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Location differences in communities' preferences for environmental improvements in selected NSW catchments: A Choice Modelling approach

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Kasia Mazur¹ and Jeff Bennett²

Abstract

A choice modelling (CM) study was conducted to elicit household willingness to pay (WTP) for improvements in environmental quality in three NSW catchments (Lachlan, Namoi and Hawkesbury-Nepean). This paper presents results of research designed to investigate variations in WTP across different communities including local residents, distant/urban and distant/rural residents. Nine split samples were established to test for 'location effect'. The analysis involved both conditional logit and random-parameters logit models.

Key words: Choice modelling, Location effects, Non-market valuation, Catchment planning, Environment

¹ Kasia Mazur is a PhD student in the Crawford School of Economics and Government at the Australian National University and an economist at the Australian Bureau of Agricultural and Resource Economics (ABARE).

² Jeff Bennett is a Professor at the Crawford School of Economics and Government at the Australian National University and the Director of the Environmental Economics Research Hub.

1. Introduction

Choice modelling (CM) is a non-market valuation technique that is increasingly being used in policy decision making processes (Champ et al., 2003, Bateman et al., 2003). The aggregated non-market values held by individuals derived using CM are used in cost benefit analysis (CBA) enabling decision makers to compare a more complete set of benefits and costs for different resource allocations (Bennett and Blamey, 2001). CM is based on the analysis of sampled individual preferences (Bateman et al., 2006). Therefore, to estimate appropriate aggregated values it is important to identify the extent of the market and to account for any differences across the market that may affect the total value of the good (Bateman et al., 2006).

Bateman et al., (2006) discusses the challenges associated with determining the appropriate extent of the market. The approaches include using economic or political jurisdictions. However, preferences across and within these jurisdictions can differ depending on the different types of communities, the socio-economic characteristics of the population and on the location or distance of peoples' residences in relation to the site of interest (Morrison and Bergland, 2006). The effects of these features therefore require identification.

Location or distance effects on non-market value estimates have been widely investigated in non-market valuation studies (Hanley et al., 2003, Pate and Loomis, 1997a, Bateman and Langford, 1997, Pate and Loomis, 1997b, Giovanni, 2007, Van Bueren and Bennett, 2004).

In this study, a CM was used to estimate the non-market values of NSW communities for improvements in environmental quality in selected catchments. The main methodological focus was to investigate the relationship between willingness to pay (WTP) and the relative location of different communities (local/rural, distant/rural and distant/urban) from the catchments under considerations. A better understanding of this relationship would help in the extrapolation of the sample WTP to obtain a more accurate aggregated value.

The term ‘location effect’ as used in this paper, refers to any potential impact of different relative locations (local/rural, distant/rural and distant/urban) of the respondent on WTP. The ‘location effect’ shares many common properties with the ‘distance effect’ but does not refer to any specific measurable distance of the respondent from the area being investigated. This study investigates non-market goods that are spread over large areas. Therefore an exact distance of the respondent from the good was difficult to measure. The differences in WTP between proximate and distant beneficiaries of the environmental goods and other sources of heterogeneity in preferences within these communities were also analysed.

Based on the results of this study we argue that a superior approach to obtaining useful aggregated values across different environmental improvements is to capture the variation in WTP between different communities together with the analysis of the impact of socio-economic characteristics of the respondents and the differences in values between proximate and distant beneficiaries of the good. This approach provides readily-transferable monetary estimates of environmental values that can be applied in CBA.

This paper is constructed as follows Section 2 describes the theoretical basis of the CM technique. Section 3 presents a short literature review of distance and location effects. Section 4 describes the study design and sets out three research hypotheses. Section 5 details the case study catchments. Section 6 sets out the questionnaire design procedure. Section 7 describes the survey logistics. The sample’ characteristics are set out in section 8. Section 9 provides an analysis of the results to test the hypothesis. The last section (10) presents some concluding comments.

2. Theoretical basis of Choice Modelling

CM is a survey based non-market valuation technique used to estimate the values associated with the impacts of changes across different attributes that describe the outcomes of different policy options (Bennett and Blamey, 2001). Unlike other non-market valuation methods, CM can estimate, cost effectively, values associated with a wide range of environmental attributes and policy options (Bennett and Blamey,

2001). It also has the capacity to avoid many of the biases faced by other stated preference (SP) techniques and has advantages in benefit transfer applications (Bennett, 2006, Morrison et al., 2002, Morrison and Bergland, 2006). CM is increasingly being used in environmental valuation studies internationally (Horne et al., 2005, Xu et al., 2007, Wang et al., 2007, Boxall et al., 1996, Adamowicz et al., 1998, Hanley et al., 1998) and in Australia (e.g. Bennett et al., 1997, Rolfe et al., 1997, Rolfe et al., 2004, Bennett et al., 2001, Blamey et al., 2000, Blamey et al., 1999b, Windle and Rolfe, 2005).

In a CM questionnaire, respondents are presented with a number of alternative resource allocations and asked to indicate their most preferred options (Rolfe et al., 2004). A baseline alternative representing the *status quo* situation is included in each choice set and so choices are made between a *status quo* scenario and a series of different proposed alternatives (Rolfe et al., 2004). Each choice option is presented in terms of a common set of attributes with different levels between the options (Blamey et al., 2000).

The theoretical base of CM evolved from Thunstone's (1927) random utility model (RUM) (Bennett and Blamey 2001). The RUM is based on the researcher being able to observe only part of respondents' utilities. The unobserved component is taken to be randomly distributed. Therefore the utility U_{an} , derived by the respondent n from the choice of an alternative a can be describe as:

$$U_{an} = V_{an} + \varepsilon_{an} \quad (1)$$

where V_{an} is the deterministic observable component of utility and ε_{an} is the stochastic, unobserved component of utility associated with option a and consumer n . The observed component (V_{an}) is a function u of the attributes Z_a and of individual characteristics S_n (Rolfe et al., 2000).

$$U_{an} = u(Z_a, S_n) + \varepsilon_{an} \quad (2)$$

While utility can never be exactly determined, it can be concluded that the probability of choosing a particular option a from choice set C_n , by the respondent n is greater if

that option has a higher level of the deterministic and stochastic components than other options (e.g. j) in the same choice set. This is expressed as:

$$P_{a/C_n} = P[(V_{an} + \varepsilon_{an}) > (V_{jn} + \varepsilon_{jn})] \quad (3)$$

for j options in a choice set C_n , $a \neq j$

Therefore, the probability of choosing alternative a increases proportionally with the difference in observed utility. Because the distribution of the random component is not known, assumptions have to be made about this distribution. The standard assumption is that the ε term is an independently and identically distributed (IID) Gumbel random variable, which leads to the familiar binary, conditional (CL) or multinomial logit (MNL) models (McFadden, 1974). The irrelevance of independent alternatives (IIA) assumption is derived from the IID. 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 means that the random error component of utility has the same variance and is uncorrelated between alternatives (Carson et al., 1994).

