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Scale and scope effects on communities' values for environmental improvements in the Namoi catchment: A choice modelling approach

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Abstract

This report presents results of research designed to investigate variations in willingness to pay (WTP) estimates across different scales and scopes of environmental investments. The goal is to help catchment management authorities better prioritise their natural resource management actions at both catchment and farm levels. Five split samples were used to test for scale and scope effects. A choice modelling (CM) analysis that involved the estimation of conditional logit was used to elicit household WTP for improvements in environmental quality attributes in the Namoi catchment. The approach was developed to facilitate the more accurate transfer of value estimates between different scopes of actions.

Key words: Choice modelling, Scale effect, Scope effect, Embedding, Non-market valuation, Catchment planning, Environment

1. Introduction

Prioritisation of natural resource management (NRM) investments is facilitated by an assessment of all the benefits and costs of potential projects. Due to a lack of markets for many environmental and social goods, the non-market benefits and costs produced are difficult to identify and can be ignored in policy decision making (Van-Bueren and Bennett, 2004). This, however, can lead to an inefficient use of resources. Therefore, a comprehensive cost benefit analysis (CBA) of NRM projects, by taking into account all marketed and non-marketed benefits and costs, will provide a more complete assessment of policy options.

A number of non-market valuation techniques can help to identify community preferences for alternative resource allocations and to estimate willingness to pay (WTP) for the potential environmental or social changes. Having identified the monetary values for all the benefits and costs, a comprehensive CBA can be conducted, providing a more complete set of information for prioritisation of NRM investments. Projects that generate increased net social benefits to society can be so identified.

NRM investment options often differ in geographical size and financial commitment. The environmental value estimates that are used in CBAs for NRM projects may be sourced from studies involving varying geographic contexts (e.g. farm, catchment, state or national level) or differing extents of the outcomes (e.g. improvement in 1km of river health or 1000km) (Bateman et al., 2006). This approach, however, may not be appropriate as the marginal value of the environmental goods involved can vary depending on the magnitude of change and the differing contexts. Reasons that could be responsible for these variations include: availability and number of substitute goods, socio-demographic and attitudinal characteristics of the recipients, and the different economic, political, social and environmental contexts of the good. Moreover, according to economic theory, marginal value diminishes with greater provision of a good. Hence, a linear function may not be the most appropriate to use in transferring values. Some adjustments or weights could be required if significant differences in levels of provision or contexts exist between sites. Analysis of the factors that cause these differences would add to the accuracy of transfers.

The overall aim of this research project is to estimate non-market values for different environmental improvements in NSW catchments to help catchment management authorities (CMAs) better prioritise their NRM investments. Management decisions require an assessment of these investments at both the catchment level (for broad planning purposes) and farm level (where the actual investments are directed) (Mazur and Bennett, 2008a). To conduct CBAs for NRM projects at different investment levels requires non-market values to be appropriate at those various contexts. However, the estimates obtained from catchment level valuation exercises are unlikely to be directly useful for farm level assessment and *vice versa*. A systematic framework for the transfer of environmental values between different contexts is required. Hence, the study reported in this Research Report involves a series of convergent validity tests to investigate the differences between catchment, sub-catchment and farm level value estimates.

The Choice Modelling (CM) technique was used to estimate people's preferences for environmental improvements in the case study context of the Namoi catchment in northwest NSW. CM is a survey-based, valuation method used to estimate the values associated with changes in different non-marketed goods (attributes) that describe the outcomes of different management options (Bennett and Blamey, 2001). A detailed description of the CM questionnaire design used for this study is included in Mazur and Bennett (2008b).

As reported by Mazur and Bennett, (2009b) the environmental value estimates for three NSW catchments (Namoi, Lachlan and Hawkesbury-Nepean) differ between rural and urban communities. Therefore, this study tests whether any detected responsiveness to different contexts varies between local/rural (Namoi) and distant/urban (Sydney) communities. The analysis of the effects of various policy contexts on value estimates allows the development of adjustment factors to improve the effectiveness and accuracy of value estimate transfer. These factors would allow the more extensive use of the study results as a guide for CMAs in the investment prioritisation process across NSW.

Based on the results of this study it is argued that the methodological approach used to develop transferable values between different contexts provides a more comprehensive and cost effective framework for environmental assessments.

This Report is constructed as follows: Section 2 defines the two types of framing effects considered: scale and scope effects. Section 3 describes the study design. Section 4 sets out the research hypotheses. Section 5 presents the CM methodology used. Section 6 describes the case study context. Section 7 outlines the questionnaire design procedure. Section 8 establishes the survey logistics. Section 9 documents the sample characteristics. Section 10 provides an analysis of the results to test the hypothesis. Section 11 shows the variations in scale and scope effects found across different communities. Section 12 describes the development of adjustment factors for the more accurate transfer of values between different scopes. The last section (13) presents some concluding comments.

2. Definitions of scope and scale

There are several definitions for scope and scale effects in the literature.

In neoclassical-economics, economies of **scale** refers to the relative size of production (of the same good) where cost advantages can be achieved due to production expansion (Gold, 1981, Tone and Sahoo, 2003, Sahoo et al., 1999). Scale thus refers to the quantity of output produced. The scale effect in non-market valuation exists when the total willingness to pay (TWTP) for a good increases with greater provision of that good (represented by higher levels of attributes). Theory also suggests that with greater provision of a good, marginal utility will decline. Hence, the TWTP may not increase linearly with the scale, but rather increases at a diminishing rate.

In neo-classical economic theory, **scope** refers to the variety of products (the number of goods) that are made by a single firm. The scope effect in a firm exists when the expansion of the variety of products reduces unit costs (Cheng and Wu, 2008, Sahoo and Tonea, 2003).

Similarly, the target of different environmental enhancement policies may involve various elements (attributes) to which the policy is to be applied, different sets of options and outcomes (alternatives) and different geographic settings (national, regional or local). All of these factors represent variations in scope. Hence, the scope effect exists when variations across these factors cause changes in estimated marginal willingness to pay (MWTP). Some factors relate to variations in the application of the value estimation method (methodological scope) while others involve different policies (policy scope).

Methodological scope therefore refers to the type of tradeoffs (number of attributes) or management options (number of alternatives) presented to respondents (Rolfe and Wang, 2008). Policy scope on the other hand refers, for example, to the extent of the target of the policy and could range from the national or regional to the local level. The varying geographical extent of the policy target region may set a different context (e.g. social, environmental, economic or political) where the priority settings are different to those used in the original or 'source' valuation study. A range of policy contexts may vary in the tradeoffs. For example, at a national level, particular environmental policies may affect a different set of attributes than at the regional level. The various geographical contexts of policies may also involve different magnitudes of the attributes used to describe each setting. These attributes may vary in the *status quo* conditions (the base level of each attribute investigated) and the proposed levels of improvements (ranges of the attribute levels). Where the scope effect relates to an increase in the geographical scope of a policy initiative (e.g. from the farm level to the regional level) the expectation is for the MWTP for the affected good to decline. This is consistent with neo-classical economic theory, when the expansion of the scope usually involves a wider range of substitute and complementary goods, therefore, the greater the scope the lower the value of an individual good. Hoehn and Randall (1989) and Hoehn (1991) provide a discussion of this theory in relation to the non-market goods.

3. Study design

The objective of this study is to test for geographical policy scope and scale effects. A split sample approach was used. Five split samples (see Table 1) across two locations were created to allow for a comparison between marginal values from three different scopes of the investment (10%, 50% and 100% of the catchment area) and to test for differences in the changes of the quantities of the provision of the good (scale) within each scope on TWTP.

