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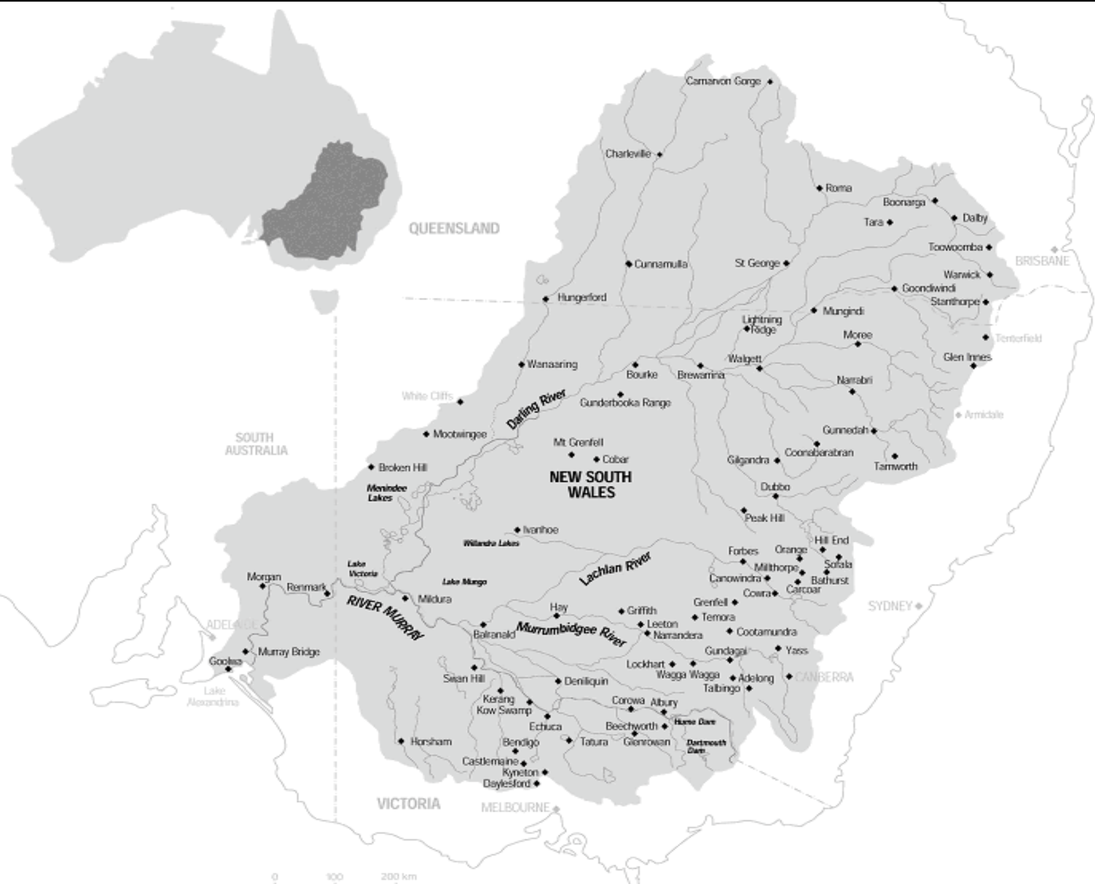

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CONSERVATION POLICIES, ENVIRONMENTAL VALUATION AND THE OPTIMAL SIZE OF JURISDICTIONS

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Abstract

The size of a jurisdiction is crucial in determining the efficiency, equity or efficacy of environmental regulations. However, jurisdictions are usually taken to coincide with political boundaries even if environmental externalities may transcend them. This paper illustrates the design and implementation of a Choice Modelling experiment to determine the spatial distribution of environmental benefits of Kings Park (Western Australia). The objective is to understand if federal, state or local resources are the appropriate form of funding a conservation policy. Results indicate that there are interstate spillovers of benefits, hence justifying federal contributions to Kings Park. They also show that some benefits are homogeneously spread within Western Australia, and this is an indication that state funding is also appropriate. Other benefits are distance-dependent; some level of local/council funding is warranted.

Keywords: *federal regulation, decentralised policies, benefits spillovers, environmental valuation, choice modelling, distance*.

