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Improving biodiversity conservation in northern Australia

Willingness of north Australian pastoralists and graziers to participate in contractual biodiversity conservation

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Willingness of north Australian pastoralists and graziers to participate in contractual biodiversity conservation: preliminary results

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Abstract

This paper reports results from a choice experiment conducted with pastoralists and graziers across Australia's tropical savannas in 2013 (n=104). The experiment is designed to inform the question under what conditions are north Australian pastoralists and graziers willing to sign up to voluntary on-farm biodiversity conservation contracts? Results are presented of random parameter logit models of best-worst responses and first preferences, revealing the importance of and trade-offs between contract attributes, and preference heterogeneity. An extended latent class model is also presented to further explore heterogeneity of respondents' preferences further. Discussion of the results in the context of the international literature is provided and policy implications are proposed.

Keywords

Choice experiment, response format, efficient design, willingness to accept, farmers, on-farm biodiversity conservation

Introduction

The tropical savannas of Australia are a vast landscape and support an abundance of endemic plants and animals. Though they may appear relatively intact, their ecological condition and biodiversity value has been extensively affected by over-grazing and spread of exotic plant and animal species (Lewis 2002; Woinarski *et al.* 2007). A below-average percentage of tropical savannas is contained in the formal conservation estate, prompting calls for farmers to be actively engaged in biodiversity conservation (Bennett 1995; Woinarski *et al.* 2007).

Farms in the tropical savannas are typically very large and derive all or most income from the production of grass fed beef (Bortolussi et al., 2005). Few are engaged in formal natural resource management projects (ABS 2011).

There have been a succession of biodiversity conservation programs in Australia, which have been ineffective in targeting and inefficient in design (Hajkowicz 2009). Designing incentive programs that are effective and efficient requires that policy makers have a detailed understanding of (i) the financial resources required to incentivize a sufficient number of farmers to participate in on-farm conservation and (ii) the way in which program and contract design and administrative features influence participation. This research generates such understanding by exploring how program attributes relate to farmers' willingness to participate in contractual on-farm biodiversity conservation.

Participation in a conservation contract and compliance with conservation requirements is conceived as farmers supplying environmental services for which they are remunerated (Greiner *et al.* 2009). Choice experiments have been used previously to inform the design of payments for environmental service programs (Ruto and Garrod 2009; Espinosa-Goded *et al.* 2010; Christensen, Tove *et al.* 2011; Beharry-Borg *et al.* 2013; Broch *et al.* 2013; Kaczan *et al.* 2013). More generally, choice experiments have become the method of choice for generating understanding to support the design of new agricultural markets (e.g. Windle and Rolfe 2014).

This paper summarises the key design features of a discrete choice experiment (DCE), which was conducted with farmers—or more specifically pastoralists and graziers—across approximately one million square kilometers of Australia's tropical savannas during 2013. The geographical coverage of the project is shown in Figure 1. Random parameter modelling (RPM) was chosen as choice modelling technique. Modelling results are presented and discussed. The modelling is ongoing and this paper offers some preliminary conclusions and ideas for further exploration.