Two subsets of the NSW population (households in Namoi and Sydney) were selected as the basis for estimating values for different scopes and scales of improvements in environmental quality in the Namoi catchment. Respondents in the Namoi catchment were asked about their preferences for improvements in environmental quality for the whole area of their own catchment (100% sub-sample) and on selected farms (10 percent of the catchment area). In order to check for any differences between the local/rural community (Namoi) and a distant/urban community, a sample of Sydney residents was also asked about their preferences for improvements in environmental quality on the whole, 50 percent and 10 percent of the Namoi catchment area.

Table 1. Research design and the study sub-samples

Questionnaires / **Sub-sample location**	**Namoi 100%**	**Namoi 50%**	**Namoi 10%**
Namoi	Local / rural		Local /rural
Sydney	Distant / urban	Distant / urban	Distant / urban

The *status quo* and change of attribute levels were adjusted according to different settings. For example, the attribute levels for the questionnaire framed at the whole catchment area (100% sub-sample) represented the possibilities that could occur as a result of proposed NRM policies at the whole catchment level. To reflect more realistic outcomes at the 50 and 10 percent of the catchment area contexts, the *status* *quo* and the change attribute levels were adjusted accordingly to the different scopes. Therefore, the levels of the attributes (including the *status quo* and the change levels) were reduced to 50 and 10 percent respectively of the whole catchment levels. Only the cost attribute levels remained constant across all three scopes (10%, 50% and 100%). For simplicity, homogeneity across the catchment was assumed.

4. Hypotheses

4.1 Scale test

HA: *The scale effect test involves observing if TWTP increases when more of any attributes' supply (q) increases within the same scope.*

The null hypothesis:

$$\mathbf{HA_0}\text{: if } \quad \Delta q > 0 \quad \text{then} \quad MWTP = 0$$

The alternative hypothesis:

$$\mathbf{HA_1}\text{: if } \quad \Delta q > 0 \quad \text{then} \quad MWTP > 0$$

The null hypothesis (HA_0) implies that an increase in quantity (Δq) of the good results in no change to TWTP (i.e. $MWTP=0$). The alternative hypothesis (HA_1) states that the TWTP increases with an increase in the provision of a good. Our prior expectation is that the HA_1 will not be rejected.

4.2 Scope test

The scope effect test looks for differences in the marginal values obtained under three different geographical policy scopes (100%, 50% and 10%). The effect of variations in the geographical scope is unavoidably confounded with changes in scale. For example, a larger scope (e.g. catchment level) involves a greater quantity of each attribute under the *status quo* than the smaller scope (e.g. farm level). The change in attribute levels is also greater. Therefore, different levels of geographic scope involve different quantities of attributes involved. As scope and scale are confounded it is difficult to determine whether changes in the scope or changes in levels of the attributes or both have an impact on the MWTP as scope is changed. Keeping one (scale of the attributes or geographic scope) constant and changing the other would result in implausible scenarios affecting the credibility of the study.

This study tests for the impact of changes in geographical policy scopes noting that commensurate changes in the scale of the attributes is a component of the overall scope impact.

The following hypotheses were formulated for testing:

HB: *Test for the impact of different scopes on MWTP*

The null hypothesis:

$\mathbf{HB_0}$: $MWTP^{100} = MWTP^{50} = MWTP^{10}$

The alternative hypothesis:

$\mathbf{HB_1}$: $MWTP^{100} < MWTP^{50} < MWTP^{10}$

The null hypothesis (HB_0) implies that the MWTPs for improvements in each attribute obtained from questionnaires framed at different scopes (10%, 50% and 100%) are equal across the different scopes. The alternative hypothesis (HB_1) states that the MWTPs decline as the scope increases. Our prior expectation is that the HB_1 will not be rejected.

HC: *Test for differences in the ratios of MWTPs for 10% and 100% between different community types (WTP_S – obtained from the Sydney sub-samples, WTP_N – obtained from the Namoi sub-samples)*

The null hypothesis:

HC_0:
$$\frac{WTP_S^{10}}{WTP_S^{100}} = \frac{WTP_N^{10}}{WTP_N^{100}}$$

The alternative hypothesis:

HC_1:
$$\frac{WTP_S^{10}}{WTP_S^{100}} \neq \frac{WTP_N^{10}}{WTP_N^{100}}$$

Based on the location theory preferences differ with the distance or relative location from the good. Therefore, the null hypothesis (HC_0) implies that the difference in MWTP for improvements in each attribute obtained from questionnaires framed at different scopes (100% or 10%) is the same between different community types. The alternative hypothesis (HC_1) states that the difference in MWTP between various scopes varies between local-rural and distant-urban communities. Our prior expectation is that the HC_1 will not be rejected.

5. Methodology

Conditional logit (CL) models were estimated using Limdep (version 4.0) software. The CL format provides the probability of an individual *n* choosing alternative *a* over alternative *j* as a function of attributes that describe each alternative:

$$P_{an} = \frac{\exp(x_{an}\beta)}{\sum_{J \in C_n} \exp(x_{an}\beta)} \quad \textbf{\textit{(1)}}$$

where x_{an} is a vector of attributes a and individual characteristics n, β is vector of parameters, J is a choice set that consists of the C_n choice set faced by each individual n.

The first CL models used in this analysis were attributes-only models. The equations for these models are:

$$U(A)=\beta_1 costs+\beta_2 NV+\beta_3 NS+\beta_4 HW+\beta_5 PA \quad (2)$$
$$U(B)=ASC+\beta_1 costs+\beta_2 NV+\beta_3 NS+\beta_4 HW+\beta_5 PA$$
$$U(C)=ASC+\beta_1 costs+\beta_2 NV+\beta_3 NS+\beta_4 HW+\beta_5 PA$$

where:
A - *Status quo* option
B and C - change options
β - estimated coefficients
ASC - alternative specific constant

Attributes:
NV - km^2 of native vegetation in good condition
NS - number of native species
HW - km of healthy waterways
PA - number of people working in agriculture

The *status quo* level was treated as the constant base for each attribute. Therefore, the differences in choice probabilities between the *status quo* and a specific option with different attribute levels were expressed in the estimated model parameters. All parameters used in the models are generic.

In order to account for preference heterogeneity, CL models with socio-economic and attitudinal variables ('full model') were estimated. Socio-economic characteristics such as age, education, income, gender, number of children, association with agricultural industry and association with environmental organisations were included in the CL full models by interacting them with the ASC.

The standard assumption of the CL model is that the ε term is an independently and identically distributed (IID) Gumbel random variable (McFadden, 1974). ε_{an} is the stochastic, unobserved component of utility associated with option *a* and consumer *n*. According to the IIA assumption, the inclusion of an irrelevant alternative in a choice set has no impact on the probability of the selection of a particular alternative by the respondent. This assumption can be violated and in such cases a different assumption regarding the stochastic term needs to be made, necessitating the use of alternative models including random parameter logit (RPL).