1. Introduction

What is the optimal size of a jurisdiction for setting environmental standards? The question is largely unexplored. Most applied and theoretical analysis takes political boundaries ─the geographical limits within which authority *is* exercised─ as given (see, for instance, Shapiro and Petchey, 1997, Sigman, 2005). However, the optimal size of a jurisdiction ─the limits within which authority *should* be exercised─ depends on the spatial spillovers of environmental costs and benefits. There is no reason for political boundaries and these geographical spillovers to correspond. In practice, defining a jurisdiction is severely constrained. Nonetheless, identifying the optimal size of a jurisdiction indicates which administrative boundaries most closely match the optimal jurisdiction. In other words, to understand whether federal regulation is preferable to state intervention, it is necessary to establish the geographical limits of externality spillovers.

Unfortunately, there are serious limitations on the ability to detect the extent of spatial spillovers. For instance, environmental benefits and costs may not depend on the direct use of resources, and estimating the utility impact of environmental changes cannot solely rely on observed behaviour. Is it possible to use stated preference techniques to determine the geographical extent of externality spillovers? This has never been the focus of Contingent Valuation (CV) or Choice Modelling (CM) studies; their primary goal is the estimation of environmental benefits or costs in monetary terms. These techniques are controversial and their ability to truly capture environmental preferences is subject to ample criticism. Blamey *et al.* (1995), for instance, argue that private and public concerns motivate answers to CV questions. In a CV setting, they argue, respondents consider the interests of the wider community, and act as 'citizens' other than consumers; hence, CV does not provide information that can be used in cost-benefit analysis. How wide is 'the wider community'? Does it coincide with local, state or federal political boundaries? If Blamey *et al.*'s criticism is correct (but see Curtis and McConnell, 2002 for a contrary opinion), it would be possible to use stated preference techniques to provide information on *the existence* of preferences over geographical regions. This information can then been used to identify the optimal jurisdiction and contrast it to the actual level of policy intervention.

This article illustrates the CM technique applied to the task of identifying the spatial distribution of the environmental benefits of Kings Park & Botanic Gardens (hereafter KP), in Perth, Western Australia. The CM application uses two samples, drawn respectively within the boundaries of the park's jurisdiction and outside these boundaries. Two ways of incorporating spatial heterogeneity in the econometric model are also compared. The results of the CM application provide useful information on the appropriate level of environmental regulation and funding for KP.

The rest of the paper is divided into five sections. Section 2 discusses the relationship between the efficiency, the equity, and the effectiveness of regulations ─both federal and state─ and the spatial distribution of environmental externalities. Section 3 highlights the methodological challenges that the heterogeneous distribution of environmental benefits pose on CM. Section 4 provides a brief summary of the KP's survey. Section 5 shows and discusses the results of the CM application. Section 6 concludes.

2. Optimal environmental regulation and spillover effects.

Efficacy, efficiency and equity guide the design, the implementation, the enforcement, and the assessment of environmental policies. Federal laws are usually advocated on efficacy and equity terms (Oates, 1999):

- State agencies may not be effective whenever environmental degradation is a trans-boundary problem;
- Federal intervention assures equal enforcement within industries, firms and communities.

The efficacy, efficiency and equity arguments can also justify decentralised environmental policies:

- Local authorities have better information on the nature of environmental problems;
- State regulations can be tailored to take into account economic, geographical and social conditions.

Shapiro and Petchey (1997) highlight the main problem associated with this classical view of state/federal relations. The view is based on the assumption that governments have well-defined preference functions, which in turn requires either homogeneous preferences or that governments are omniscient Pigovian welfare maximisers. For instance, take the argument that federal regulation is better in case of trans-boundary environmental issues. One way to deal with externality spillovers is to increase the size of the jurisdiction so as to internalise benefits and costs. Such an extension is justified on welfare terms if benefits (or costs) *are uniformly distributed across the larger jurisdiction*. However, increasing the size of the jurisdiction can determine a welfare loss when benefits or costs are not spatially homogeneous. The loss may arise either from the reduced capacity to differentiate local outputs, or because some businesses or communities are forced to take unwarranted actions. The welfare loss may also occur from the excess of costs (e.g. increase in income tax) over environmental benefits for some individuals. Hence, the relative efficacy, efficiency and equity of both centralised and decentralised environmental policies depend crucially on the degree of overlapping between the spatial distribution of the environmental benefits and the jurisdictional limits of the environmental policy.