The two most common models in choice modelling analysis are CL and MNL. The CL model provides the probability of an individual n choosing alternative a as a function of attributes that describe each alternative:

$$P_{an} = \frac{\exp(x_{an}\beta)}{\sum_j \exp(x_{jn}\beta)} \quad (4)$$

where x_{an} is a vector of attributes a and individuals n

The MNL gives the probability of an individual n choosing the alternative a as a function of individual characteristic (Haab and McConnell, 2003):

$$P_{an} = \frac{\exp(x_n\beta_a)}{\sum_j \exp(x_n\beta_j)} \quad (5)$$

By combining the MNL and CL formulations a General Multinomial Logit Model can be obtained. In this model both attributes that describe each alternative and the individual characteristics can be used. Therefore the probability of an individual n choosing the alternative is expressed as:

$$P_{an} = \frac{\exp(x_{an}\beta + x_n\beta_a)}{\sum_j \exp(x_{jn}\beta + x_n\beta_j)} \quad (6)$$

Therefore a utility function for choice models takes the form:

$$V_{an} = \beta_a + \sum_k \beta_k Z_{ka} + \sum_p \theta_p S_{pn} + \sum_{kp} \phi_{kp} Z_{ka} S_{pn} + \sum_{pa} \psi_{pa} \beta_a S_{pn} \quad (7)$$

Where:

β_a is the alternative specific constant for $A-1$ of the $a= 1, \dots, A$ choice options;

β_k is a matrix of $k=1, \dots, K$ attributes that relate to choice options, Z_{ka} ;

θ_p is a matrix of $p=1, \dots, P$ characteristics that relate to individual respondents, S_{pn} ;

ϕ_{kp} is a matrix of possible relationships of choice option attributes with the characteristics of the individuals, $Z_{ka}S_{pn}$; and

ψ_{pa} is a vector of possible interactions between individual characteristics and choice option intercepts (Louviere, 2001).

The utility function estimated for each alternative therefore contains the effects of attributes, an alternative specific constant (ASC) and the individual respondent characteristics that can interact with the attributes or the ASC (Blamey et al., 2001). ASCs capture the influence of any variation in choices that cannot be explained by the attributes or the socio-economic characteristics (Bennett and Adamowicz, 2001, Rolfe et al., 2000).

If the IIA condition is not met, a different assumption regarding the stochastic term needs to be made, necessitating the use of alternative models including random parameter logit (RPL).

RPL relaxes the IIA assumption and accounts for observed and unobserved preference heterogeneity across respondents. In the RPL model it is assumed that a random vector β_n varies among respondents. The utility function is described as:

$$U_{an} = \beta_n X_{an} + \varepsilon_{an} = \beta X_{an} + \delta_n X_{an} + \varepsilon_{an} \quad (8)$$

where β_n is the sum of the population mean β and individual deviation from the mean δ_n . Therefore the stochastic part of utility $\delta_n X_{an} + \varepsilon_{an}$ is correlated among alternatives (Alpizar et al., 2001). This relaxes the IIA “despite the presence of the IID assumption for the random components ε_{an} of the alternatives” (Louviere et al., 2000). This means that the RPL model separates IIA from IID and allows cross-correlation amongst alternatives in the estimated models (Hensher and Reyes, 2000).

The researcher does not know the individual’s preferences, therefore it is assumed that individual preferences vary across the population with density $f(\beta/\theta^*)$, where θ^* are the parameters of this distribution (representing the mean and standard deviation of preferences) (Train, 1998). Hence the probability that the individual n choosing the alternative a can be expressed as the integral of the conditional probability (equation 4) over all possible values of β weighted by the density of β (Train, 1998). Therefore the actual probability of individual choices is given by:

$$P_{an} = \int \left(\frac{\exp(\beta_n x_{an})}{\sum_j \exp(\beta_n x_{jn})} \right) f(\beta/\theta^*) d\beta \quad (9)$$

3. Location/distance effect

The importance of accounting for the location/distance effect has been highlighted in the non-market valuation literature (Sutherland and Walsh, 1985, Bateman et al., 1999, Jiang et al., 2005, Giovanni, 2007). The main advantage of location/distance tests are that it provides information about the substitution possibilities (Sutherland

and Walsh, 1985) and it is important for further benefit transfer (Bateman et al., 1999, Jiang et al., 2005). Giovanni (2007) claims that distance tests can provide valuable information for policy makers in regards to whether investment funding should come from local, state or federal governments. Sutherland and Walsh (1985) and Pate and Loomis (1997b), argue that the omission of a location/distance test could produce biased parameters especially when the sample is geographically limited; Some positive values may be experienced by those outside of the sampled area.

The location/distance effect depends on the type of good involved, the use and non-use values ratio for each attribute, the availability of information, the number of substitute goods and experience with the good (Stouffer, 1940). For example, Clawson and Knetsch (1966) argue that if the good is iconic or scarce, the WTP may stay the same across different distances from that good. However, in some instances people who live close to an environmental amenity such as a national park may value this good less than people who live further away (Espey and Owusu-Edusei, 2001, Imber et al., 1991). Distance also influences the availability of information and consequently peoples' preferences (Beckmann, 1999). For example, Heberlein et al., (2005) argue that people who know more about a good tend to value this good more than people who know less. A relationship between distance and knowledge was also found by Pate and Loomis (1997). Bateman et al., (2006), however, argues that average values should decline with increasing distance from that site as the number of users (who hold higher values than non-users) declines with the distance. In general, it is assumed that WTP for used goods declines with distance (Hanley et al., 2003).

Southerland and Walsh (1985) and Hanley (2003) have shown a negative relationship between the WTP and the distance. Some other studies (Espey and Owusu-Edusei, 2001, Imber et al., 1991, Do and Bennett, 2007) have shown a positive relationship between the WTP and the distance but Pate and Loomis, (1997) and Loomis, (1996) , and Ece Ozdemiroglua et al., (2004) did not show any impact of the distance on the value estimates. Morrison and Bennett (2004), Hanley et. al (2003), Rolfe and Bennett (2000) and van Buren and Bennett (2004) also showed differences in preferences between those living within a study area and beyond.

The impact of location/distance on the WTP for improvements in environmental quality can also depend on the type of population tested (e.g. urban or rural) and socio-economic and attitudinal factors. The importance of accounting for different community types and their locations has been tested in a previous study by Rolfe and Bennett (2000). That study found significant differences in values between different community types (rural and urban) within Queensland.

4. Hypothesis and study design

This study tests for variations in environmental benefit estimates across different communities including local/rural, distant/urban (Sydney) and distant/rural residents. Based on the review of literature presented in the previous section, hypotheses were formulated for testing the location effect:

HA: *The local/rural (WTP^{LR}) versus distant/rural (WTP^{DR}) community test.*

The null hypothesis:

$$\mathbf{HA}_0: \quad WTP^{LR} = WTP^{DR}$$

The alternative hypothesis:

$$\mathbf{HA}_1: \quad WTP^{LR} \neq WTP^{DR}$$

The null hypothesis (HA_0) implies that WTP for improvements in environmental quality are not significantly different between the local/rural (WTP^{LR}) and distant/rural (WTP^{DR}) communities. The alternative hypothesis (HA_1) states that these two communities hold different WTP for improvement in environmental quality. Our prior expectation is that the HA_1 will not be rejected.