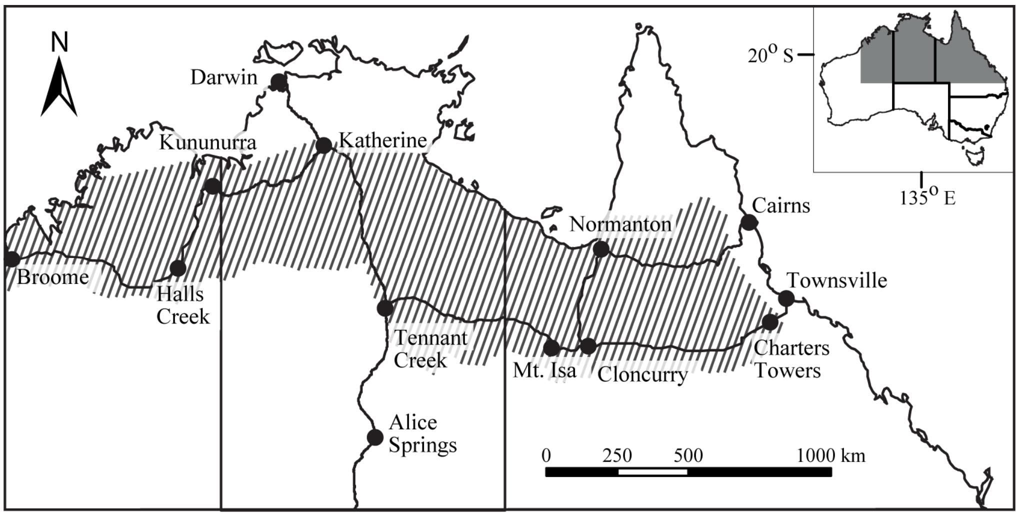
Design aspects of the choice experiment

The design of the choice experiment is detailed in a forthcoming paper by Greiner et al. (2014) and the following provides a synopsis of key design aspects.

The aim of a DCE is to estimate the weights that respondents place on each of the attributes which define the alternatives. A respondent acting rationally is expected to evaluate the alternatives in a choice task and choose the alternative which gives the greatest relative utility (Hensher *et al.* 2005).

Thus, a pastoralists is expected to choose land management alternative A over B, if U (X_A, Z) > U (X_B, Z), where U represents his/her indirect utility function from given land management alternatives, X_A the attributes of land use A, X_B the attributes of alternative B, and Z the personal (e.g. socio-demographic and attitudinal) and property characteristics (e.g. size, land productivity, farm profitability, ownership structure) that influence the pastoralist's utility. Choices made in

Figure 1: Overview of research area



DCEs are analysed using random utility theory, meaning a stochastic error term ε is included in the utility function to reflect the unobservable factors in the respondent's utility function (Hensher et al., 2005). Thus, a pastoralist will choose alternative A over B, if V (X_A, Z) + ε_A > V (X_B, Z) + ε_B, where V is the measurable component of utility estimated empirically, and ε_A and ε_B reflect the unobservable factors in the pastoralist's utility function of alternative A and B respectively.

Design dimensions fundamentally influence the results of choice experiments and resulting recommendations (Rolfe and Bennett 2009). In particular, design dimensions influence the fit of the econometric model applied to data analysis, as measured by the relative size of *ε*. A good design is able to explain more of the observed variance and minimizes the stochastic element. Decisions need to be made particularly in relation to (Hoyos 2010; Bliemer and Rose 2011):

- Number of alternatives defining a choice
- Attributes and attribute levels defining an alternative
- Response mechanism
- Make-up of the utility function
- Statistical properties of the experimental design
- Likely model to be used for data analysis
- Number of choice tasks

This DCE adopted a 'best-worst' response format, which revealed the first preference but also provided a full scaling of the four alternatives contained in every choice task. Best-worst scaling can pose an advantage in situations where the sample size is expected to be low and/or number of choice tasks needs to be minimised (Potoglou *et al.* 2011; Lancsar *et al.* 2013). Best-worst scaling has been found to be superior to 'pick one' format when dealing with qualitative data such as the different conservation requirements and different monitoring arrangements (Goodman *et al.* 2005; Flynn *et al.* 2007).

A 3-alternative design was adopted and a 'none' option was also included to reflect unconditional demand and thus ensure conceptual validity of the design given the voluntary nature of farmer participation in a payments-for-ecosystem services program. The alternatives were of an unlabelled type and had generic titles (options 'A', 'B' and 'C') to increase the respondents' focus on contract attributes and trade-offs between them (Louviere *et al.* 2000; de Bekker-Grob 2009).

Attributes and attribute levels were determined in a multi-stage process involving literature review, expert and industry consultation, and pilot testing (Ryan *et al.* 2008; Hoyos 2010; Klojgaard *et al.* 2012). They are summarized in Table 1. Payment levels were guided by historical data about the land productivity of the tropical savannas, in particular the value of cattle sales per hectare during 1992-2011 as derived from farm survey data (ABARES, 2012) and industry comment.