Willingness to pay for changes in each attribute level (i.e. MWTP) were calculated by dividing the β coefficients of the attributes (NV, NS, HW, and PA) by the β coefficient of the cost parameter and multiplying by *-1*.

$$\text{IP}=-1\left(\frac{\beta_{\text{attribute}}}{\beta_{\text{cost}}}\right) \qquad (3)$$

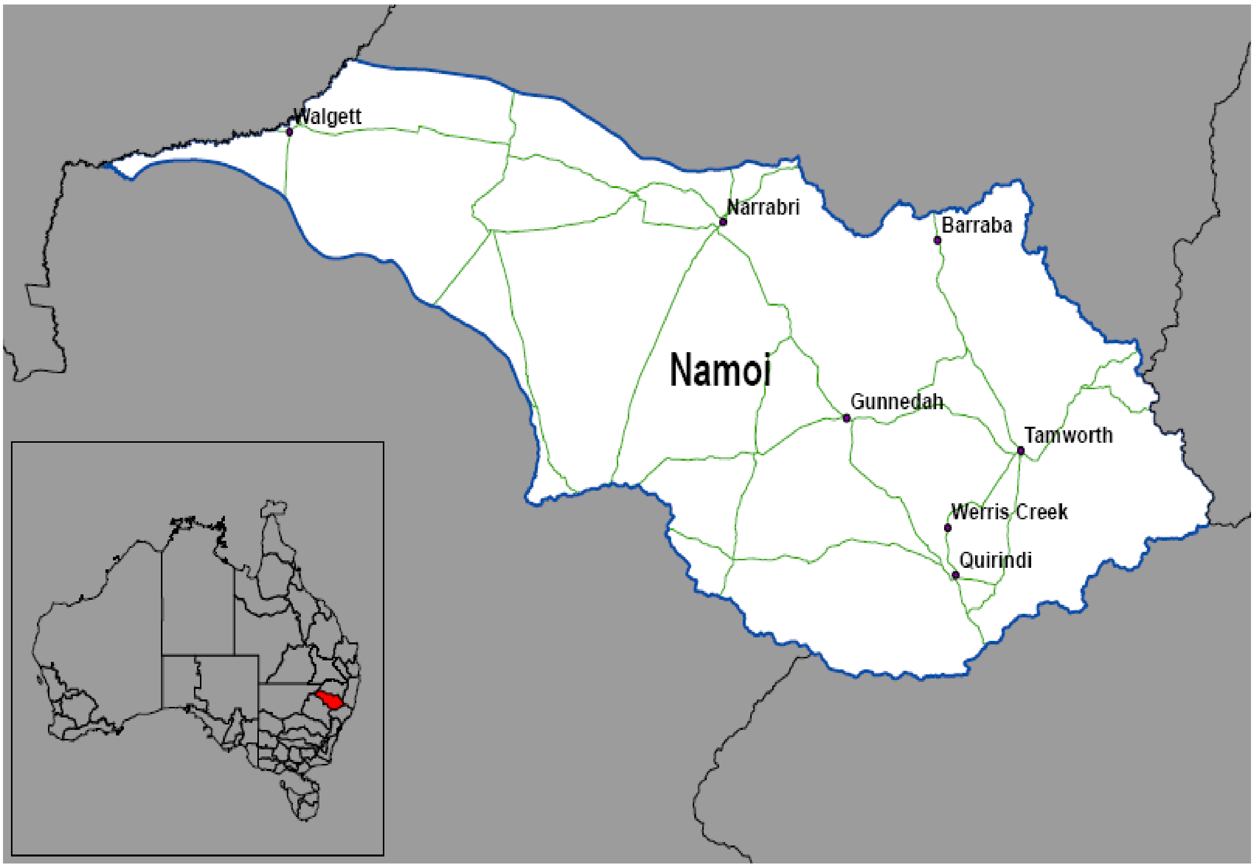
6. Case study

The Namoi catchment (see Figure 1) was chosen as a case study for the scale and scope effects tests. The Namoi catchment covers 42,000km^2 and 100,000 people live in this catchment. About nine percent of the catchment area is devoted to agriculture with a majority of area used for grazing. Native vegetation covers about 30 percent of the catchment area and national parks occupy less than five percent.

The main environmental issues in the Namoi catchment include declining biodiversity, loss of native vegetation and reduced water quality. The area of native vegetation of good quality has declined by about 95 percent since pre-European settlement. Water quality has declined in 80 percent of the total waterways in the catchment. Currently about 20 percent of the waterways in the Namoi catchment are of good enough quality for drinking, swimming and fishing. The number of native species in the Namoi catchment is 2,130 of which 93 are endangered or vulnerable.

Planting more trees, protecting existing vegetation, fencing and revegetating river banks and wetlands, pest and weed control are just some of the NRM actions that could improve environmental quality in the catchment. More information about the Namoi's characteristics is included in Mazur and Bennett (2009a).

Figure 1. The Namoi catchment.



7. Questionnaire development

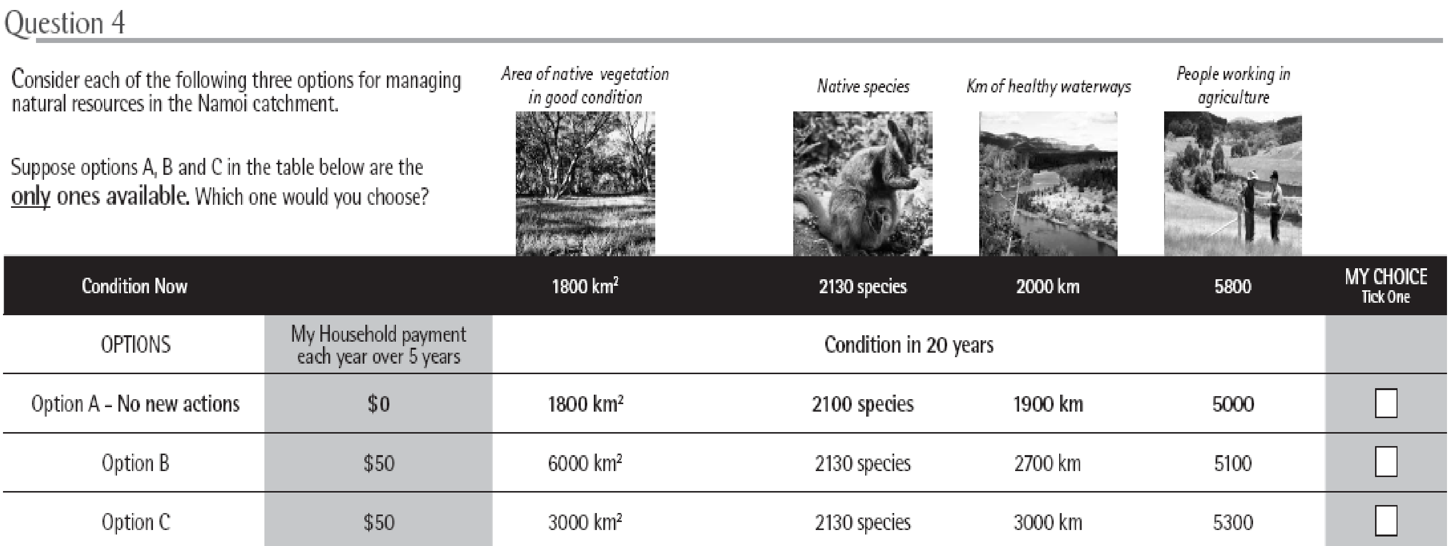
To test the hypothesis, three different questionnaires were developed involving three different contexts (100%, 50% and 10% of the catchment area). The attributes and their current and potential future levels used in the questionnaire framed at 100 percent of the catchment area were determined through consultations with policy makers and NRM specialists. Further consultations and verifications of a draft questionnaire were undertaken during four focus group discussions (for more details see Mazur and Bennett, 2008b).

Three attributes that represent the main potential environmental benefits derived from NRM investments in the three catchments were used: area of native vegetation in good condition (NV), kilometres of healthy waterways (HW), and number of native species (NS). One additional attribute - people working in agriculture (PA) - was chosen to capture the social consequences of changes in NRM actions. The fifth attribute was a monetary cost. The annual payment to be made by respondents for new NRM actions was specified to continue for five years. The payment vehicle was described as a mixture of increased taxes, council rates, prices and recreational charges. Three different levels of each attribute in each questionnaire type were determined and used in an orthogonal, main effects experimental design to structure the choice sets used in the questionnaires. The ranges of the attribute levels for each of the three types of questionnaires are set out in Table 2. The 25 choice alternatives were randomly blocked into five different questionnaire versions, each with five choice sets for the three different context variants of the questionnaire (10%, 50% and 100%). This resulted in 15 different versions of the questionnaire. Two change options and a *status quo* option were included in each choice set. Examples of choice sets for 100%, 50% and 10% improvements in the catchment area are presented in Figure 2, 3 and 4.