HB: *The local/rural (WTP^{LR}) versus distant/urban (WTP^{DU}) community test.*

The null hypothesis:

$$\mathbf{HB}_0: \quad WTP^{LR} = WTP^{DU}$$

The alternative hypothesis:

$$\mathbf{HB}_1: \quad \text{WTP}^{\text{LR}} \neq \text{WTP}^{\text{DU}}$$

The null hypothesis (HB_0) implies that WTP for improvements in environmental quality are the same for local/rural (WTP^{LR}) and distant/urban (WTP^{DU}) communities. The alternative hypothesis (HB_1) states that the WTP for these improvements differs between these two communities. Our prior expectation is that the HB_1 will not be rejected.

***HC:** The distant/rural (WTP^{LR}) versus distant/urban (WTP^{DU}) community test.*

The null hypothesis:

$$\mathbf{HC}_0: \quad \text{WTP}^{\text{DR}} = \text{WTP}^{\text{DU}}$$

The alternative hypothesis:

$$\mathbf{HC}_1: \quad \text{WTP}^{\text{DR}} \neq \text{WTP}^{\text{DU}}$$

The null hypothesis (HC_0) implies that WTP for increased environmental benefits is the same for distance/rural (WTP^{LR}) and distant/urban (WTP^{DU}) communities. The alternative hypothesis (HC_1) states that these two communities hold different values for improvements in environmental quality. Our prior expectation is that the HC_1 will not be rejected.

In order to perform the above tests, four subsets of the NSW population (Sydney, Lachlan, Namoi and Hawkesbury-Nepean) were selected as the basis for estimating NSW population values for improvements in environmental quality in the three NSW catchments. A split sample approach was employed to test for the effect of different communities' locations on value estimates. Nine split samples were created to make a comparison between local/rural, distant/rural and distant/urban communities' attitudes and preferences (see Table 1.).

Table 1. Research design and the study sub-samples

Sub-samples location Type of questionnaire	Hawkesbury - Nepean (Goulbourn, Moss Vale)	Namoi (Tamworth, Gunnedah)	Lachlan (Cowra, Parkes)	Sydney
Hawkesbury-Nepean	Local – rural (HN/HN)	Distant – rural (HN/Namoi)		Distant – urban (HN/Sydney)
Namoi		Local – rural (Namoi/Namoi)	Distant – rural (Namoi/Lachlan)	Distant – urban (Namoi/Sydney)
Lachlan	Distant – rural (Lachlan/HN)		Local – rural (Lachlan/Lachlan)	Distant – urban (Lachlan/Sydney)

People in the three catchments, in separate sub-samples, were asked about their NRM preferences in their catchment and in the other catchments in NSW. In order to make a comparison with distant/urban communities' attitudes towards improvement in environmental quality in rural areas, sub-samples of Sydney residents were asked about their preferences for resource allocation in all three selected catchments. Each respondent from each area received only one version of the questionnaire (Namoi, Lachlan or Hawkesbury-Nepean) asking about NRM management in one of these three catchments.

5. Case studies

Three NSW catchments: Lachlan, Namoi and Hawkesbury-Nepean were chosen as the case studies. The selected catchments represent a wide variety of NSW catchment characteristics and their NRM issues.

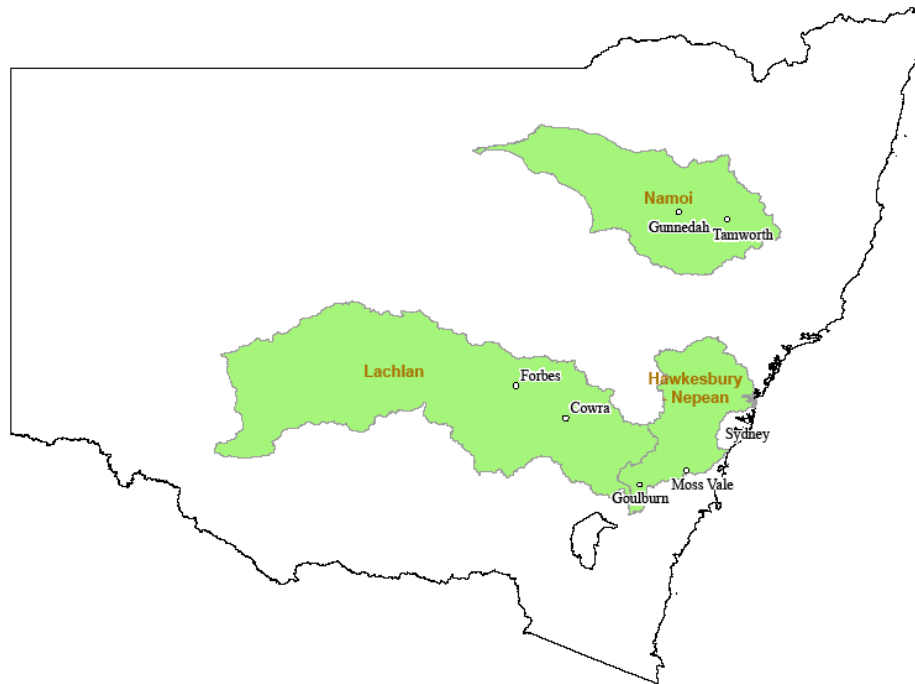
The Hawkesbury-Nepean, Namoi and Lachlan (see Figure 1) catchments differ in land use, size and population. In terms of land use there are some similarities between the Namoi and Lachlan catchments. Both catchments are mostly devoted to agriculture (about 90 percent of the land) with a majority of area used for grazing. Native vegetation in both locations covers between 30 to 40 percent of the catchment area and national parks occupy less than five percent. Both catchments have similar

populations of about 100,000 people. The Lachlan catchment (84,700 km²) is the largest of the three. It has twice the area of the Namoi (42,000 km²) and almost four times the area of the Hawkesbury Nepean catchment (22,000 km²). The Hawkesbury Nepean catchment has the greatest population (one million people). Over 50 percent of the area of that catchment is park, only 30 percent of the area is used for agriculture and about 20 percent is urbanised.

Despite the many differences between these catchments there are also similarities in terms of the environmental issues faced. These include declining biodiversity, loss of native vegetation and reduced water quality. Across the total area of the three case studies, the area of native vegetation in good quality has declined by about 87 percent since pre-European settlement. The greatest area of native vegetation of good quality is in the Hawkesbury-Nepean catchment (50 percent of the total) but only five and seven percent respectively of the total area of Namoi and Lachlan catchments has native vegetation in good quality. Over 200 native species across the three catchments are endangered. Water quality has declined in 85 percent of the total waterways in the catchments. Currently about 20 percent of the waterways in Namoi's catchment, 15 percent of the Hawkesbury-Nepean's and 10 percent of the Lachlan's are of good enough quality for drinking, swimming and fishing.

NRM actions such as planting more trees, protecting existing vegetation, fencing and revegetating river banks and wetlands, pest and weed control are just some of the actions that can improve environmental quality in the catchments. More information about each catchment's characteristics is included in Appendix E.

Figure 1. Case study catchments areas.



6. Questionnaire development

Environmental attributes and their current and potential future levels were determined through consultations with policy makers and NRM specialists. Further consultations and verifications of a draft questionnaire were undertaken during eight focus group discussions.

Three attributes that describe the main environmental benefits derived from NRM actions in the three catchments were selected: native vegetation in good quality (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 from 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 were determined and used in an experimental design for each type of questionnaire.