Table 1: Attributes and attribute levels

Attributes	Definitions / levels	Details
Conservation requirement / environmental service	Focus is on broad-acre species conservation by removing cattle either for the duration of the contract period or spelling the contract area each year for maximum biodiversity outcomes. 3 levels	Defined relative to cattle grazing: expressed as exclusion of cattle from the contract area ('spelling') and associated opportunity cost. SHORT spelling period each year depending on biodiversity need, e.g. during nesting season of brolga. Zero reduction in cattle production from that land. PROLONGED spelling each year, e.g. wetlands spelled during dry season; riparian areas during wet season. This may result in up to 50% reduction in cattle production from that land. TOTAL exclusion of cattle ('locking up country') resulting in zero cattle production from that land. Weed and feral animal control to be conducted and burning regime as defined necessary to achieve desired biodiversity outcomes.
Remuneration	Payment received [$ ha-1 a-1]; 6 levels	$1, $2, $4, $8, $16, $32; Payments are annual and indexed [basis year 2013]. Necessary infrastructure is paid for separately and up-front.
Contract length	Duration [years] 4 levels	5, 10, 20, 40 years
Flexibility	Ability to suspend the contract in 'exceptional circumstances' 2 levels	Not flexible: Standard contract with no ability to modify contract conditions. Penalties may apply if conditions are violated. Flexible: Option to 'suspend' participation in contracts of >5 year duration: Farmer can negotiate a 1-year suspension of the contract in 'exceptional circumstances' and graze the contract area during specified exclusion periods without incurring a penalty. Maximum frequency 1 in 5 years. No conservation payment received during that year.
Monitoring	Who conducts the monitoring 2 levels	External monitoring: The administrating agency undertakes regular monitoring or contracts an independent provider for the task. Self: The pastoralists undertakes the monitoring but random spot-checks are conducted to validate results of self-monitoring.

In terms of statistical properties of the design, a Bayesian D-efficient design was adopted (Bliemer and Rose, 2011; Sándor and Wedel, 2001). Efficient designs tend to lead to smaller standard errors in model estimation at smaller sample sizes compared to orthogonal design and enable much smaller designs in terms of the number of choice sets (Bliemer *et al.* 2009; Bliemer and Rose 2013). An efficient design was developed using ®Ngene 1.1.1 software (ChoiceMetrics 2012) and applying the Modified Federov algorithm.

The choice experiment adopted a panel design with 24 choice tasks being blocked into four versions of six choice tasks (i.e. each respondent completed six choice tasks). Figure 2 illustrates a discrete choice task.

Figure 2: Illustration of a discrete choice task

Block B Choice Situation 2	Option A	Option B	Option C	None
Conservation requirements	Cattle exclusion for prolonged periods; 50% loss of cattle production	Total exclusion of cattle + managing for biodiversity outcomes	Total exclusion of cattle + managing for biodiversity outcomes	
Annual payment ($/ha)	$ 8 / ha	$ 32 / ha	$ 16 / ha	
Contract length (years)	10 years	40 years	5 years	
Flexibility of conditions	Flexibility	No flexibility	No flexibility	
Monitoring conducted	Self (25% random spot-checks)	Self (25% random spot-checks)	External	
Q1: Which option would you choose?	○	○	○	○
Q2: Which is your least preferred option?	○	○	○	○
Q3: Which is your 2nd preferred option?	○	○	○	○

The DCE design was optimised for random parameter logit (RPL) modelling of choice data. RPL is a mixed multinomial logit model, which relaxes key assumptions constraining the interpretation of a multinomial logit (MNL) model, namely (i) IID—ie. that unobserved effects are 'extreme value 1' distributed, independent and identically distributed, (ii) independence of observed choices and (iii) homogeneity of preferences (Hensher et al., 2005). RPL models thus take into account heterogeneity of the parameter values among respondents (Train 1998; Hensher *et al.* 2005; Marsh 2012; Mariel *et al.* 2013). RPL also provide more flexibility, are behaviourally more appropriate and provide the analyst with information about heterogeneity in the data while estimating unbiased parameter estimates (Marsh 2012).