These arguments can be illustrated with reference to KP. The state of Western Australia supports the management of the park with around Au$8 million a year, the equivalent of about Au$8.00 per West Australian taxpayer. A small fraction of this amount (around Au$300,000) is spent every year for the conservation of native bushland. Improving conservation strategies for native vegetation requires additional financial resources. Four funding schemes are possible:

- the federal government sustains the whole costs of KP's conservation. This funding option is efficient if, for every Australian resident, direct or indirect benefits from KP are positive. Otherwise, a welfare loss would arise —for some Australians, conservation costs exceed conservation benefits. Further, given that each taxpayer pays the same amount for KP's conservation, this funding scheme is also fair if benefits from KP are equally distributed, so that each Australian taxpayer receives the same amount of net benefits.
- the state of Western Australia (WA) funds the conservation of KP's bushland. State funding is efficient if benefits from KP do not spill over to other states. Otherwise, state funding would provide an insufficient level of conservation. Also, in case of spillovers, there would be an equity issue because residents outside WA would benefit but would not pay the cost of KP's conservation. Further, if preferences over KP's conservation are not homogeneous within WA, welfare loss is likely because, for some WA taxpayers, conservation costs will be higher than conservation benefits.

- local authorities, such as councils or the park authority, should collect revenues to fund KP. Local funding is optimal if only users, or Western Australians living in the proximity of KP, gain from improved bushland management. Otherwise, this funding alternative would be neither efficient nor fair.
- Any combination of the three levels of financial support could be efficient and fair if benefits are not equally distributed and vary as distance from KP increases.

The crucial question is how to determine if KP produces benefits beyond its boundary, and eventually to identify the geographical limits of spillover effects. For some environmental problems, such as air pollution, it is usually possible to use information on the physical effect on the environment to infer the loss ─or gain─ in human welfare. For some others, such as biodiversity conservation, there is no clear link between the spatial manifestation of the phenomena and human welfare. Detecting the geographical limits of benefits and costs cannot rely on some physical effect on the environment, and it is necessary to use stated preference techniques such as CM or CV to estimate the effects of an environmental change on human welfare. As noted above, the estimated effects could either be the respondent's true welfare change or reflect the respondent's assessment of the welfare effects on a wider community. Either way, the information from stated preference techniques could be used to test the hypothesis of homogeneous environmental benefits ─or costs─ over the sample population. If the hypothesis is accepted, the sampled population ─the 'wider' community of Blamey *et al.* (1995)─ is the appropriate level of environmental regulation. If the hypothesis is rejected, the sampled population is divided in smaller communities, and environmental regulation should be enforced only on homogenous groups.

3. Spatial heterogeneity and environmental valuation.

CM (also known as Choice Experiment) is basically "a structured method of data generation" (Hanley *et al.*, 1998). It has been used in a large number of marketing, transportation and health care applications and it is increasingly applied in environmental valuation (Adamowicz, 2004). CM is based on Lancaster's characteristic approach (Lancaster, 1966) and Random Utility Theory (RUT). According to these approaches, choice behaviour can be described by:

- a function which relates the utility U_{ij} of each alternative j for an individual i to the set of the alternative's attributes Q_j and individual characteristics S_i:

  $$U_{ij}=V_{ij}(\boldsymbol{Q}_j, \boldsymbol{S}_i) + \varepsilon_{ij} \tag{1}$$

  It is assumed that each utility value can be partitioned into two components: an observable or systematic component V_{ij} and an unobservable, random component, ε_{ij}. Because of the random component, the choice problem is inherently stochastic from the point of view of the researcher and it can be formulated in probabilistic terms.