Table 2. Attributes and their levels

	Cost	NV	NS	HW	PA
Namoi (100% sub-sample)					
Condition now		**1800**	**2130**	**2000**	**5800**
Status quo	**$0**	**1800**	**2100**	**1900**	**5000**
Outcomes in 20 years time	$50	3000	2110	2300	5100
	$200	5000	2120	2700	5200
	$300	6000	2130	3000	5300
Namoi (50% sub-sample)					
Condition now		**900**	**1065**	**1000**	**2900**
Status quo	**$0**	**900**	**1050**	**950**	**2500**
Outcomes in 20 years time	$50	1500	1050	1150	2550
	$200	2500	1060	1350	2600
	$300	3000	1065	1500	2650
Namoi (10% sub-sample)					
Condition now		**180**	**213**	**200**	**580**
Status quo	**$0**	**180**	**210**	**190**	**500**
Outcomes in 20 years time	$50	300	211	230	510
	$200	500	212	270	520
	$300	600	213	300	530

Figure 2. Example of a choice set for the Namoi catchment questionnaire



Question 4

Consider each of the following three options for managing natural resources in the Namoi catchment.

Suppose options A, B and C in the table below are the only ones available. Which one would you choose?

		Area of native vegetation in good condition	Native species	Km of healthy waterways	People working in agriculture	
Condition Now		1800 km²	2130 species	2000 km	5800	MY CHOICE Tick One
OPTIONS	My Household payment each year over 5 years	Condition in 20 years				
Option A – No new actions	$0	1800 km²	2100 species	1900 km	5000	☐
Option B	$50	6000 km²	2130 species	2700 km	5100	☐
Option C	$50	3000 km²	2130 species	3000 km	5300	☐

Figure 3. Example of a choice set for the 50% of the Namoi catchment questionnaire

Question 4

Consider each of the following three options for managing natural resources in parts of the Namoi catchment.

Suppose options A, B and C in the table below are the <u>only</u> **ones available.** Which one would you choose?

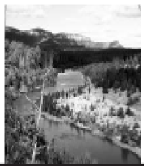
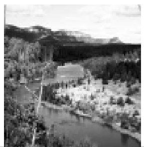
		Area of native vegetation in good condition	*Native species*	*Km of healthy waterways*	*People working in agriculture*	
						
Condition Now		**900 km²**	**1065 species**	**1000 km**	**2900**	**MY CHOICE** Tick One
OPTIONS	My Household payment each year over 5 years	Condition in 20 years				
Option A - No new actions	$0	900 km²	1050 species	950 km	2500	☐
Option B	$50	1500 km²	1055 species	1150 km	2600	☐
Option C	$200	3000 km²	1060 species	1500 km	2600	☐

Figure 4. Example of a choice set for the 10% of the Namoi catchment questionnaire

Question 4

Consider each of the following three options for managing natural resources on selected farms in the Namoi catchment.

Suppose options A, B and C in the table below are the <u>only</u> **ones available.** Which one would you choose?

		Area of native vegetation in good condition	*Native species*	*Km of healthy waterways*	*People working in agriculture*	
						
Condition Now		**180 km²**	**213 species**	**200 km**	**580**	**MY CHOICE** Tick One
OPTIONS	My Household payment each year over 5 years	Condition in 20 years				
Option A - No new actions	$0	180 km²	210 species	190 km	500	☐
Option B	$50	300 km²	211 species	230 km	520	☐
Option C	$200	600 km²	212 species	300 km	520	☐

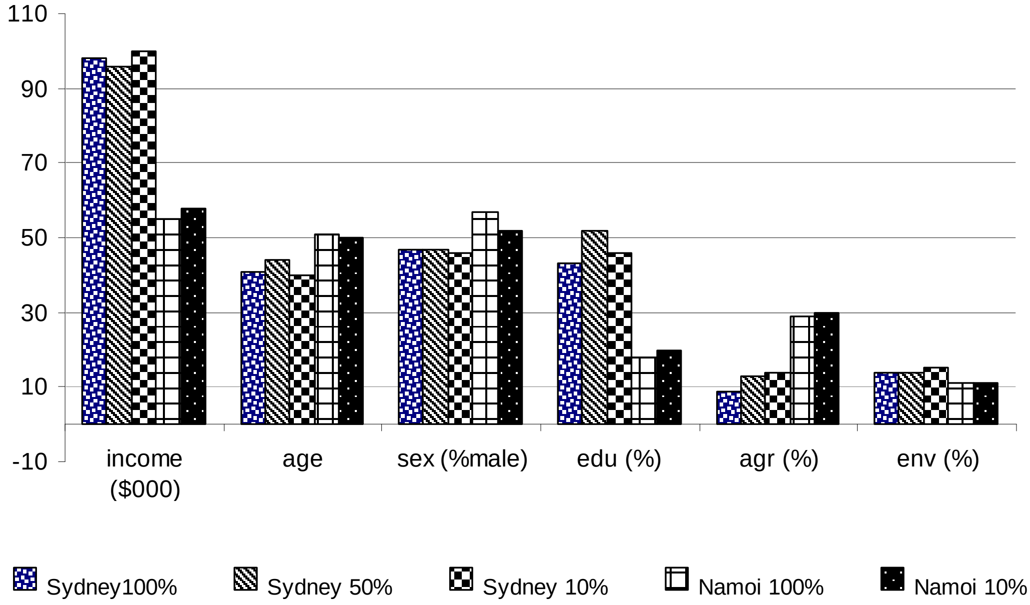
8. Survey Logistics

A drop-off/pick-up approach for the distribution of the questionnaire was used. Questionnaires were distributed in two main towns in the Namoi catchment (Tamworth and Gunnedah) and in Sydney. Geographically stratified random sampling was applied to choose the households to ensure a representation of the NSW population in terms of gender, age, income etc. A more detailed description about the sampling procedure is included in Mazur and Bennett (2009a)

9. Sample characteristics

The socio-economic characteristics of the sub-samples are presented in Figure 5.

Figure 5. Descriptive statistics of the sub-samples from the Namoi catchment and Sydney.



Note: income- $000 household annual income, edu – represents respondents with tertiary degree and above, agr- represents association with agricultural industry of the respondents and their close family, env- represents association with environmental organisations of the respondents and their close family. Sydney 100% - the questionnaire framed at the whole catchment area tested in Sydney, Sydney 50% - the questionnaire framed at the half of the catchment area tested in Sydney, Sydney 10% - the questionnaire framed at the 10 percent of the catchment area (farm level) tested in Sydney, Namoi 100% - the questionnaire framed at the whole catchment area tested in the Namoi catchment, Namoi 10% - the questionnaire framed at the 10 percent of the catchment area (farm level) tested in the Namoi catchment.

A comparison of the socio-economic characteristics of the sub-samples with ABS (2006) Census data was undertaken. The χ^2 test was used to compare the distribution of age, income and education level between the sub-samples against the Census data.

No significant differences in household size and the age distribution between the samples and the ABS census data were found. However, the distribution of educational level was significantly different for all the sub-samples[1] (Sydney 100% χ^2 =74.23, Sydney 50% χ^2 =88.55, Sydney 10% χ^2 =64.16, Namoi 100% (χ^2 =91.84, Namoi 10% χ^2 =68.44). The proportion of people with a tertiary degree was higher in the study sub-samples than recorded by the ABS census.

