Chi-square (D. of Freedom = 15)		144.09		102.26		193.68

P<0.001
** - P<0.01
* - P<0.05

As with the site hypothesis, there are three tests that can be applied to determine if the models for the two similar sites are equivalent. These are reported in turn.

5.2.1 Location Significance Test

The first test for this population hypothesis is that of location significance. The test is performed by combining data sets and estimating a model, but without specifying a location attribute. Then a model is calculated where a dummy variable is included for one of the locations. The log-likelihood values for each of the models are used to calculate the test statistic. The results of the test for the different possible combinations of the datasets are reported in Table 10.

The results indicate that while no significant difference exists between the Rockhampton and Brisbane, and Emerald and Brisbane populations, a significant difference does exist between the Emerald and Rockhampton population. When the data from the three data sets is combined, and one location at a time is tested (see Table 11), the addition of Rockhampton creates a significant difference while the addition of Emerald or Brisbane does not.

Table 10. Log-likelihood tests for location significance

Population	LL	-2*Difference	$\chi 2$ statistic	Equiv.
ROK & EMD	-1178.65		(1) deg. freedom	
Add Emerald parameter	-1174.48	8.34	3.84	X
ROK & BNE	-1227.90		(1) deg. freedom	
Add Brisbane parameter	-1226.01	3.78	3.84	✓
EMD & BNE	-1189.93		(1) deg. freedom	
Add Brisbane parameter	-1189.22	1.42	3.84	✓
EMD, ROK & BNE	-1807.05		(2) deg. freedom	
Add Rockhampton variable	-1801.72	9.78	5.99	X
Add Emerald variable	-1804.16	5.78	5.99	✓
Add Brisbane variable	-1806.73	0.68	5.99	✓

5.2.2 Part-Worth (Implicit Price) Tests for Population differences

The part-worths, together with confidence intervals for the three sites of interest can assist in testing for equivalence. The part-worths and the 95% confidence intervals are shown below in Table 11. The part-worths for *People leaving* in the Rockhampton sample and *Reserve* in the Brisbane sample are omitted because these coefficients were not significant in the models (see Table 9).

Table 11. Part Worth and Confidence Interval Estimates for EML, ROK and BNE

	Emerald			Rockhampton			Brisbane		
Attribute	P-worth	Lower	Upper	P-worth	Lower	Upper	P-worth	Lower	Upper
Vegetation	1.74	0.86	2.70	2.04	0.60	3.69	1.74	1.05	2.74
Water	0.07	0.04	0.10	0.07	0.02	0.13	0.02	0.00	0.05
People	-0.29	-0.54	-0.10		Not significant		-0.30	-0.49	-0.08
Reserve	1.97	-0.16	3.99	2.81	0.06	5.97		Not significant	

The results indicate substantial overlap between the confidence intervals for each of the attributes. This result suggests that the null hypothesis should be accepted.

5.2.3 Compensating Surplus Population Test

The third test involves a comparison of compensating surplus values for the three populations across a representative sample of possible scenarios. The results for the compensating surplus population tests are detailed below.

The results indicate that values for the Emerald and Brisbane populations are similar with significant overlap in the lower and upper confidence intervals across the nine scenario alternatives. For the Rockhampton and Brisbane populations there is overlap between confidence intervals for four scenarios, and significant differences for the other five. These differences may be caused by the omission of an insignificant variable in both the Rockhampton and Brisbane models, which may tend to magnify value differences[4]. It is

[4] This is because the omission of the *People leaving* attribute in the Rockhampton model would tend to increase compensating surplus values, while the omission of the *Reserve* attribute in the Brisbane model would tend to reduce compensating surplus values.

possible that models based on larger sample sizes may be more accurate, not have insignificant attributes, and have more similar compensating surplus values.