A fractional factorial experimental design was employed to structure the combinations of attribute levels used to describe the outcomes of the alternative NRM actions presented to the respondents in choice sets. The levels of each attribute across the predicted range were used in an orthogonal design that produced 25 alternative NRM options. These alternatives were randomly blocked into five different versions, each with five choice sets for the three different versions of the questionnaire (Namoi, Lachlan and Hawkesbury–Nepean). This resulted in 15 different versions of the questionnaire. Two change options and a *status quo* option were included in each choice set (see Figure 2)

Figure 2. Example of a choice set for the Hawkesbury-Nepean catchment

Question 4

Consider each of the following three options for managing natural resources in the Hawkesbury–Nepean 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		10500 km ²	3000 species	630 km	8000	MY CHOICE Tick One
OPTIONS	My Household payment each year over 5 years	Condition in 20 years				
Option A - No new actions	\$0	10500 km ²	2970 species	600 km	7000	<input type="checkbox"/>
Option B	\$50	11000 km ²	2980 species	650 km	7200	<input type="checkbox"/>
Option C	\$200	12000 km ²	2990 species	750 km	7200	<input type="checkbox"/>

7. Survey Logistics

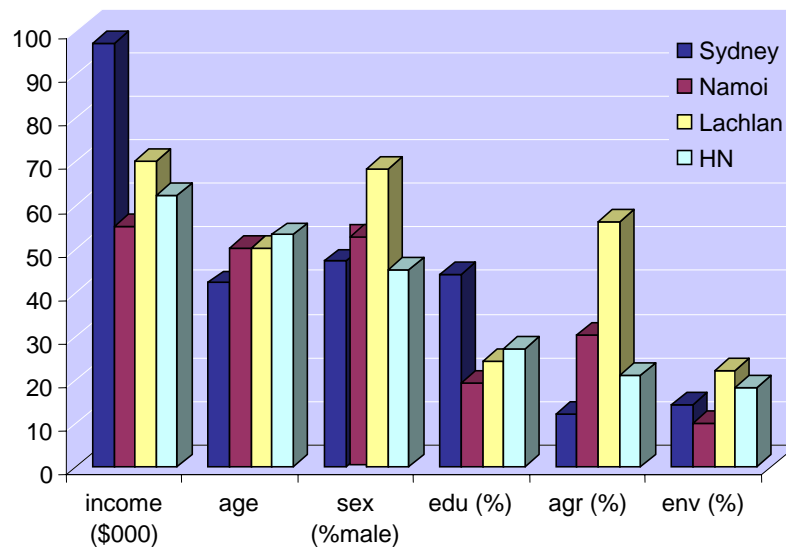
A drop-off/pick-up approach for the distribution of the questionnaire was used. In total, 2,529 responses which account for 12,645 choices observations from nine sub-samples were obtained. Out of 12,645 choice sets about three percent were not answered. About 24 percent of respondents chose the *status quo* option in each choice set.

In order to test for location effects, an appropriate spatial distribution of the population was chosen to avoid a potential self selection bias. This involved ensuring an equal number of responses from different locations. This is important because in previous studies (Bateman and Langford, 1997, Hanley et al., 2003), random sampling yield more responses from areas closer to the goods investigated due to self-selection bias. Questionnaires were distributed in two main towns in each case study catchment 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.

8. Sample characteristics

The socio-economic characteristics of the sub-samples are presented in Figure 3.

Figure 3. Descriptive statistics of the sub-samples from each case study 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.

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 and the Census.

Significant differences in the age distribution between the sub-samples and the population data was observed in Parkes ($\chi^2 = 38.13$), Moss Vale ($\chi^2 = 30.32$), Cowra ($\chi^2 = 26.59$) and Goulburn ($\chi^2 = 23.12$) where the χ^2 was higher than the critical $\chi^2 = 24.99$ at the 0.05 level. For the Sydney ($\chi^2 = 5.33$), Gunnedah ($\chi^2 = 13.92$) and the Tamworth ($\chi^2 = 12.92$) the distribution of age was not significantly different from the ABS census data.

No significant differences in household size between the samples and the ABS census data were found. However, the proportion of people with a tertiary degree is higher in the sub-samples than recorded by the ABS census. Significant differences were observed in Sydney, Moss Vale and Cowra where 30 to 40 percent of the respondents held a tertiary degree in comparison to approximately 10 percent stated in the ABS census. Also the education level recorded in the Namoi catchment was twice as high as that recorded by the ABS census. Only the education level recorded in Goulburn ($\chi^2 = 1.33$) and Parkes ($\chi^2 = 2.0$) was not significantly different from the ABS census data where χ^2 was lower than the critical χ^2 value of 3.84 at 0.05 level. For the other sub-samples the χ^2 value was higher than the critical value indicating that there are significant differences between the average population and the sample's education level.

The income ranges presented in the questionnaire were consistent with ABS household ranges presented in the 2006 Census. Significant differences between the sub-samples and Census income were recorded in Cowra ($\chi^2 = 102.28$), Gunnedah ($\chi^2 = 41.68$), Goulburn ($\chi^2 = 24.29$), and Sydney ($\chi^2 = 23.86$). No significant differences in the distribution of income were found between the Census and the Moss Vale ($\chi^2 = 16.85$), Parkes ($\chi^2 = 14.91$), and Tamworth ($\chi^2 = 6.90$) sub-samples where χ^2 was lower than the critical χ^2 value of 22.36 at 0.05 level.

9. Results

The models

The data obtained from the CM survey were analysed using conditional logit (CL) and random parameter logit (RPL) models. The Limdep version 4.0 software was used to compute the CM models.

The first choice model used in this analysis was a CL model with attributes only as explanatory variables and the alternative specific constant. The equations for this model are:

$$\begin{aligned} U(A) &= \beta_1 \text{costs} + \beta_2 \text{NV} + \beta_3 \text{NS} + \beta_4 \text{HW} + \beta_5 \text{PA} \\ U(B) &= \text{ASC} + \beta_1 \text{costs} + \beta_2 \text{NV} + \beta_3 \text{NS} + \beta_4 \text{HW} + \beta_5 \text{PA} \\ U(C) &= \text{ASC} + \beta_1 \text{costs} + \beta_2 \text{NV} + \beta_3 \text{NS} + \beta_4 \text{HW} + \beta_5 \text{PA} \end{aligned} \quad (10)$$

where:

A - *Status quo* option

B and C - change options

β - estimated coefficients

ASC - alternative specific constant

Attributes:

NV - km² 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 this model are generic.

In order to account for preference heterogeneity, a CL model with socio-economic and attitudinal variables ('full model') was estimated. Socio-economic characteristics

such as age, education, income, gender, number of children, association with agricultural industry and association with environmental organisation were included in the CL full model by interacting them with the ASC.

The results from the choice models for each sample are presented in Tables 2, 3 and 4. The results indicate a good overall model performance. For the sub-samples, a better model fit (higher pseudo-R²) was obtained by accounting for preference heterogeneity. The pseudo R² for most of the CL full models were around 10 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 important gains in model fit were obtained by accounting for the 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 Namoi/Namoi³ sub-sample suggests that there is no systematic favouring by respondents of the *status quo*. The highest proportion (about 30 percent) of respondents choosing the *status quo* option was obtained from the Lachlan/HN⁴ and Namoi/Lachlan⁵ sub-samples. The lowest preference towards the *status quo* option was from all local/rural sub-samples (HN/HN⁶, Namoi/Namoi and Lachlan/Lachlan⁷).