The income ranges presented in the questionnaire were consistent with ABS household ranges presented in the 2006 Census. No significant differences[2] between the sub-samples and Census income were recorded in Namoi 10% sub-sample (χ^2=11.02), Namoi 100% sub-sample (χ^2=16.46) and Sydney 50% (χ^2=16.20). Significant differences in the distribution of income were found between the relevant populations and Sydney (100% χ^2 =38.33, 10% χ^2 =36.55) sub-samples.

The comparison of the socio-demographic characteristics between the sub-samples indicates that there were no significant differences between sub-samples drawn from the same population.

10. Results

In total, 1302 responses provided 6,510 choice observations from the five sub-samples. Out of the 6,510 choice sets about three percent were not answered. In about 34 percent of the choice sets, the *status quo* option was chosen. This percentage was consistent across all sub-samples.

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[1] The critical χ^2 = 11.07 at 0.05 level with 5 dof.

[2] The critical χ^2 = 22.36 at 0.05 level with 13 dof.

10.1 The models

The choice models estimated for each sub-sample are presented in Tables 4 to 6. In this study the conditional logit (CL) model was used. The pseudo R^2 for most of the CL full models were around the ten percent level which is acceptable for this type of data (Louviere et al., 2000). The values of the χ^2 statistics for the CL full models show that gains in model fit were obtained by accounting for heterogeneity in preferences.

The ASC (coded as 1 for the change options) was negative and significant for most of the sub-samples. This implies that respondents systematically prefer the *status quo* option over the change options. The insignificant ASC for the local Namoi 100% sub-sample suggests that there is no systematic favouring by respondents of the *status quo*.

The results show that for all the split samples, the signs of the model parameters are in accordance with *a priori* expectations. All the environmental attribute parameter coefficients have positive signs which mean that those NRM scenarios which result in higher levels of any single attribute are preferred. The cost coefficient was negative and significant for all the models. The significance of the attributes varied between different scales and community types.

Hausman tests showed that there were breaches in the IIA assumption in most of the CL-attributes-only models. However, full CL models resulted in no violation of the IIA assumption at the five percent level of significance for four out of five sub-samples. To address the violation of the IIA assumption for the questionnaire, the RPL model Sydney 10% was tested. However, the model fit improvement was achieved and the results were not significantly different. Therefore for consistency the full CL model was used for further analysis in all the split-samples.

Table 3. Variables used in the Choice Models

ASC	alternative specific constant
NV	km^2 of native vegetation in good condition
NS	number of native species
HW	km of healthy waterways
PA	number of people working in agriculture
COST	cost of choice alternative ($ pa per household over 5 years)
ASCAGE	respondent age x ASC
ASCEDU	respondent education status (1=with tertiary degree) x ASC
ASCINCOME	respondent household income ($000) x ASC
ASCGENDER	respondent gender (1= female) x ASC
ASCCHILDERN	respondent children (1= with children) x ASC
ASCENV	respondent association with environmental organisation (1=associated) x ASC
ASCAGR	respondent association with agricultural industry (1=associated) x ASC

Table 4. Results of CL models for 100% sub-samples.

Sub-samples	Local/rural Survey conducted in Namoi			Distant/urban Survey conducted in Sydney		
	CL AO▲	CL full	Quadratic	CL AO▲	CL full	Quadratic
ASC	-.0003	.7449	.2752	.3552	-3.1315***	-4.5265***
	(.2666)	(.6281)	(.9914)	(.2687)	(.7019)	(1.0584)
COST	-.0051***	-.0054***	-.0052***	-.0068***	-.0065***	-.0062***
	(0004)	(.0005)	(.0005)	(.0004)	(.0006)	(.0006)
NV	.5530D-0	.6305D-04*	.0003	.9140D-04***	.0001***	.0007**
	(.349D-04)	(.392D-04)	(.0003)	(.364D-04)	(.464D-04)	(.0003)
NS	.0121**	.0133**	.1127***	.0125**	0156**	.0831
	(.0054)	(.0061)	(.0454)	(.0058)	(.0073)	(.0529)
HW	.0005***	.0006***	-.0027**	.8099D-04	.772D-04	-.0003
	(.0002)	(.0002)	(.0013)	(.0001)	(.0002)	(.0016)
PA	.0009**	.0008	.0078*	.0005	.0012*	.0075*
	(.0005)	(.0006)	(.0043)	(.0006)	(.0007)	(.0005)
ASCAGE		-.0056	-.0056		.0107*	.0105*
		(.0048)	(.0048)		(.0060)	(.006)
ASCEDU		-.0683*	-.0717**		.1446***	.1440***
		(.0375)	(.0375)		(.0407)	(.0408)
ASCINCOM		.010***	.010***		.0047***	.0047***
		(.002)	(.002)		(.0017)	(.0017)
ASCGENDE		-.2233	-.2221		-.1680	-.1713
		(.1562)	(.1564)		(.1725)	(.1726)
ASCCHILDR		-.1348	-.1268		.0897	.0991
		(.2116)	(.2119)		(.1972)	(.1975)
ASCENV		1.0290***	1.0437***		1.0137***	1.0225***
		(.3170)	(.3167)		(.2698)	(.2702)
ASCAGR		.8962***	.8925***		1.5529***	1.5628***
		(.1869)	(.1868)		(.4240)	(.4252)
NV^2			-.3791D-07			-.9829D-07
			(.5642D-07)			(.6496d-07)
NS^2			-.0024**			-.0017
			(.0011)			(.0013)
HW^2			.2173D-05***			.2281D-06
			(.8868D-06)			(.1054D-06)
PA^2			-.1788D-04*			-.1572D-06
			(.1075D-04)			(.1266D-06)
Pseudo R2	0.05262	0.09119	0.09653	0.09044	0.13422	0.13697
Log likelihood	-1307.570	-984.9534	-979.1676	-1239.520	-731.0136	-728.6910
D.F.O	6	13	17	6	13	17
Chi^2(critical Chi^2 in brackets)	145.2460	197.6532	209.2248	246.5000	226.64760	231.29280
	(9.4877)	(16.9190)	(24.9958)	(9.4877)	(16.9190)	(24.9958)
Observations	1263	999	999	1245	769	769

Notes: Significance levels indicated by: * 0.1, **0.05, ***0.01, standard errors in brackets
▲CL Attributes only model

Table 5. Results of CL models for 50% sub-samples.

Sub-samples		**Distant/urban**	
		Survey conducted in Sydney	
	CL AO▲	CL with interactions	Quadratic model
ASC	-.1319 (.2569)	-5.2769*** (.6887)	-5.4195 *** (.9762)
COST	-.0049*** (.0004)	-0056*** (.0006)	-.0057 *** (.0006)
NV	.0002*** (.7068D-04)	.0003*** (.8963D-04)	.0008 (.0011)
NS	.0213** (.0107)	.0326** (.0136)	-.0263 (.0982)
HW	.0012*** (.0003)	.0016*** (.0004)	.0068 (.0106)
PA	.8545D-04 (.0011)	.0006 (.0014)	.0067 (.0014)
ASCAGE		.0318*** (.0062)	.0317*** (.0063)
ASCEDU		0.2369*** (.0357)	.2373*** (.0358)
ASCINCOME		.0017 (.0016)	.0016 (.0016)
ASCGENDER		1.0318*** (.1816)	1.0305*** (.1818)
ASCCHILDREN		-.5918*** (.2218)	-.5900*** (.2221)
ASCENV		- .0328 (.2948)	-.0297 (.2949)
ASCAGR		.5873* (.3248)	.5900* (.3251)
NV^2			-.1074 (.2467D-06)
NS^2			.0030 (.0049)
HW^2			-.1921D-05 (.3985D-05)
Pseudo R2	0.04718	0.13614	0.13659
Log likelihood	-1306.474	-754.3050	-753.9072
D.F.O	6	13	16
Chi^2(critical Chi^2 in brackets)	129.39 (9.4877)	237.75 (21.0261)	238.54200 (24.9957)
Observations	1260	807	807

Notes: Significance levels indicated by: * 0.1, **0.05, ***0.01, standard errors in brackets

▲CL Attributes only model

Table 6. Results of CL and RP models for 10% sub-samples.