- a function linking the probability of an outcome to the utility associated with each alternative, which can be written as:

$$\Pr_{ij}[j \mid \boldsymbol{Q}_j, \boldsymbol{Q}_k, \boldsymbol{S}_i] = \Pr[(V_{ij}+\varepsilon_{ij}) > (V_{ik}+\varepsilon_{ik})] \qquad \forall\, j \neq k \qquad (2)$$

Individuals are assumed to choose the alternative that yields the highest utility. That is, alternative j is chosen if $U_{ij} > U_{ik}$ for each $j \neq k$. Equation (2) becomes:

$$\Pr_{ij}[j \mid \boldsymbol{Q}_j, \boldsymbol{Q}_k, \boldsymbol{S}_i] = \Pr[(\varepsilon_{ik}-\varepsilon_{ij}) < (V_{ij}-V_{ik})] \qquad \forall\, j \neq k \qquad (3)$$

Depending on the distributional properties of the error terms and the design of the experiment, parameters of the deterministic element V_{ij} can be estimated. In the most general form, V_{ij} can be parameterized as follow:

$$V_{ij} = \alpha_j + \Sigma_q \beta_q \mathbf{Q}_{jq} + \Sigma_{qs} \theta_{qs} \boldsymbol{Q}_{jq} \boldsymbol{S}_{is} + \Sigma_{js} \varphi_{js} \boldsymbol{S}_{is} + \Sigma_{js} \psi_{js} \boldsymbol{Q}_q \boldsymbol{Q}_p \qquad (4)$$

where α_j, β_q, γ_s, θ_{qs}, φ_{js} and ψ_{js} are parameters to be estimated conditional on: a) a vector of intercept terms for J-1 of the J choice options; b) the matrices of choice attributes $\mathbf{Q}$; c) interaction terms of attributes $\boldsymbol{Q}_q\boldsymbol{Q}_p$, and of attributes and individual characteristics $\boldsymbol{Q}_{jq}\boldsymbol{S}_{is}$; and d) the interactions between intercept terms and individual characteristics.

This model can be used to understand how and if preferences for environmental changes vary across jurisdictions. Spatial heterogeneity of preferences can be basically accommodated in two ways. The first possibility is to specify the source of preference heterogeneity directly in the systematic element V_{ij} of the utility function. The utility impact of a change in an environmental attribute —that is, β_q— depends on a variable representing spatial variability S_{i1}:

$$\beta_{qi} = \beta_q + f(S_{i1}) \quad (5)$$

$\boldsymbol{S_{i1}}$ can be either a categorical variable identifying, for instance, to which jurisdiction the individual i belongs, or it can be a continuous variable, such as the individual's distance from the environmental goods. If the error terms ε_{ij} in equation (1) are assumed to be i.i.d. extreme value, the model corresponds to the classic Multinomial Logit (MuL) model (Kenneth, 2003). The second possibility consists in superimposing random (unobserved) heterogeneity over the non-random (observed) heterogeneity of the previous method:

$$\beta_{qi} = \beta_q + f(S_{i1}) + \phi_i \quad (6)$$

where ϕ_i is assumed to be normally distributed across individuals. Hence, the utility impact of environmental changes β_{qi} depends on the distribution properties of the random element ϕ_i and individual characteristic S_{i1}. This formulation is appropriate if there are reasons to believe that S_{i1} does not fully capture the source of preference heterogeneity. Assuming that ε_{ij} are i.i.d. extreme value, the model is a Mixed Logit model (MiL) (Bhat, 2000).

In order to make operational these behavioural models it is necessary to ensure that the sample represents the populations with regards to the S_{i1} variable. It is also important to select a metric for S_{i1} by balancing its explanatory power with its measurability. Finally, no particular specification should be imposed on the function $f(S_{i1})$.

4. Background of the survey on Kings Park.

The CM survey was designed in consultation with KP management authority. KP extends for over 400 hectares at the centre of the Perth's metropolitan area. It consists of two basic landscapes: bushland and developed areas. The bushland ─320 hectares─ is mainly covered by native vegetation representative of the West Australian environment. It contains more than 450 species of plants, 70 types of birds, and one of the richest assemblies of small reptiles in the region. The developed areas contain recreation facilities, memorials, and a botanic garden. The park has a strong spiritual meaning for the Aboriginal people and is regarded as a place of commemoration, education and recreation. The management authority indicated three major problems in KP's bushland: weeds, trampling and fires. Hence, the CM study aimed to help the management authority to prioritise its conservation efforts, and to investigate the possibility of raising funds to further improve the bushland. This last issue was particularly important, given that state funds for the park are controversial.

The data generating mechanism of the CM technique requires:

- the definition of the set of attributes Q_j for the choice alternatives;
- the identification of the possible levels for each attribute;

- the description of alternatives and attributes in meaningful and comprehensible way;
- the definition of the choice set *J*.