The design assumed a MNL model without accounting for covariate effects and was inspected for efficiency under panel RPL assumptions (Bliemer and Rose 2010). A constant representing the 'none' option was included in the design and the. The design was optimised using priors developed through a best-practice sequential process. Data from the pre-test were analysed in ®NLOGIT 5 software (Econometric_Software_Inc 2012) and resulting RPL parameter estimates were used as priors to inform an improved (more efficient) panel DCE design. Priors β_k for parameters *k* were defined as Bayesian prior distributions, assuming a normal distribution of parameter value with a mean value $\hat{\mu}_k$ and standard deviation $\hat{\sigma}_k$ so that $\beta_k \sim N(\hat{\mu}_k, \hat{\sigma}_k^2)$. The use of Bayesian priors took uncertainty about the prior parameter values into account and lead to a more robust efficient design (Sándor and Wedel 2001).

Survey administration and response

The choice experiment formed the key part of a survey of graziers and pastoralists. The survey further explored structural and financial aspects of the business, land management system, cattle enterprise, risk attitudes and management, environmental attitudes and management, and personal and family circumstances. These respondent-specific parameters could be included in the CE model specification so that their influence on likely participation in contractual biodiversity conservation could be quantified.

The unit of investigation was a farm business. A business unit often comprised several pastoral stations.

Two principal survey administration methods were adopted to maximise response rate and minimise participation bias of the sample (Wagner 2012). Research meetings were convened to coincide with industry meetings in the research area and station visits were made to conduct face-to-face interviews. In situations where several persons from the same pastoral property were present during the completion of the survey, they key decision maker was asked to apply the usual approach to decision making, which might mean the other attendees were consulted to various degrees or only got to watch and listen. Research meetings and on-farm visits took approximately 2-2.5 hours and respondents received a $ 200 gratuity.

Research meetings were organized to coincide with industry meetings or other events such as. To ensure integrity of the quantitative data in terms of independence of responses, possible interaction between respondents during meetings was minimised and influence by the meeting moderator was limited to that of the interviewer in a face-to-face situation. Station visits were arranged mostly by telephone along a travel path, which was often determined by the location and timing of an industry event. All business managers who could be contacted, were prepared to participate in the survey and available at a time matching the travel itinerary were interviewed.

Data collection occurred during April to July 2013 and 104 valid surveys were completed. Total area coverage was approximately 250,000 km^2, or about one quarter of the research area, with good coverage achieved in all three states/territories and a realm of property sizes and situations represented in the sample (Table 2).

Table 2: Overview statistics of survey respondents (n=104)

Property size (km^2)	Mean	2411
	Median	775
	Minimum	18
	Maximum	16116
	Total	250750
Herd size (head)	Mean	15925
	Median	7000
	Minimum	50
	Maximum	110000
	Total	1656200
Stocking rate (head/km^2)		
	Mean	8.9
	Median	8.1
	Standard deviation	4.9
	Minimum	0.8
	Maximum	22.8
Profit of the beef enterprise in 2011/12 (% of respondents)		
	Large profit	7%
	Small profit	36%
	Broke even	21%
	Small loss	17%
	Large loss	20%
Respondent's role on the property (% of respondents)		
	Owner-Manager	62.1%
	Employed manager	26.2%
	Other	11.7%
Gender of primary respondent (% of resondents)		
	male	81.6%
Age of primary respondent (% of respondents)		
	<30 years	5.8%
	30-39 years	24.3%
	40-49 years	26.2%
	50-59 years	25.2%
	60+ years	18.5%
Business structure (% of respondents)		
	Family owned	80.8%
	Corporation owned	19.2%
Length of current property ownership (% of respondents)		
	<5 years	8.7%
	5-9 years	11.7%
	10-19 years	26.2%
	20-39 years	29.1%
	40+ years	24.3%
Membership of industry / NRM organisation(s) (% pf respondents)		
	Yes	76.7%

Data analysis and model results

Random parameter logit models

Recognition of the heterogeneity in farm conditions and farmer preferences, and the desire to make this heterogeneity relevant for policy formulation, have underpinned the increasing use of RLP and LC models for the analysis of choice experiments in farming contexts (e.g. (e.g. Jaeck and Lifran 2014a; Schulz *et al.* 2014). Similarly, the reason for using RPL models was to establish the influence that attributes had on stated willingness to participate in contractual biodiversity conservation, trade-offs between them, and preference heterogeneity. Systematic influence of any covariates was also important to establish.