Sub-samples	Local/rural			Distant/urban		
	Survey conducted in Namoi			Survey conducted in Sydney		
	CL AO▲	CL full	Quadratic	CL AO▲	CL full	Quadratic
ASC	-.0143	-2.3749***	-3.0434***	-.1356	-2.4273***	-2.0769**
	(.2478)	(.6302)	(.8981)	(.2809)	(.6766)	(1.0570)
COST	-.0052***	-.0058***	-.0058***	-.0051***	-.0043***	-.0043***
	(.0004)	(.0005)	(.0005)	(.0004)	(.0006)	(.0006)
NV	.0007**	.0008**	.0004	.0005	.0010**	.003
	(.0003)	(.0004)	(.0005)	(.0004)	(.0005)	(.0007)
NS	.0376	.0530	.228	.1272**	.1434**	.1248
	(.0522)	(.0593)	(.1181)	(.0576)	(.0730)	(.1466)
HW	.0057***	.0057***	.0065**	.0029*	.0036*	.0013
	(.0014)	(.0016)	(.0031)	(.0016)	(.0021)	(.0039)
PA	.0182***	.0178***	.0433***	-.0002	.0042	.0157
	(.0053)	(.0060)	(.0120)	(.0058)	(.0073)	(.0144)
ASCAGE		.0073	.0073		.0041	.0039
		(.0047)	(.0047)		(.0064)	(.0064)
ASCEDU		.1455***	.1458***		.0651**	.0648
		(.0367)	(.0367)		(.0330)	(.0330)
ASCINCOME		.005***	.005**		.0048***	.0048***
		(.002)	(.002)		(.0015)	(.0015)
ASCGENDER		.6254***	. 6209***		-.1425	-.1382
		(.1514)	(.1515)		(.1684)	(.1687)
ASCCHILD		-.4577**	-.4551**		.5680***	.5692***
		(.2085)	(.2087)		(.2028)	(.2030)
ASCENV		.4781	.4699		.0332	.0329
		(.3035)	(.3035)		(.2817)	(.2817)
ASCAGR		.3625**	.3658**		.5351*	.5352
		(.1771)	(.1774)		(.2861)	(.2863)
NV^2			.0717			.1219
			(.0812)			(.0979)
NS^2			.0310			.2270
			(.1045)			(.1274)
HW^2			-.0298			.0807
			(.0921)			(.1131)
PA^2			-.2531***			-.1176
			(.1057)			(.1271)
Pseudo R2	0.06021	0.09828	0.10176	0.04488	0.06316	0.06524
D.F.O	6	13	17	6	13	17
Log likelihood	-1366.79	-1029.90	-1025.920	-1245.97	-735.76	-734.13
Chi^2(critical Chi^2 in brackets)	175.14	224.49	232.45	226.73	154.48	102.47
	(9.4877)	(16.9190)	(24.9958)	(14.0671)	(41.3371)	(24.9958)
Observations	1330	1053	1053	1224	724	724

Notes: Significance levels indicated by: * 0.1, **0.05, ***0.01, standard errors in brackets

▲CL Attributes only model

10.2 Implicit Prices

The full CL models were used to calculate MWTP. The 95 precent confidence intervals (CI) for the MWTP estimates using a bootstrapping procedure (Krinsky and Robb, 1986). A vector of 1000 sets of parameters was drawn for each attribute from the covariance matrix for each sub-sample.

Table 7. The mean annual household's MWTP from the different sub-samples.

Location	Sydney			Namoi	
Scope	**10%**	**50%**	**100%**	**10%**	**100%**
NV	**$0.24****	**$0.06*****	**$0.02*****	**$0.13****	**$0.01**
	(0.03 ~ 0.49)	(0.03 ~ 0.10)	(0.01 ~ 0.04)	(0.00 ~ 0.26)	(0.00 ~ 0.03)
NS	**$33.13***	**$5.79****	**$2.43****	**$9.33**	**$2.50****
	(-.84 ~ 67.09)	(0.96 ~ 11.19)	(0.23 ~ 4.64)	(-12.16 ~ 28.82)	(0.24 ~ 4.75)
HW	**$0.83***	**$0.29*****	**$0.01**	**$0.98*****	**$0.11*****
	(-0.12 ~ 1.90)	(0.15~ 0.44)	(-0.05 ~ 0.07)	(0.42 ~ 1.57)	(0.05 ~ 0.18)
PA	**$0.97**	**$0.11**	**$0.19***	**$3.02*****	**$0.15**
	(-2.36 ~ 4.53)	(-0.38 ~ 0.57)	(-0.03 ~ 0.41)	(1.09 ~ 5.24)	(-0.07 ~ 0.37)

Notes: Significance levels indicated by: * 0.1, **0.05, ***0.01, 95% CI in brackets calculated using a bootstrapping (Krinsky and Robb, 1986)

10.3 Hypothesis testing

10.3.1 Scale test

The positive signs of the coefficients and statistical significance (see tables 4, 5 and 6) for the majority of the non-market attributes suggest that respondents have positive MWTP for the higher provision of NV, NS and HW. Only the PA attribute coefficient is not significantly different from zero in the majority of sub-samples. Hence, as the TWTP increases with the amount of the provision of the environmental attributes observed within each scope (10%, 50% and 100%) it can be concluded that the scale test was passed. Therefore, the hypothesis HA_1 is accepted and the null hypothesis HA_0 is rejected implying a scale effect.

While respondents were found to be willing to pay in total more for higher amounts of the good provided, the increase may be diminishing due to diminishing marginal utility (DMU). In order to test for DMU a quadratic form utility function was modelled. In the quadratic model all attributes and their squares were included. For the significant attributes the outcomes of the quadratic models show that utilities for NS, HW and PA at the whole catchment scope in the Namoi sub-sample are increasing at a diminishing rate (see Table 4). The quadratic terms are not significant for other significant attributes indicating that the marginal utility of these attributes is constant (at least over the range of levels examined here). This finding suggests that DMU is observed for the biggest scope where the levels of the attributes were also larger. At the small scope (10% sub-samples) where the attributes were also ten times smaller than at the catchment scope the DMU is not observed.

10.3.2 Scope test

In order to perform the hypotheses tests for the scope effect, it was necessary to identify whether the differences between the estimated MWTP of the attributes across the different sub-samples are statistically significant. The Poe et al. (1994) test was used to compare MWTP between different sub-samples. The Krinsky and Robb (1981) bootstrapping procedure was used to simulate the distribution of each MWTP by using 1000 random draws. Using these random draws, the distributions of MWTP differences between sub-samples pairs were compared. This process was repeated 100 times for each pair of MWTP in order to generate the average proportion of differences where the differences are greater than zero. The results of the Poe et al. (1994) test are presented in Table 8.