Three focus groups addressed the first three tasks. They concluded that choice options should be described in terms of management options for KP's bushland using four attributes ─ percentage of weed-free bushland, percentage of bushland annually destroyed by fires, percentage of the accessible bushland, and individual contribution to support the preferred management strategy. Hence, a management option illustrates how the park authority can allocate its resources – eradicating weeds, preventing fire, or closing the bushland to the public. Table 1 shows the final set of attributes and attribute levels. Focus groups also gave important suggestions on the format and wording of the questionnaire. The choice set *J* was designed by systematically varying the attribute levels with a Graeco-Latin orthogonal procedure. Respondents were presented with eight choice sets, each composed by the current management strategy (status quo) and two other management options. Figure 1 gives an example of a choice set.

Sampling was conducted in Western Australia (WA) and in Queensland (QLD). The WA population was stratified in 11 distance zones (table 2). From each distance zone, WA residents were randomly selected; then they were firstly contacted by phone and successively received the KP questionnaire by mail, with a pre-paid envelope to send it back. Random selection, phone contact and questionnaire posting were repeated to obtain a sufficient number of responses from each zone. 750 questionnaires were sent and 324 were returned (42% response rate). The final sample is geographically balanced ─ it mirrors the spatial distribution of the WA population in each zone (table 3). The WA sample allows testing the hypothesis that benefits from KP are homogeneous within the WA borders. The QLD sample consists of 42 interviews collected in Brisbane (QLD), and is based on a questionnaire different from the one used for the WA sample. The major changes involve the amount of information on KP provided to the respondents and the levels of the cost attribute. While WA residents contribute via income tax to fund KP, QLD residents do not. Hence the status quo is necessarily different for the two samples. Despite these changes, there were serious self-selection problems. As a result, the QLD sample is mostly made up of female, well-educated and wealthy individuals (table 3). Furthermore, the sample is practically made up of people living at the same distance from KP. It offers no spatial variability. However, it can still provide an indication of the existence of KP's benefit spillovers across the boundaries of WA.

5. Empirical results.

Different specifications of the two behavioural models are possible. Spatial variability S_{i1} is specified using two distance metrics ─subjective travel time and geographical distance. The function $f(S_{i1})$ takes several forms ─linear, log-linear, quadratic, and 2nd, 3rd, and 4th order polynomial, and a simplified gravitational model (Beckmann, 1999). Two classes of statistical tests are used to select the best specification. The Likelihood Ratio (LR) test compares nested specifications (Louviere *et al.*, 2000). The Vuong test is used to discriminate among non-nested specifications (Vuong, 1989). Whenever this test is inconclusive, Clarke's distribution-free test is used (Clarke and Signorini, 2003). The variables entering the models are distinguished in five groups:

- the Status Quo (SQ) dummy whose coefficient measures the utility associated with choosing the current management strategy for KP;
- the interactions of individual characteristics ─income, education level, environmental attitude─ with the SQ;
- the choice attributes Weed, Fire and Accessibility. Their parameters measure the marginal utility associated with the attribute change. In the MiL models, these parameters are assumed to be normally distributed;
- the interactions of the choice attributes with the distance variates. Because variations in the choice attribute change the possibility of directly and indirectly benefiting from KP, distance is expected to take a different functional form for each choice attribute.
- the choice attribute COST, measuring the individual contribution required by each management option.

WA sample.

The chosen specifications for the WA models, with travel time and geographical distances, are reported in table 4. In terms of goodness of fit, the MiL models perform slightly better, as indicated by a larger Adjusted R^2 (Louviere *et al*., 2000). The SQ is never significant, but respondents who believe more money should be spent on the environment (environmental attitude = 1) have a preference for changing the management strategy for KP. The attribute coefficients have the expected signs. The Weed attribute has a positive sign, indicating respondents' preferences over increasing efforts to control weeds in KP. The Weed parameter is also constant across models and distance metrics. The Fire attribute has negative coefficients, but its magnitude and statistical significance change across models and distance metrics. The negative signs show that people prefer a reduction in fire damages in KP's bushland. The Accessibility attribute has either a positive coefficient or it is not significant. A positive coefficient indicates that respondents prefer having access to the KP's bushland. The parameters of the Cost attributes have the expected sign and are very similar across the models and distance metrics.