Table 12: Compensating Surplus Estimates for EML, ROK and BNE

Scenario.	Attribute Changes (from base)	Emerald	Rockhampton	Brisbane
1	Veg +10%, Water +300k 's, People –25, Reserve +5%	2.67 (-1.49, 7.36)	1.84 (-5.14, 7.35)	1.55 (-2.58, 5.12)
2	Veg +10%, Water +600k 's, People +25, Reserve +10%	17.09 (4.15, 29.96)	29.77 (14.30, 49.69)	-1.35 (-9.25, 7.09)
3	Veg +10%, Water +900k 's, People +50, Reserve +10%	15.74 (-1.25, 33.16)	35.19 (15.78, 57.16)	-5.17 (-19.91,10.46)
4	Veg +20%, Water +300k 's, People+25, Reserve +10%	3.54 (-4.42, 10.30)	13.30 (6.15, 22.19)	-4.75 (-9.99, 1.55)
5	Veg +20%, Water +600k 's, People+50, Reserve +5%	-1.76 (-14.45, 11.51)	13.09 (-0.38, 22.84)	-8.57 (-20.02, 4.87)
6	Veg +20%, Water +900k 's, People-25, Reserve +15%	34.25 (19.12, 51.15)	41.02 (19.12, 67.52)	9.78 (0.53, 19.84)
7	Veg +30%, Water +300k 's, People+50, Reserve +15%	0.47 (-14.15, 13.13)	19.13 (7.31, 33.30)	-11.96 (-21.68, -0.19)
8	Veg +30%, Water +600k 's, People-25, Reserve +10%	20.69 (11.95, 31.00)	24.55 (11.79, 39.94)	6.39 (0.62,12.75)
9	Veg +30%, Water +900k 's, People+25, Reserve +5%	23.28 (10.26, 38.78)	35.60 (16.20, 57.63)	2.56 (-8.66, 14.15)

Overall, the results of the population tests are mixed. It is clear that the different populations have similar values for floodplain development in the Fitzroy. The Rockhampton population (at the mouth of the catchment) appears to have the highest values, while the Brisbane population (outside of the catchment) appears to have the lowest values.

While most of the tests showed equivalence of values between the populations, some of them did not. There does not appear to be sufficient evidence to either accept or reject the null hypothesis on this evidence.

5.3 Scale equivalence results

The test for scale differences revolves around the issue of whether values for protection options differ according to the scale of the issue. Testing for scale differences is a form of a scope test, where the key issue is that respondents make some distinction between different amounts of a good on offer. In the case study, the key issue is whether values for the Fitzroy catchment can be disaggregated down into sub-catchments. The test for this is whether values for changes in the Fitzroy catchment are equal to values for the equivalent amount of changes in two major sub-catchments. The hypothesis can be formally stated as follows:

Ho: $CS_{CNM} + CS_{DAW} = CS_{FTZ}$
H1: $CS_{CNM} + CS_{DAW} \neq CS_{FTZ}$

where CS represents the consumer surplus that can be estimated from the models for the different catchments.

If the null hypothesis is accepted, it implies that respondents to valuation experiments automatically consider scale issues in their responses, and that values can be safely aggregated or disaggregated to different scales. If the null hypothesis is rejected, it implies that it is not accurate to simply aggregate or disaggregate values to different scales. However, there is some difficulty in finding appropriate tests for scale differences. The use of part-worths and compensating surplus values to test the null hypothesis are discussed in turn.

5.3.1 Part-worth scale tests

The part-worth tests are not appropriate to test the null hypothesis because marginal values might change according to the absolute values involved. This would be an expected difference between models where there was substantial variation in the levels of attributes between sub-catchment and whole-of-catchment levels. This has already been shown to occur in the comparison between the CNM and Dawson models, where the part-worths for *People leaving* were significantly different. However, a comparison of the part-worth values helps to guide the comparison of compensating surplus values for a sample of alternatives.

The differences in part-worths can be demonstrated with the CNM, Dawson and Fitzroy models sampled from the Brisbane population. To make the comparison, an equivalent model has been estimated for the Fitzroy basin, and is reported in Table 13. The partworths and corresponding confidence intervals for each catchment are reported in Table 14.

Table 13. Nested logit model for Fitzroy (Brisbane population).

Variables	Coeff.	St. Error
Utility Variables		
ASC_1	.2027*	.1058
Cost	-.0214***	.0025
Vegetation	.0349***	.0088
Waterways	.0006**	.0003
People	-.0067***	.0020
Reserve	.0044	.0173
Branch Choice Equations		
ASC	.9514***	.3667
Education	-.3092***	.0080
Income	-8.2E-06**	.3.7E-06
Inclusive Value Parameters		
Pay	.7491***	.1865
No Pay (Fixed Para.)	1	
Model Statistics		
N (Choice Sets)	650	
Log L	-604.83	
Adj. rho-square	.23201	
Chi-square (DoF = 10)	377.64	

Table 14: Part Worth & Confidence Interval Estimates for the Fitzroy (Brisbane popn.)