Table 8. Test for the equivalence between MWTP obtained from different scopes

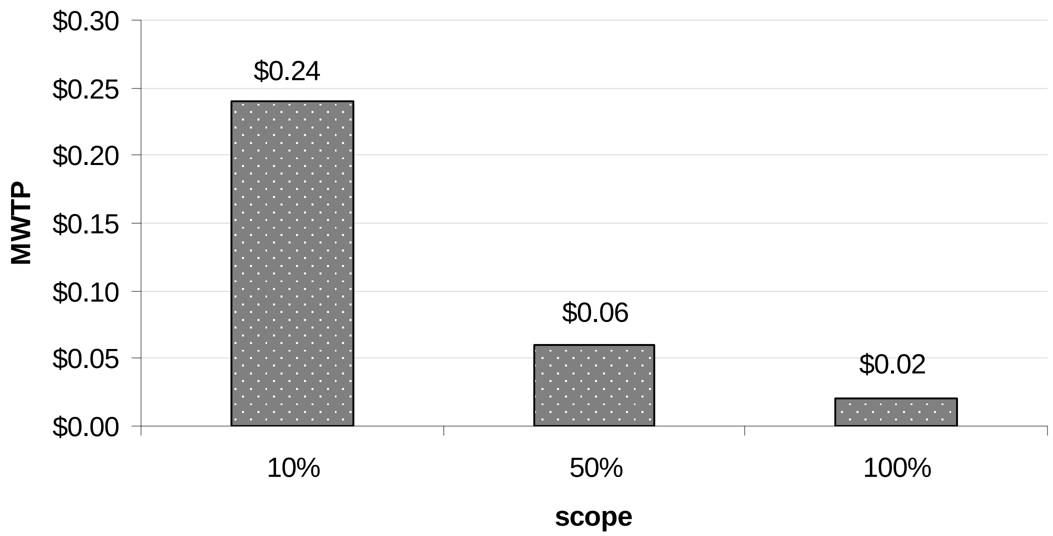
Sub-sample	Equivalence between:	NV p-value	NS p-value	HW p-value	PA p-value
Namoi	$MWTP^{10} - MWTP^{100} > 0$	0.03298	0.25262	0.00223	0.00454
Sydney	$MWTP^{10} - MWTP^{100} > 0$	0.02314	0.04052	0.05253	0.35114
	$MWTP^{50} - MWTP^{100} > 0$	0.01833	0.10506	0.00005	0.62926
	$MWTP^{10} - MWTP^{50} > 0$	0.05547	0.05619	0.14113	0.33487

Note: Two tile test.

Sydney sub-samples

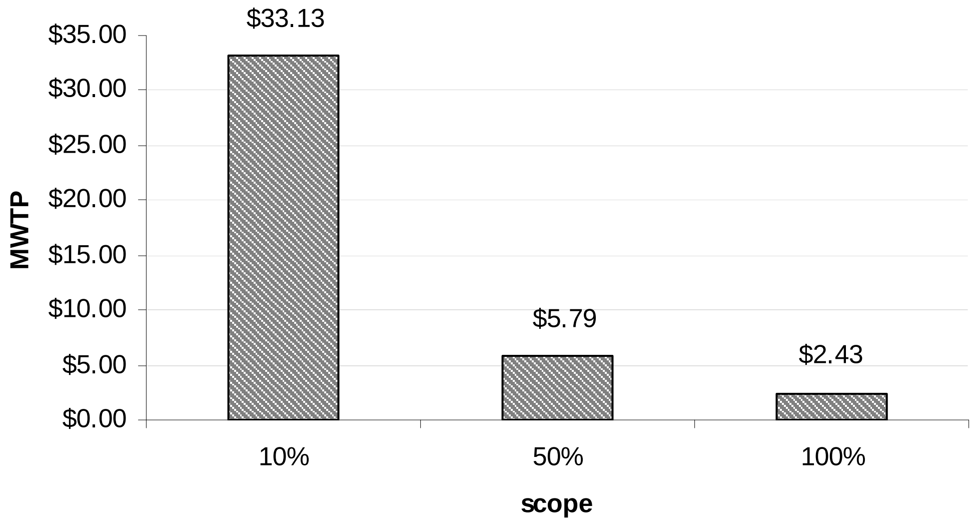
In the Sydney sub-sample the Poe et al. (1994) test showed significant differences (at the 10 percent level) in MWTP for the NV attribute between the values obtained from the 100% sub-sample and the other two sub-samples (10% and 50%) (see Figure 6). The mean MWTP for the attributes at the 100% and 50% sub-samples indicate that Sydney respondents value the improvement in one square kilometre of NV in the whole catchment ($0.02) significantly lower (at the 5 percent level) than an improvement in one square kilometre in NV on the 50% sub-sample ($0.06) and 10% sub-sample ($0.24). There was no significant difference (at the 10 percent level) in NV values between the 50% sub-sample and the 10% sub-sample but a significant difference exists at the 11 percent level.

Figure 6. The MWTP for NV per Sydney respondent household.



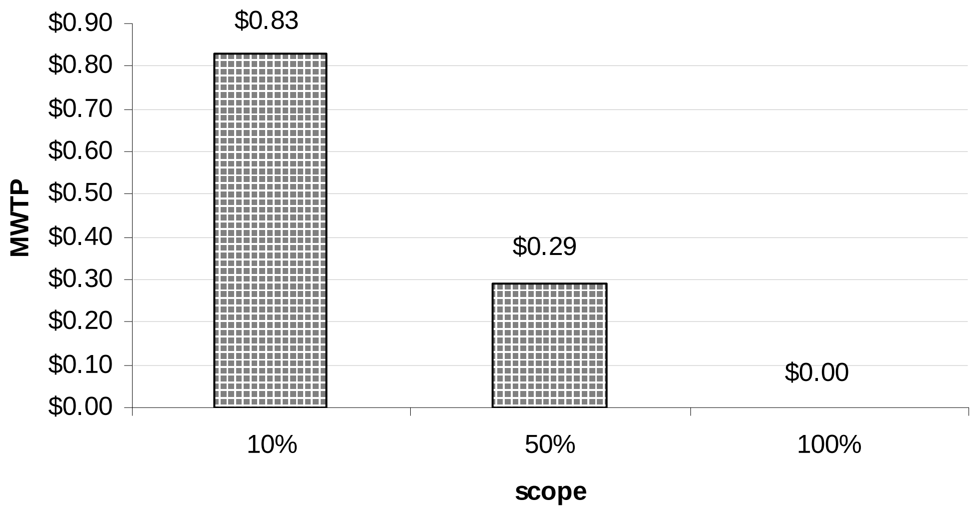
The Poe et al. (1994) test of Sydney sub-samples did not show a significant difference in MWTP for NS between the 50% and 100% sub-samples and between 10% and 50% sub-sample (see Figure 7). The value for the increase in one NS at the 10% sub-sample ($33.13) was significantly different at the 11 percent level from the value ($2.43) for NS obtained from the whole catchment scope but no significant difference was observed at the 10 percent level.

Figure 7. The MWTP for NS per Sydney respondent household.



In the Sydney sub-samples the HW attribute was significant for the 50% sub-sample ($0.26) and the 10% sub-sample ($0.83) however it was insignificant for the 100% sub-sample (ie=$0) (see Figure 8). There were also no significant differences in MWTP for HW between 50% and 10% sub-samples. There were however significant differences in MWTP for this attribute between 100% and 10% sub-samples (at the 10 percent level) and also 100% and 50% sub-samples (at the 5 percent level).

Figure 8. The MWTP for HW per Sydney respondent household.