Figure 2 depicts the effect of distance on the attribute implicit prices -—the monetary value of the utility change produced by a 1% variation of the attribute. There are some regularities and some inconsistencies. No effect of distance is recorded for the Weed attribute. No matter how distance is measured and how it enters the econometric model, the coefficient of the Weed attribute does not vary over space. Distance effects on the coefficients of the Accessibility attribute are recorded only in models that use the Time distance, probably because this metric has more explanatory power than geographical distance (McConnel and Strand, 1981). These effects are negative and take either a logarithmic or quadratic form. They indicate that less importance is assigned to access as distance from KP increases. With the logarithmic specification, distance never brings the Accessibility implicit price below zero within the dataset. The results for the Fire attributes are more troublesome. Distance effects are not significant in the MiL-Time distance model. They take a logarithmic form in the MuL-Geographic distance model; in the MuL-Time distance model, distance enters according to a 3rd order polynomial. Finally, in the MiL-Geographical distance model, distance effects take a 4th polynomial shape. Fires in Australia are a highly emotive issue. Hence, the spatial behaviour of the Fire coefficient could be partially explained by recent fire episodes and the different spatial distribution of risks of fires. Unfortunately, the distance variable is not able to capture this last feature. Indeed, fire risk is connected to weather patterns that clearly do not change linearly according to the distance from KP. The models, however, treat respondents living in the tropical north the same as those living in the Mediterranean-type climate of the south. There is clearly some spatial variability that is not captured by the distance variable, as indicated by the statistically significant standard deviation of the Fire attribute in the MiL-Geographical distance model.

QLD sample.

As noted above, the QLD sample is strongly biased in favour of highly educated, wealthy and female individuals. This is an indication in itself. Sampling the QLD population in Brisbane was a lengthy process; many contacted individuals refused to take part in the survey because they did not have time for the interview; others simply were not interested in KP. Any results from the QLD sample must then be seen in the light of these facts. The QLD dataset is analysed separately from the WA dataset because the survey format was different between the samples. Further, the QLD sample is analysed using both a MuL model and a MiL model, but distance does not enter the models because the whole sample was collected in one location. Table 5 reports the results for the QLD sample. The MuL and the MiL models perform similarly in terms of the Adjusted R^2; also, the estimated standard deviations of the normally distributed parameters ─the attribute coefficients─ in the MiL model are not significantly different from zero. This indicates that there are no sources of unobserved heterogeneity within the sampled individuals. The coefficient for the SQ dummy variable is negative but not significant. The coefficients of the choice attributes are significant. The Weed coefficient has a positive sign ─less weeds is better;

the Fire coefficient has a negative sign ─less fires is better; the coefficient for the Accessibility attribute is negative ─reduced accessibility is better.

Comparison of the two samples.

Assume the KP authority increases the area of weed-free bushland by 20% while leaving unchanged accessibility and fire damages. That is, in this new management scenario only the distance-independent attribute improves. From each sample, take an individual with the same socio-economic characteristics ─a university-level education and with a "green" attitude[1]; the two individuals are similar but they come from different jurisdictions. What is the impact of the new management strategy on their welfare? Welfare effects are given by the difference between the utility associated with the status quo V_0 and the utility of the new management strategy V_1, divided by the marginal utility of income β_{COST} (Boxall *et al.*, 1996). Welfare changes are calculated using the parameter estimates from the MuL and MiL models. Table 6 shows the results. The four models for the WA sample estimate a welfare gain that ranges from Aus$5.34 to Aus$7.14 per year. Using the geographical distance gives the higher estimates. For the QLD sample, the MuL and the MiL models give an estimate of Aus$5.16 and Aus$9.11 per year, respectively. As previously noted, the MiL model for the QLD sample is redundant; it does not perform better than the MuL

[1] Environment attitude=1 if the respondent declares governments should spend more money on the environment.

model, and the estimated standard error of the normally distributed attributes are not statistically significant. Hence, the welfare gains from the alternative management scenario for a Queenslander are slightly lower than the welfare gains of a Western Australian. This indicates that for individuals with strong environmental preferences, jurisdictions do not matter.

Discussion.