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 values which mean that those NRM scenarios which result in a higher level of any single attribute are preferred. The cost coefficient was negative and significant for all the models. The significance of the attributes varies between sub-samples locations and community types (see Tables 2, 3 and 4).

³ Namoi/Namoi means that the respondents from the Namoi catchment were asked about their own catchment.

⁴ Lachlan/HN means that the respondents from the Hawkesbury-Nepean catchment were asked about the Lachlan catchment.

⁵ Namoi/Lachlan means that the respondents from the Lachlan catchment were asked about the Namoi catchment.

⁶ HN/HN means that the respondents from the Hawkesbury-Nepean catchment were asked about their own catchment.

⁷ Lachlan/Lachlan means that the respondents from the Lachlan catchment were asked about their own catchment.

Lachlan catchment: In the Lachlan/Lachlan sub-sample all the attributes were significant implying that the Lachlan respondents want to have more of each of these four attributes in their own catchment. In the Lachlan/Sydney⁸ sub-sample all the environmental attributes (NS, HW and NV) were significant but PA was insignificant. This means that Sydney respondents are more likely to choose the change option if it provides more of the environmental improvements in the Lachlan catchment but are unconcerned by impacts on the values of people working in agriculture. In the Lachlan/HN sub-sample, NS and HW were significant at the five percent level, PA was significant at the 10 percent and the NV attribute was not significant.

Namoi catchment: In the Namoi/Namoi sub-sample, all the attributes except PA were significant, implying that the Namoi respondents are more likely to choose the change option if it provides more environmental benefits but the social impacts are not relevant. In the Namoi/Sydney⁹ sub-sample NS and NV were significant but HW and PA were not. In the Namoi/Lachlan sub-samples only the NV attribute was significant and the other attributes were insignificant implying that Lachlan respondents are only concerned by impact on native vegetation in the Namoi catchment.

Hawkesbury-Nepean catchment: In the HN/HN sub-sample the NS and HW attributes were significant at the five percent level and the PA attribute was significant at the ten percent level. NV was insignificant. In the HN/Namoi¹⁰ sub-sample only NS and HW were significant but the other attributes were insignificant. In the HN/Sydney¹¹ sub-sample all the environmental attributes were significant and the social attribute was insignificant.

The significant coefficients for the socio-economic attributes indicated that the respondents with higher levels of environmental consciousness for all sub-samples except the HN/HN, HN/Namoi and Lachlan/HN sub-samples respondents are likely to prefer NRM scenarios that provide higher levels of environmental goods. However, a negative significant coefficient for association with environmental organisation in the

⁸ Lachlan/Sydney means that the respondents from Sydney were asked about the Lachlan catchment.

⁹ Namoi/Sydney means that the respondents from Sydney were asked about the Namoi catchment.

¹⁰ HN/Namoi means that the respondents from the Namoi catchment were asked about the Hawkesbury-Nepean catchment.

¹¹ HN/Sydney means that the respondents from Sydney were asked about the Hawkesbury-Nepean catchment.

HN/Namoi sub-sample implies that Namoi residents who are associated with environmental organisations are less likely to choose a change option for the environmental improvement in the Hawkesbury-Nepean catchment. Also people with higher income in almost all the sub-samples are more likely to choose the change option. Only respondents in the Lachlan/HN sub-sample did not show any strong relationship between the income and their preferences towards improvement in environmental quality. Association with agricultural industry also indicated a higher probability of choosing new NRM actions for all the distance/urban sub-samples and the Namoi/Namoi and Lachlan/Lachlan sub-samples.

A Hausman test showed that there was a breach in the IIA assumption in all of CL - attributes except the HN/Sydney sub-sample. However, the CL full models resulted in violation of the IIA at the five percent level of significance for the Namoi/HN sub-sample. To address the violation of the IIA the RPL model was used. Simulations were undertaken in order to determine the appropriate distribution for the random variables. Triangular distributions were used for the final models. The cost attribute coefficient was treated as a fixed parameter whilst other coefficients were allowed to vary. Estimates for the RPL models were derived using 1000 random draws. The attributes that constantly showed an insignificant standard deviation were treated as non-random and the model was re-estimated. In order to identify the sources of both the random and conditional heterogeneity, interactions of the random parameters with respondent-specific socio-economic and attitudinal characteristics were also undertaken. For this particular sub-sample, the NV parameter was treated as random. The mean effect on the random parameter was insignificant but the standard deviation was significant (see table 4). The interactions of the random parameter with socio-economic characteristics resulted in a significant positive coefficient for income indicating that people with higher income prefer more NV. Also, the age and environmental coefficient was significant and negative indicating that older people and people associated with environmental organisations prefer less NV.

Table 2. Results of CL models for the Lachlan catchment

	Local/rural Lachlan/Lachlan		Distant/urban Lachlan/Sydney		Distant/rural Lachlan/HN	
	Survey conducted in Lachlan		Survey conducted in Sydney		Survey conducted in HN ^A	
	CL Attributes only	CL with interactions	CL Attributes only	CL with interactions	CL Attributes only	CL with interactions
ASC	-.7531*** (.3232)	-2.6241*** (.6236)	-.2145 (.3599)	-4.1152*** (.8008)	-.9228*** (.3297)	-4.5051*** (.7712)
COST	-.0052*** (.0004)	-.0055*** (.0005)	-.0059*** (.0004)	-.0060*** (.0006)	-.0044*** (.0004)	-.0049*** (.0005)
NV	.5801D-04** (.3125D-04)	.6906D-04** (.3452D-04)	.4482D-04 (.3459D-04)	.0001*** (.4510D-04)	.2163D-04 (.3309D-04)	.451829D-04 (.3908D-04)
NS	0.0208** (.0098)	.0244** (.0110)	.0254** (.0011)	.0480*** (.0142)	.0350*** (.0103)	.0362*** (.0123)
HW	.0038*** (.0008)	.0046*** (.0009)	.0028*** (.0008)	.0021** (.0011)	.0057*** (.0008)	.0063*** (.0010)
PA	.0016*** (.0005)	.0015*** (.0005)	-.0005 (.0005)	-.0006 (.0007)	.0008 (.0005)	.0011* (.0006)
ASCAGE		-.0014 (.0045)		.0140** (.0065)		.0008 (.0057)
ASCEDU		.0494 (.0324)		.1282*** (.0402)		.2764*** (.0448)
ASCINCOME		.0128*** (.0019)		.0141*** (.0021)		.0012 (.0021)
ASCGENDER		.2879** (.1505)		.5813*** (.1768)		-.1996 (.1779)
ASCCHILDREN		.0551 (.1950)		-.2210 (.2202)		-.8383*** (.2860)
ASCENV		.4363*** (.1826)		-.1295 (.2718)		-.0670 (.2329)
ASCAGR		.3211** (.1423)		.6610* (.3706)		.0591 (.2113)
Pseudo R2	0.05118	0.09258	0.06602	0.12458	0.05672	0.10400
Log likelihood	-1577.946	-1215.845	-1366.542	-753.7176	-1348.963	-921.3986
D.F.O	6	13	6	13	6	13
Chi ² (critical Chi ² in brackets)	170.24600 (9.4877)	248.09800 (16.9190)	193.18200 (9.4877)	214.51280 (16.9190)	162.2200 (9.4877)	213.9068 (16.9190)
Observations	1534	1247	1342	786	1331	966