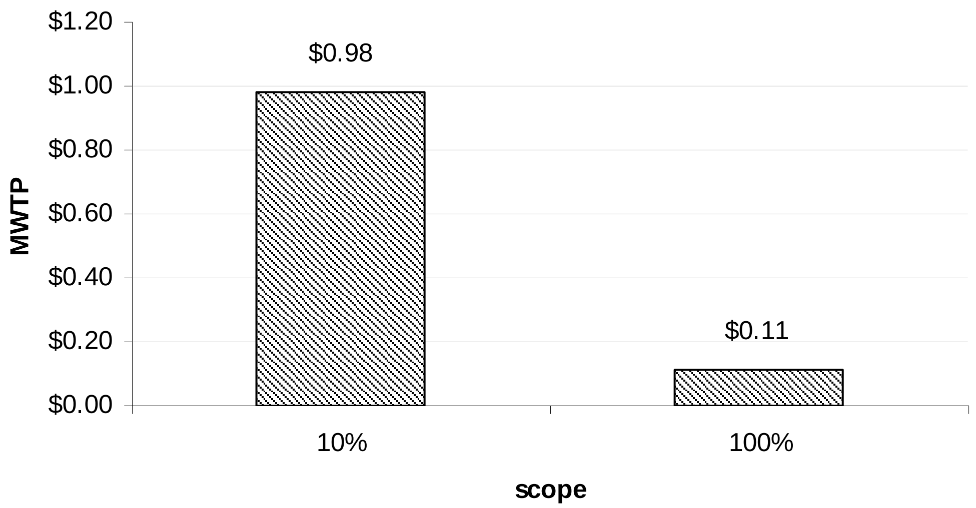
PA was only significant at the catchment scope but there were no significant (at 10 percent level) differences for this attribute between scopes in the Sydney sub-samples.

Therefore, in the Sydney sub-samples the hypothesis HB_0 is accepted for the PA attribute. For the HW and the NS the hypothesis HB_0 is partially accepted and for NV HB_0 is rejected.

Namoi sub-samples

In the Namoi catchment sub-samples the Poe et al. (1994) test shows a significant (at the 10 percent level) difference in the MWTP for HW, NV and PA between the two sub-samples (100% and 10%). Namoi respondents valued the HW at \$0.11 at the catchment level which is significantly (at the 5 percent level) lower than at the farm level (\$0.98) (see Figure 9).

Figure 9. The MWTP for HW per Namoi household.



The NV attribute was significantly (at the 10 percent level) different between 100% and 10% sub-samples in Namoi. The value for NV was insignificant (ie=\$0) at the catchment scope (100% sub-sample) but significant (\$0.13) at the 10% sub-sample. A significant difference (at the 5 percent level) in MWTP for PA between both sub-samples (100% and 10%). Also, the value of PA at farm level was \$3.02 and significant but it was insignificant (ie=$0) for the 100% sub-sample. No significant difference in MWTP between these two sub-samples was found for NS. The value for NS was $2.50 for the 100% sub-sample but it was insignificant for the 10% sub-sample (ie=$0). Therefore, for the Namoi sub-samples hypothesis HB_0 is rejected for all attributes except NS.

The value estimates for attributes NV, HW and PA were significantly different between 10% and 100% sub-samples in the Namoi sub-samples. However, the values for protection of NS at different scopes were not significantly different.

Unlike for other attributes, the protection of one species in one area consequently results in protection of this species at the whole catchment level. However, the protection of one species at the whole catchment may not necessarily impact the NS population at the smaller scopes as this particular area might not be a habitat for some of the catchment's endangered species. This factor needs to be taken into account in any future NRM investment planning to avoid potential double counting of the NS attribute.

11. Community perceptions of different scopes and scales

In order to perform the hypotheses tests for the differences in impact of the scope effect between different communities, it was necessary to identify whether the differences in ratios of the estimated MWTP of the attributes for different scopes (10% and 100%) are significantly different between the local/rural an distant/urban communities (Namoi and Sydney). The Poe et al. (1994) test was used to compare the ratios of MWTP of different scopes between the two communities' sub-samples. The Krinsky and Robb (1981) bootstrapping procedure was used to simulate the distribution of each ratio of MWTP by using 1000 random draws. Using these random draws, the distributions of differences in the ratios of MWTP of two scopes were compared between different community pairs. This process was repeated 100 times for each pair of the ratios of MWTP in order to generate the average proportion of differences where they are greater than zero. The results of the Poe et al. (1994) test showed that for all attributes the ratios of MWTP for different scopes were not significantly different (at the 5 percent level) between the Sydney and Namoi communities.

12. Adjustment factor

In this and other studies, the MWTP estimated at various scopes has been shown to differ significantly as respondents take into account different substitutes and quantities of environmental goods (Rolfe et al., 2002). An adjustment factor that allows for more accurate adjustment of these values between different scopes (catchment, sub-catchment and farm level) would be a useful indicator of non-market values at different scopes. To develop an adjustment factor a similar approach to the one van Bueren and Bennett (2004) developed for value transfer between national and regional levels, was used.

The test results show some significant differences in values obtained from the three scopes in the local-rural community sub-samples and also in the distant-urban community sub-samples. For the values that showed insignificant differences (at the 10 percent level) between scopes it is assumed that the values from the catchment level can be used without the need for adjustment between the farm or sub-catchment levels (i.e. adjustment factor of 1). The magnitude of differences is an indication of the adjustment factors required (see Table 10). The values for the HW attribute obtained from the Sydney sub-sample and for NV and PA obtained from the Namoi sub-sample were insignificant at the whole catchment area but became significant at the smaller scopes. As there were significant differences in values between different scopes for these attributes an adjustment factor cannot be identified.

Table 10. Adjustment factors for calibrating whole of catchment values to the sub-catchment (50% of the catchment area) and farm level (10% of the catchment area).

Attribute	Adjustment factor		
	Sydney		Namoi
	10%	50%	10%
NV	x 12.5	x 3.0	-
NS	x 13.6	x 1	x1
HW	-	-	x 8.8
PA	-	-	-

13. Conclusion

This report provides separate analyses of the scale and scope effects on the values of improved environmental quality in the Namoi catchment. Five split samples were used to tests for these effects using local/rural and distant/urban communities.

The scale effect was observed in all the sub-samples implying that respondents are willing to pay more for a higher provision of environmental goods. Three attributes showed diminishing marginal utility. These were NS, HW and PA for the Namoi 100% sub-sample.

The study also shows that there are significant differences in MWTP for the same good when it was valued at different scopes. Therefore a linear transfer of non-market values between different scopes can produce inaccurate results. The ratio of the MWTP from 10% and 100% sub-samples for NS was not significantly different between Sydney and Namoi communities. A comparison of the marginal values between different scopes allowed for the development of an adjustment factor for local/rural and distant/urban communities for a more accurate comparison of the value estimates between different scopes.

The scope tests shows that the MWTP obtained from the smaller scope sub-samples (e.g. 10%, 50%) were usually significantly higher than the values obtained from the higher scope sub-samples (e.g. 100%). Significant differences (at the 10 percent level) were found between 10% and 100% sub-samples in the Namoi sub-sample for NV, HW and PA and in the Sydney sub-sample for NV and HW. Significant differences (at the 10 percent level) were found for NV and NS between the 10% and 50% sub-samples. Also, there were significant differences (at the 10 percent level) in NV, and HW between values from the Sydney 50% and 100% sub-samples.

The impact of socio-economic characteristics on choices was identified to be of a different significance at various scopes. For example, a higher education level had a negative impact on choosing the change option in the whole catchment area (100% sub-sample) for the Namoi respondents but had a positive impact in all other sub-samples. Also, at the 10% sub-samples, respondents with more children were more likely to choose the change option in the Sydney sub-sample whereas in the Namoi sub-sample the change option was less likely to be chosen. These differences imply that an appropriate aggregation of the value estimates for various scopes of environmental policies and scales of improvements should be made on the basis of socio-economic characteristics.

The approach developed in this study aimed to facilitate a more accurate comparison of different community value estimates between different scopes. This information will allow CMAs to more effectively prioritise the natural resources investments in NSW catchments.

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