A number of policy-relevant issues can be drawn from the model results. First, there are some spatially homogeneous benefits within the WA border. If respondents are expressing their true individual welfare gains and losses, or if they are giving an assessment of welfare changes for a wider community, their preferences indicate that the conservation of KP's bushland determines benefits that spread to the whole West Australian community. State funding from the WA government is warranted. Second, for some attributes and/or for some model specifications, distance drives the benefits to become negatives. Financial assistance from councils in the proximity of KP would be a good way to increase the equity of the taxation system. Thirdly, there is also ground for contributions from inter-state residents. These contributions could be in the form of federal transfers or simply an access fees to KP for inter-state visitors.

On methodological grounds, this application suggests that it is possible to design and implement an environmental valuation study with the goal of determining the optimal size of a jurisdiction. This issue is largely unexplored, and environmental valuation techniques seem to be suited and versatile to tackle the task. There are clearly several developments to be made. In order to increase response rates from jurisdictions other than the one where environmental good is located, new sampling strategies should be developed. Improvements in the definition of spatial variability, possible with a combination of indicators, are also needed.

6. Conclusions.

Controversies between levels of government on matters of environmental policy design, implementation and enforcement are common and widespread. There are several arguments in favour of more efficient federal interventions or fairer state/local regulation. In this paper it is argued that the relative efficiency, equity and effectiveness of an environmental policy depend on the degree of overlapping between the political boundaries and the geographical distribution of environmental externalities. The argument is discussed with regards to Kings Park (KP), Perth (Western Australia). In order to determine the appropriate level of environmental regulation and funding, the paper illustrates the use of a Choice Modelling technique to determine the effect of distance on the benefits of alternative management strategies for KP. The Choice Modelling application is based on the use of samples from two jurisdictions, two different distance metrics, several different functional form specifications, and two econometric models.

The results suggest that federal, state and local funding support for KP are all justified. Some benefits from the park are distance-independent or distance effects are small, indicating that individuals living as far as 1500 km from the park still benefit from it. Also, residents of other states could benefits from improved management strategies for KP. For sampled individuals with strong environmental preferences, the crossing of a jurisdiction does not make much difference. Other benefits are strongly affected by distance. This shows that a certain level of local (council level) financial support for the park is justified. A funding system for KP based on federal, state and local resources would improve the equity of the tax collection mechanism.

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Table 1. Attributes, levels and corresponding variables.

Attributes	Levels	Variable in Model
Weed-free Bushland (in %)	30, 40 (sq)*, 50, 60	*Weed*
Bushland annually destroyed by Fire (in %)	1, 3, 6 (sq)*, 9	*Fire*
Bushland accessible to the Public (in %)	25, 50, 75, 100 (sq)*	*Acc*
Annual increase on income tax (in $)	0.30 (sq)*, 1, 3, 6	*Cost*

*(sq) = status quo levels

Table 2. Distance zones, population and sample shares.

	Distance from KP	Population	Population Share	Returned Questionnaires	Sample Share
ZONE 1	0-5 Km	170,945	9.4	33	10.2
ZONE 2	5-10Km	330,966	18.2	58	17.9
ZONE 3	10-15 Km	317,817	17.4	55	17.0
ZONE 4	15-20 Km	223,801	12.3	41	12.7
ZONE 5	20-30 Km	157,472	8.6	29	9.0
ZONE 6	30-50 Km	125,513	6.9	22	6.8
ZONE 7	50-100 Km	78,206	4.3	11	3.4
ZONE 8	100-150 Km	87,731	4.8	14	4.3
ZONE 9	150-300 Km	70,587	3.9	13	4.0
ZONE 10	300-700 Km	97,337	5.3	18	5.6
ZONE 11	Over 700 Km	162,289	8.9	30	9.3
TOTAL		1,822,664	100	324	100

Table 3. Population and sample characteristics.

	Western Australia		Queensland	
	Population	*Sample*	*Population*	*Sample*
Gender				
Male (%)	49.8	42.6	48.8	40.5
Female (%)	50.2	57.4	51.2	59.5
Average Age	34.3	50.3	35	39.02
Average Weekly Income ($)	693.2	989.5	300-399	771.5
Level of Education				
University (%)	18.5	30.2	36.47	71.43
Certificate (%)	16.7	14.2	17.59	9.52
Up to Y12 (%)	13.5	22.2	23.29	7.14
Up to Y10 (%)	40.3	26.2	18.37	4.76
Other (%)	10.9	7.1	4.27	7.14

Table 4. Results of model estimation, WA sample.