Table 3. Results of CL models for the Namoi catchment

Sub-samples	Local/rural Namoi/Namoi		Distant/urban Namoi/Sydney		Distant/rural Namoi/Lachlan	
	Survey conducted in Namoi		Survey conducted in Sydney		Survey conducted in Lachlan	
	CL Attributes only	CL with interactions	CL Attributes only	CL with interactions	CL Attributes only	CL with interactions
ASC	-.0003 (.2666)	.7449 (.6281)	.3552 (.2687)	-3.1315*** (.7019)	-.2048 (.2414)	-2.917*** (.5924)
COST	-.0051*** (.0004)	-.0054*** (.0005)	-.0068*** (.0004)	-.0065*** (.0006)	-.0047*** (.0004)	-.0050*** (.0005)
NV	.5530D-04 (.349D-04)	.6305D-04* (.392D-04)	.9140D-04*** (.364D-04)	.0001*** (.464D-04)	.8310D-04*** (.35D-04)	.8512D-04** (.3939D-04)
NS	.0121** (.0054)	.0133** (.0061)	.0125** (.0058)	.0156** (.0073)	.0072 (.0053)	.0087 (.0060)
HW	.0005*** (.0002)	.0006*** (.0002)	.8099D- (.0001)	.772D-04 (.0002)	.0001 (.0001)	.0002 (.0002)
PA	.0009** (.0005)	.0008 (.0006)	.0005(.0006)	.0012* (.0007)	.0009* (.0005)	.0009 (.0006)
ASCAGE		-.0056 (.0048)		.0107* (.0060)		.0054 (.0047)
ASCEDU		-.0683* (.0375)		.1446*** (.0407)		.1098*** (.0333)
ASCINCOME		.010*** (.002)		.0047*** (.0017)		.0112*** (.0019)
ASCGENDER		-.2233 (.1562)		-.1680 (.1725)		.6282*** (.1600)
ASCCHILDREN		-.1348 (.2116)		.0897 (.1972)		.1297 (.1911)
ASCENV		1.0290*** (.3170)		1.0137*** (.2698)		.4676*** (.1713)
ASCAGR		.8962*** (.1869)		1.5529*** (.4240)		-.1192 (.1426)
Pseudo R2	0.05262	0.09119	0.09044	0.13422	0.03941	0.08675
Log likelihood	-1307.570	-984.9534	-1239.520	-731.0136	-1460.606	-1090.818
D.F.O	6	13	6	13	6	13
Chi ² (critical Chi ² in brackets)	145.2460 (9.4877)	197.6532 (16.9190)	246.5000 (9.4877)	226.64760 (16.9190)	119.852 (9.4877)	207.242 (16.9190)
Observations	1263	999	1245	769	1408	1099

Notes: Significance levels indicated by: * 0.1, **0.05, ***0.01, standard errors in brackets ^A Hawkesbury-Nepean

Table 4. Results of CL and RP models for the Hawkesbury-Nepean catchment

	Local/rural HN/HN		Distant/urban HN/Sydney		Distant/rural HN/Namoi			
	Survey conducted in HN ^Δ		Survey conducted in Sydney		Survey conducted in Namoi			
	CL Attributes only	CL with interactions	CL Attributes only	CL with interactions	CL Attributes only	CL with interactions	RP	RP with interactions
ASC	-1.986 (.2424)	-3.8937*** (.6445)	-.4672** (.2456)	-3.955*** (.7050)	-.5550** (.2454)	-.4269 (.5140)	-.2570 (.3114)	.0222 (.3448)
COST	-.0045*** (.0004)	-.0047*** (.0005)	-.0053*** (.0004)	-.0052*** (.0005)	-.0042*** (.0004)	-.0045*** (.0005)	-.0049 (.0006)	-.0053*** (.0006)
NV random parameter	.6190D-04 (.0004)	.0001 (.0001)	.0003*** (.0001)	.0003*** (.0001)	.3623D-04 (.0001)	.4990D-04 (.0001)	-.0002 (.0002)	-.0003 (.0006)
NS	.0283*** (.0052)	.0325*** (.0061)	.0198*** (.0054)	.0269*** (.0067)	.0192*** (.0053)	.0219*** (.0059)	.0238*** (.0062)	.0260*** (.0069)
HW	.0033*** (.0010)	.0042*** (.0012)	.0045*** (.0010)	.0057*** (.0013)	.0037*** (.0010)	.0038*** (.0011)	.0046*** (.0012)	.0046*** (.0014)
PA	.0006 (.0005)	.0011* (.0006)	.0008 (.0005)	.0009 (.0007)	.0008 (.0005)	.0004 (.0006)	.0006 (.0006)	.0002 (.0007)
ASCAGE/NVAGE		.0223*** (.0049)		.0189*** (.0061)		-.0123** (.0042)		-.0001** (.5341D-04)
ASCEDU/NVEDU		.1257*** (.0368)		.0777* (.0418)		.0388 (.0297)		.3480D-04 (.3613D-04)
ASCINCOME/NVINCOME		.0085*** (.0023)		.0119*** (.0018)		.005*** (.002)		.6046D-05*** (.2502D-05)
ASCGENDER/NVGENDER		.5930*** (.1508)		.5283*** (.1701)		-.3368*** (.1353)		-.0003* (.0002)
ASCCHILDREN/NVCHILDREN		-.2922 (.2016)		-.1987 (.1990)		.1368 (.1129)		.5191D-04 (.0001)
ASCENV/NVENV		.3475 (.2174)		.5477*** (.2320)		-.5319** (.2393)		-.0049* (.0003)
ASCAGR/NVAGR		-.0238 (.2077)		.4834** (.2529)		-.0411 (.1424)		-.0001 (.5341D-04)
<u>Standard deviation</u>							.0012*** (.0004)	.0012*** (.0004)
NV Pseudo R2	0.0469	0.0886	0.06347	0.12079	0.03982	0.06059	.0549	.0648
D.F.O	6	13	6	13	6	13	7	14
Log likelihood	-1423.711	-1000.866	-1394.734	-847.1601	-1464.555	-1154.783	-1461.927	-1157.925
Chi ² (critical Chi ² in brackets)	139.9880 (9.4877)	194.6540 (16.9290)	189.04400 (9.4877)	232.78460 (16.9190)	121.468 (9.4877)	148.958 (16.9190)	169.8374 (14.6071)	160.4211 (33.9234)
Observations	1365	1004	1360	879	1408	1127	1408	1127

Notes: Significance levels indicated by: * 0.1, **0.05, ***0.01, standard errors in brackets ^Δ Hawkesbury-Nepean

The implicit prices

Given that one of the attributes was presented as a cost term, respondents' WTP for changes in each attribute level was estimated as implicit price (IP) estimates. The marginal value of a change in a single attribute was calculated by dividing the β coefficient of the attributes (NV, NS, HW, and PA) by the β coefficient of the costs parameter and multiplied by -1 .

$$IP = -1 \left(\frac{\beta_{\text{attribute}}}{\beta_{\text{money}}} \right) \quad (13)$$

In most cases, the full CL models were used to calculate WTP but in one case, the RPL model gave a better fit and was used for the calculations. The 95 percent confidence intervals (CI) for the implicit prices (IP) for the CL models and for the non-random parameters for RPL models were calculated using a bootstrapping procedure (Krinsky and Robb, 1986). Using this procedure a vector of 1000 sets of parameters for each attribute was drawn from the covariance matrix for each sub-sample. IPs for random parameters were estimated using unconditional parameter distributions and conditional means methods. A Poe et al. (1994) test was used to compare the IPs derived from CL and RPL models. No significant differences were found.