Attribute	Fitzroy	CNM	Dawson
	P Worth (confidence interval)	P Worth (confidence interval)	P Worth (confidence interval)
Vegetation	1.82 (0.98 – 2.78)	1.43 (0.33 – 2.53)	1.20 (0.63 – 1.77)
Water	0.03 (0.01 – 0.06)	0.09 (0.02 – 0.18)	0.09 (0.05 – 0.13)
People	-0.25 (-0.48 - -0.04)	-0.67 (-1.22 - -0.35)	-0.14 (-0.28 - -0.05)
Reserve	Not significant	6.61 (3.32 – 12.36)	2.50 (1.81 – 3.46)
ASC 1	10.80 (1.23 – 22.86)	Not significant	-8.78 (-13.81 - -2.55)

The comparison shows that while the confidence intervals for the *People leaving* attribute do not overlap between the CNM and Dawson models, the confidence intervals do overlap between each of these models and the Fitzroy model. The two sub-catchments have very different patterns in population movement, which generates the different results. Across the whole catchment though the population changes average out, which is reflected in the value estimates. The implication is that the point estimate for the whole catchment cannot be simply transferred to sub-catchments if the levels change substantially.

The *Reserve* attribute was significant in both the CNM and Dawson samples, but not in the Fitzroy sample. This can be explained by the fact that the amount of reserve water in the CNM and Dawson catchments is already limited, and is likely to be allocated out to irrigators over the next twenty years. For the overall Fitzroy catchment though there are other substantial reserves of water which are unlikely to be allocated away in the foreseeable future. The point value estimates reflect the relative scarcity of reserve water in the different catchments, and the value is not significant where there is no foreseeable scarcity of reserves. Again, the implication is that the point estimate for the whole catchment cannot be simply transferred down to the sub-catchments when very different levels are involved.

Compensating surplus scale tests

A comparison of compensating surplus values does offer a robust method for testing the null hypothesis. Essentially the test is whether the value of change A in the CNM basin plus the value of change B in the Dawson basin is equivalent to the value of the A+B change in the Fitzroy basin. In the test, these changes incorporate changes in the levels for the *Vegetation*, *Waterways*, and *People leaving* attributes. The *Reserve* attribute is not included, because it is insignificant in the model for the Brisbane population, for the reasons mentioned above.

The levels used in the tests are shown in Table 15 below. The levels of the *Vegetation* attribute for the CNM and Dawson systems have been averaged to derive the level for the Fitzroy. For *Waterways*, the improvements in the CNM and Dawson systems above the combined base (700 kilometers) have been added to the Fitzroy base (1500 kilometers). This has the effect of limiting improvements in waterway health to the CNM and Dawson basins. The levels of the *People leaving* attribute has been added up across the CNM and Dawson systems to derive the Fitzroy levels (assuming no net change in the other parts of the catchment).

To test the hypothesis, values have been generated for the nine scenarios for each basin. The CNM and Dawson values were added for each corresponding scenario. To calculate confidence intervals, the Krinsky and Robb (1987) procedure was used to generate 200 values for each scenario. The 200 values for the CNM were added to the 200 values for the Dawson, and then the 2.5% tails removed to generate confidence intervals for the CNM & Dawson sample. Confidence intervals for the Fitzroy sample were also calculated with the Krinsky and Robb (1987) procedure. The results are reported in Table 16.

The results show that no significant difference exists between the compensating surplus values for each scenario. This indicates that the null hypothesis can be accepted. The results suggest that it is may be valid for values to be disaggregated from the basin level down to sub-catchment levels, or up from sub-catchment levels to the whole basin.

However, care should be taken in extrapolating this null hypothesis widely to other situations. The confidence intervals may overlap because of a lack of statistical power. Collecting larger samples and using other measures to generate tighter confidence intervals may identify more scale differences between the samples. As well, it is likely that the population of interest (Brisbane) may not have identified a particular scale difference between the whole-of-catchment and sub-catchment options. The scale test reported here is much more limited than the ones explored by Van Bueren and Bennett (2000) and Bennett and Morrison (2001).

The results do offer support for BT to proceed where limited scale differences apply. Each of the CNM and Dawson basins are approximately one-quarter of the Fitzroy basin, and it appears in these cases that many values and value functions can be transferred directly

Table 15 Scenarios used to test scale hypothesis

Scenario	Attribute	CNM	Dawson	Fitzroy
1	Vegetation	.3	.2	.25
	Waterways	500	400	1700
	People	0	275	275
2	Vegetation	.3	.2	.25
	Waterways	650	550	2000
	People	25	325	350
3	Vegetation	.3	.2	.25
	Water	800	700	2300
	People	50	350	400
4	Vegetation	.4	.3	.35
	Water	500	400	1700
	People	25	325	350
5	Vegetation	.4	.3	.35
	Water	650	550	2000
	People	50	350	400
6	Vegetation	.4	.3	.35
	Water	800	700	2300
	People	0	275	275
7	Vegetation	.5	.4	.45
	Water	500	400	1700
	People	50	350	400
8	Vegetation	.5	.4	.45
	Water	650	550	2000
	People	0	275	275
9	Vegetation	.5	.4	.45
	Water	800	700	2300
	People	25	325	350

between scales. In contrast, the scale differences identified by Van Bueren and Bennett (2001) involved comparisons between regional and national levels, while those identified by Bennett and Morrison (2001) involved comparisons between catchment and state levels. It is not unexpected that these starker differences in scale should be identified with different value estimates.