	Multinominal Logit				Mixed Logit			
	Time Distance		Geographical Distance		Time Distance		Geographical Distance	
	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
SQ	0.16	*0.806*	0.46	*0.460*	0.04	*0.951*	0.60	*0.425*
SQ*Envir.Attitude	-0.92***	*0.000*	-0.91***	*0.000*	-1.02***	*0.000*	-1.1***	*0.000*
SQ*Ln(INC)	0.12	*0.139*	0.06	*0.394*	0.16	*0.080*	0.09	*0.332*
SQ*Educ(=Y12)	-0.00	*0.992*	-0.04	*0.746*	0.01	*0.923*	-0.03	*0.871*
SQ*Educ(Cert)	-0.11	*0.480*	-0.04	*0.813*	-0.14	*0.437*	-0.01	*0.978*
SQ*Educ(Uni)	0.24*	*0.061*	0.19	*0.118*	0.24*	*0.098*	0.18	*0.213*
WEED	0.03***	*0.000*	0.03**	*0.000*	0.03***	*0.000*	0.03***	*0.000*
FIRE	-0.09***	*0.004*	-0.01	*0.775*	-0.13***	*0.000*	-0.14***	*0.000*
ACCESSIBILITY	-0.001	*0.890*	0.01***	*0.000*	0.01***	*0.000*	0.01***	*0.002*
Fire*Distance	-1.432	*0.161*					-0.47	*0.549*
Fire*Distance^2	10.64**	*0.038*			0.757	*0.102*	6.663*	*0.079*
Fire*Distance^3	-14.53**	*0.022*					-12.3***	*0.029*
Fire*Distance^4							5.78***	*0.021*
Fire*Ln(Distance)			0.025***	*0.005*				
Access*Ln(Distance)	-0.003**	*0.031*						
Access*Distance^2					-0.08***	*0.014*		
COST	-0.24**	*0.000*	-0.23***	*0.000*	-0.24***	*0.000*	-0.24***	*0.000*
Standard Deviation of Random Parameters								
Weed					0.045	*0.051*	0.058***	*0.010*
Fire					0.163	*0.183*	0.245***	*0.017*
Access					0.003	*0.744*	0.008	*0.364*
Observation	1424		1656		1424		1656	
Log Likelihood	-1369.29		-1592.93		-1371.01		-1593.09	
Adjusted R^2	0.078		0.074		0.118		0.120	

*** *significant at 1%*
** *significant at 5%*
* *significant at 10%*

Table 5. Results of model estimation, QLD sample

	Multinominal Logit		Mixed Logit	
	Coeff.	P-value	Coeff.	P-value
SQ	-0.799	0.600	-0.989	0.689
SQ*Envir.Attitude	-0.624	0.203	-1.151	0.193
SQ*LN(INC)	0.253	0.215	0.380	0.259
SQ*Educ(=Y12)	0.317	0.625	0.293	0.775
SQ*Educ(Cert)	-0.232	0.514	-0.333	0.560
SQ*Educ(Uni)	-0.634	0.184	-1.191	0.149
WEED	0.042***	0.000	0.061***	0.007
FIRE	-0.136***	0.000	-0.308**	0.049
ACCESSIBILITY	-0.016***	0.000	-0.023***	0.001
COST	-0.163***	0.001	-0.135	0.127
Standard Deviation of Random Parameters				
Weed			0.096	0.153
Fire			0.597	0.102
Access			0.017	0.397
Number of observations	336		336	
Log likelihood	-292.771		-290.198	
Adj R^2	0.112		0.116	

*** *significant at 1%*
** *significant at 5%*
* *significant at 10%*

Table 6. Individual welfare gains from a new KP management strategy.

Sample	*Model*	*Distance Metric*	Welfare Gains (in Aus$ per year)
WA	Multinominal	Time	5.34
		Geographical	6.37
	Mixed	Time	5.68
		Geographical	7.14
QLD	Multinominal		5.16
	Mixed		9.11

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