The results show that the IPs for the NS attribute for all the sub-samples except the Namoi/Lachlan sub-sample are positive and significant implying that respondents have positive WTP for protecting NS. The IPs for NV were positive for all distant/urban sub-samples, one rural/local (Lachlan/Lachlan) and one distant/rural (Namoi/Lachlan) sub-sample but for the other sub-samples the IPs for NV were not significant. All the IPs for the improvement in HW in the Hawkesbury-Nepean catchment were positive and significant for all the sub-samples (HN/Namoi, HN/Sydney and HN/HN) implying that the respondents from all these three catchments have positive WTP for the improvement in water quality in the Hawkesbury-Nepean catchment. The WTP for HW in the Lachlan catchment was positive and significant at the five percent significance level in the Lachlan/HN and Lachlan/Lachlan sub-samples but for the Lachlan/Sydney sub-sample, it was significant at the ten percent significance level. The WTP for HW in the Namoi catchment was only positive and significant in the Namoi/Namoi sub-sample but in both the Namoi/Sydney and Namoi/Lachlan sub-samples the WTP for HW was insignificant. The IP for PA was significant at the one percent significance level and positive in the Lachlan/Lachlan sub-sample. It was also significant at ten percent in the Lachlan/HN and the HN/HN sub-samples. For all Sydney sub-samples (Namoi/Sydney, HN/Sydney and Lachlan/Sydney) the PA attribute was not significant across all catchments. The IPs and their CI of distant/rural, distant/urban and local/rural communities for different environmental improvements are presented in Table 5.

Table 5. The mean annual households WTP from the different location sub-samples

Quest.	Attributes Sub-sample	NV (km ²)	NS (species)	HW (km)	PA (person)
Namoi	distant/urban Namoi/Sydney	\$0.02*** (0.01 ~ 0.04)	\$2.43** (0.23 ~ 4.64)	\$0.01 (-0.5 ~ 0.07)	\$0.19 (-0.03 ~ 0.41)
	local/rural Namoi/Namoi	\$0.01 (0.00 ~ 0.03)	\$2.50** (0.24 ~ 4.75)	\$0.11*** (0.05 ~ 0.18)	\$0.15 (-0.07 ~ 0.37)
	distant/rural Namoi/Lachlan	\$0.02** (0.00 ~ 0.03)	\$1.79 (-0.61 ~ 4.18)	\$0.04 (-0.03 ~ 0.11)	\$0.18 (-0.06 ~ 0.42)
	distant/urban Lachlan/Sydney	\$0.02** (0 ~ 0.03)	\$8.11*** (3.36 ~ 12.85)	\$0.35* (-0.02 ~ 0.73)	-\$0.10 (-0.34 ~ 0.14)
Lachlan	local/rural Lachlan/Lachlan	\$0.01** (0 ~ 0.03)	\$4.51** (0.52 ~ 8.50)	\$0.83*** (0.49 ~ 1.18)	\$0.27*** (0.08 ~ 0.47)
	distant/rural Lachlan/HN	\$0.01 (-0.01 ~ 0.03)	\$7.45*** (2.43 ~ 12.46)	\$1.29*** (0.83 ~ 1.75)	\$0.22* (-0.02 ~ 0.47)
	distant/urban HN/Sydney	\$0.06** (0.01 ~ 0.11)	\$5.25*** (2.61 ~ 7.90)	\$1.10*** (0.56 ~ 1.64)	\$0.17 (-0.08 ~ 0.42)
	local/rural HN/HN	\$0.03 (-0.02 ~ 0.08)	\$6.97*** (4.21 ~ 9.74)	\$0.90*** (0.37 ~ 1.42)	\$0.23* (-0.02 ~ 0.48)
Hawkesbury -Nepean	distant/rural HN/Namoi	\$0.01 (-0.04 ~ 0.06)	\$4.97*** (2.26 ~ 7.68)	\$0.84*** (0.30 ~ 1.38)	\$0.09 (-0.17 ~ 0.35)
		-\$0.07 _{RPL}	\$4.85*** _{RPL}	\$0.87*** _{RPL}	\$0.04 _{RPL}

Notes: IPs calculated from the CL full model, significance levels indicated by: * 0.1, **0.05, ***0.01, 95% CI in brackets calculated using a bootstrapping (Krinsky and Robb, 1986).

Hypothesis testing

In order to perform the hypotheses tests for the location effect it is necessary to identify whether the differences between IPs are statistically significant. Poe et al. (1994) test was used to compare IPs between different sub-samples. The Krinsky and Robb (1981) bootstrapping procedure was used to simulate the distribution of each IP by using a 1000 of random draws. Using these random draws, distribution of IP differences between two models were compared. This process was repeated 100 times for each pair of IP in order to generate the average proportion of differences where the differences are greater than zero.

HA: *The local/rural (WTP^{LR}) versus distant/rural (WTP^{DR}) community test.*

The Poe et al.(1994) test was conducted to compare IPs for each attribute between local/rural and distant/rural communities. This includes a comparison of the IPs for each attribute (NV, NS, HW and PA) in the three tests: Namoi/Namoi *versus*

Namoi/Lachlan, Lachlan/Lachlan *versus* Lachlan/HN and HN/HN *versus* HN/Namoi sub-samples.

The results of these comparisons showed that at the five percent significance level there are no significant differences in any attributes' IPs in all three tests for local/rural *versus* distant/rural communities.

Therefore the null hypothesis HA_0 that implies that there are no significant differences in WTP between these two types of communities is not rejected and the alternative hypothesis HA_1 that implies that there are significant differences between local/rural and distant/rural communities is rejected.

HB: *The local/rural (WTP^{LR}) versus distant/urban (WTP^{DU}) community test.*

A comparison of the IPs for each attribute between local/rural and distant/urban communities was undertaken. The tests for the comparison include: the Namoi/Namoi *versus* Namoi/Sydney, Lachlan/Lachlan *versus* Lachlan/Sydney and HN/HN *versus* HN/Sydney sub-samples.

The Poe et al. (1994) test showed no significant differences in IPs for NS and HW in all three tests between local/rural versus distant/urban communities. However, some significant differences in IPs for the HW and PA attributes between distant/rural and distant/urban communities were found. For example, there was a significant difference in values for the HW attributes in the two tests: Namoi/Namoi *versus* Namoi/Sydney sub-samples and the Lachlan/Lachlan *versus* Lachlan/Sydney. The local Namoi community (Namoi/Namoi) WTP for this attribute was (\$0.11) significantly different from zero and the value held by Sydney respondents in the Namoi/Sydney sub-sample was insignificant (see Figure 4). Also Sydney respondents' value for the HW in Lachlan catchment (Lachlan/Sydney sub-sample) the value estimate was insignificant but for the respondents from the local catchment (Lachlan/Lachlan sub-sample) the value estimate was \$0.83 and significantly different from zero. However there was no significant difference in IP for HW in the HN/HN *versus* HN/Sydney sub-samples test. No significant differences in IP for PA were found in the HN/HN *versus* HN/Sydney and Namoi/Namoi *versus* Namoi/Sydney

tests. But significant differences in WTP for PA in one test Lachlan/Lachlan *versus* Lachlan/Sydney sub-sample was found. Lachlan residents' WTP for the increase in one person working in agriculture in their own catchment was \$0.27 and significant whereas the WTP for Sydney respondents was not significant.