Although scale effects have not been identified in this study, it does not mean that differences do not exist. Indeed, the comparison of expected values in Table 16 does suggest that some differences in value may be present. What the results do suggest is that the scale differences may not be significant enough to affect some BT applications. Within the catchment, the value functions may be accurate enough for BT purposes. This transfer process may extend down as far as the level of individual off-stream storages, so that the value of environmental impacts may be assessed.

Table 16. Compensating surplus estimates for CNM & Dawson and Fitzroy

Scenario.	CNM & Dawson	Fitzroy[5]
1	-81.61	-1.69
	(-163.62, 1.18)	(-48.13, 41.80)
2	-83.49	-12.85
	(-164.39, -7.56)	(-55.09, 22.11)
3	-84.518	-18.14
	(-173.04, -10.28)	(-66.90, 15.36)
4	-98.05	-19.17
	(-178.45, -22.76)	(-61.25, 14.21)
5	-99.08	-24.46
	(-183.93, -28.14)	(-70.42, 8.50)
6	-52.02	11.31
	(-136.67, 22.91)	(-36.46, 51.58)
7	-113.64	-30.78
	(-136.59, -41.29)	(-81.76, 2.95)
8	-66.58	4.99
	(-140.93, -8.54)	(-42.22, 48.27)
9	-68.46	-6.00
	(-150.63, 4.97)	(-49.00, 31.08)

6.0 Conclusions.

In this paper, three different tests are reported that are relevant to benefit transfer issues. The first test focused on whether the same population viewed tradeoffs for two similar issues in the same way. This was tested by comparing the values that respondents from Brisbane had for floodplain protection in the Dawson and Comet-Nogoa-Mackenzien (CNM) catchments in Central Queensland. While the models were not shown to be equivalent, the part-worth tests showed the differences appear to be linked to one attribute that was given very different levels in the experiment. Where the attributes for the levels were broadly similar, there was no significant difference in the models. Importantly for benefit transfer purposes, the compensating surplus estimates for similar scenarios were not significantly different.

Two important conclusions can be drawn from these site tests. First, the transfer of point estimates (part-worths) from one location to another is not recommended if there is a large difference in the characteristics of the site. Second, the transfer of value functions is recommended, even if there is some differences between the sites (i.e. in one of the attributes).

The second test focused on whether different populations viewed the same tradeoff in similar ways. This was tested by comparing values held by Emerald, Rockhampton and Brisbane populations for floodplain protection in the Fitzroy basin. Emerald is an irrigation town in the upper Fitzroy catchment, Rockhampton is a regional centre at the mouth of the catchment, and Brisbane is the state capital some 700 kilometers to the south.

The results of the population test are mixed. The location parameter significance tests indicates that there is some difference between the Emerald and Rockhampton populations, and the compensating surplus tests indicates that there is some difference between the Brisbane population relative to the other two, but not between Emerald and Rockhampton. The part-worth tests suggest that these differences are focused on one or two attributes.

[5] The compensating surplus value calculated for the status quo option is -$11.42. The compensating surplus values for the scenarios can be compared to this to gain some idea of the value of the change.

The third test focused on whether values were related to the scale of the issue presented to respondents. The particular issue of interest was whether adding up values for sub-catchments estimated seperately would lead to higher values than if values were estimated for the river basin as a whole. This was tested by comparing values for the CNM and Dawson systems added together with the Fitzroy.

There was clearly a difference in one attribute (*Reserve*) which was insignificant in the Fitzroy model, but significant in the models for the two sub-catchments. This is because reserves are plentiful in the Fitzroy system as a whole, but much more limited in the two sub-catchments. When compensating surpluses were estimated for changes in the CNM and Dawson systems, and compared to equivalent changes in the Fitzroy, no statistical differences could be determined.

The conclusions to be drawn are there appears to be strong support for benefit transfer processes to continue. It is not appropriate to transfer point values where there are large differences between the sites for that attribute. Care has to be taken in extrapolating results across populations. Care should also be taken in extrapolating values across different scales. However, it does appear valid to transfer values between similar sites where there are not substantial bio-physical and policy differences. It may also be valid to disaggregate values within catchments where the differences in scale may not appear large to relevant populations. Transferring values across larger scales (ie from catchment to state level) would still be expected to invoke scale differences. The challenge for valuation practitioners is to identify where scale issues limit or influence the application of BT results.

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