Hence, the null hypothesis HB_0 that implies that there are no significant differences in values between local/rural and distant/urban communities is rejected and the alternative hypothesis HB_1 that implies that there are significant differences between these two communities is accepted.

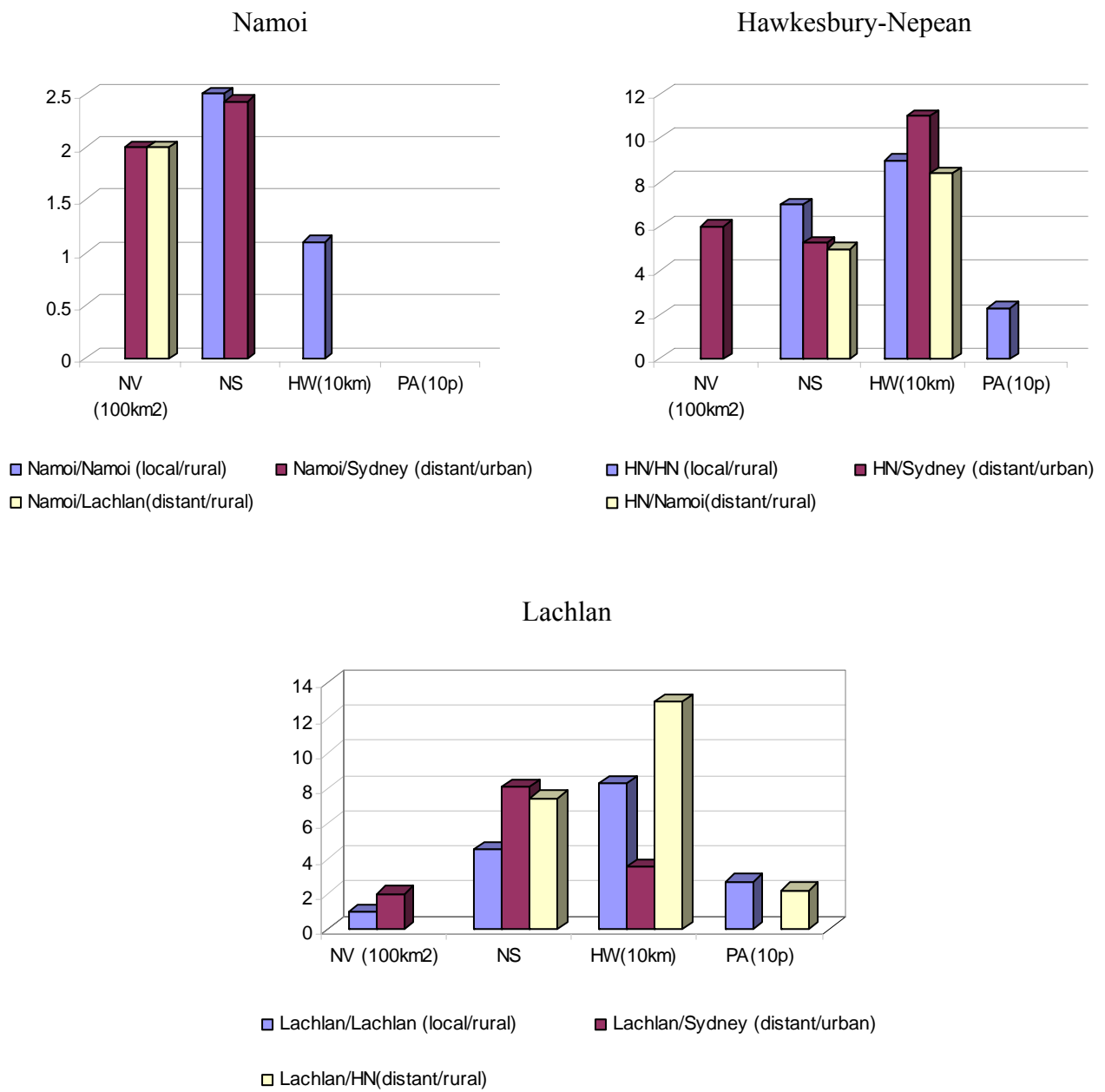
HC: *The distant/rural (WTP^{LR}) versus distant/urban (WTP^{DU}) community test.*

A comparison of the IPs for each attribute includes the following tests: Namoi/Lachlan *versus* Namoi/Sydney, Lachlan/HN *versus* Lachlan/Sydney and HN/Namoi *versus* HN/Sydney.

Only for one test (Lachlan/HN *versus* Lachlan/Sydney) significant differences for the HW and PA attributes were found (see figure 4). The results showed that in the Lachlan/Sydney sub-sample value for the improvement in one kilometre of HW in the Lachlan was insignificant but respondents from the Hawkesbury-Nepean catchment value this good at \$1.29 (Lachlan/HN sub-sample). Also the IP for PA was not significant in the Lachlan/Sydney sub-sample whereas in the Lachlan/HN sub-sample the value for this attribute was \$0.22 and significantly different from zero. The IPs for NS and NV were not significantly different between Lachlan/HN *versus* Lachlan/Sydney sub-samples. Also the IPs for all the attributes do not differ significantly between Namoi/Lachlan *versus* Namoi/Sydney, and HN/Namoi *versus* HN/Sydney sub-samples.

The null hypothesis HC_0 that implies that there are no significant differences in WTP between distant/urban communities and distant/rural communities is rejected and the alternative hypothesis HC_1 that implies that there are significant differences between these two communities is accepted.

Figure 4. A comparison of significant IPs for each three catchments



10. Conclusion

A key issue that arises from the valuation of entire population values towards different non-market goods is whether value estimates differ across different communities and locations. The empirical results for the CL and RPL models that account for preference heterogeneity emphasise the need to account for heterogeneity in preferences across different communities and locations. The tested hypotheses show significant differences between the distant/urban *versus* distant/rural and distant/urban *versus* local/rural communities. The differences mostly exist between the IPs for HW and PA for the Lachlan and Namoi catchments. However, there are no significant differences in all the attributes' values for the Hawkesbury-Nepean catchment between the three different types of communities. Also the IPs of NV and NS were not significantly different between all the communities.

Moreover, the impact of different socio-economic characteristics on choices was identified to be of different significance for different communities' types as indicated by the sign and significance of the coefficients. This implies that an appropriate aggregation of the values for environmental improvements should be made on the basis of different communities' preferences and socio-economic characteristics.

This study has shown that by taking into account the heterogeneity in preferences across different communities the aggregated values for the NRM could be estimated. A representative sample and survey procedure that reduces self-selection bias should also be applied.

By using this method, calculated values can provide information of the environmental priorities that different communities hold towards a variety of environmental improvements. The outcome of this study can be used in the CBA to guide NRM investment prioritization processes and to direct the environmental investments to those areas and environmental issues that provide the greatest net benefits.

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