Before the choice data were analysed, protest votes were identified in a follow-up question after the choice sets. Four responses (3.8%, all from Queensland) were identified as such and removed from the analysis (Windle and Rolfe 2014). The choice data were analysed using two RPL models one considering the entire preference specifications of the 'best-worst' design, the second model focusing on the first choice within each choice task thus mimicking a 'pick one' design. All attributes were included as random parameters with a normal distribution. As per Windle and Rolfe (2014), the monetary variable was also specified as random and normal distribution was considered the most appropriate distribution to apply to a whole-of-industry sample. Testing indicated no notable improvement in model fit when other distributions, e.g. triangular, were applied. Both models applied 1000 Halton draws for simulations.

In addition to the attributes, a number of covariates were included in both models as non-random parameters. Covariates that were tested and found to be not significantly associated with choices included respondent age, property size, ownership and enterprise profitability. They were deleted from the final models. Significant covariates were retained, namely land productivity (measured as stocking rate, respondent attitude towards biodiversity and respondent opinion of the concept of payments for environmental services as a policy mechanism (Table 3).

At a general level, considering coefficient direction and significance, the two models yielded very similar results (Table 4). Direction of attribute influence was consistent with economic theory. In particular, higher conservation payments increased the likelihood of participation in conservation contracts while longer contract terms and higher opportunity costs from lost production (exclusion of cattle) generated significant disutility and reduced the likelihood of participation. The inclusion of flexibility provisions in contract design was found to influence stated uptake of conservation contracts significantly and favourably.

Table 3: Model variables

Variables	Details
Attributes	
TOTAL	Dummy coded 1 = Total exclusion of cattle is a required to care for biodiversity
LONG	Dummy coded 1 = Long spelling periods every year are required to care for biodiversity resulting in a loss of up to 50% of cattle production from that area
PAY	Conservation payment [$/ha/a]
YEARS	Contract period [years]
FLEX	Flexibility, ie. ability to suspend contract in 'exceptional circumstances': 1 = yes, 0 = no
MONITOR	Who conducts the monitoring: 1 = self (ie. grazier but with spot-checks), 0 = external
ASC	Alternative specific constant = 1 for status quo alternative
Covariates	
AGE	Age of respondents [5 categories: 1 = <30 years old to 5 = 60+ years old; see Table 2]
PROFIT	Stated profitability of cattle enterprise during 2011/12 [5-point response scale: 1=large loss, 2=small loss, 3=broke even, 4=small profit, 5=large profit]
HEADPKM2	Stocking rate as indicator of land productivity [head/km^2]
BIO-ATT	Attitude towards biodiversity as measured in terms of agreement with statement 'Biodiversity is important to me personally' [5-point response scale: 1=strongly disagree to 5=strongly agree]
PES-ATT	Perceived effectiveness of 'financial incentive schemes such as the one explored in this research to help you undertake (more) conservation activities on your operation' [5-point response scale: 1=not effective at all to 5=extremely effective]

Table 4: RPL model results for 1st preference and best-worst data

	Model 1: 'Best-worst' (1643 observations)		Model 2: 1st preference (598 observations)	
	Coefficient	SE	Coefficient	SE
Random parameter means				
CR-High	-1.1023 ***	0.2508	-2.8657 ***	0.5526
CR-Medium	-0.1103	0.1443	-0.9114 **	0.3548
PAY	0.1136 ***	0.0155	0.2612 ***	0.0344
YEARS	-0.0448 ***	0.0051	-0.1073 ***	0.0167
FLEX	0.8257 ***	0.1496	1.5266 ***	0.3195
MONITOR	-0.2369 **	0.1000	-0.2987	0.2210
Random parameter standard deviations				
CR-High	1.1637 ***	0.2791	2.1840 ***	0.5877
CR-Medium	0.9409 ***	0.1321	1.7450 ***	0.3457
PAY	0.1077 ***	0.0147	0.1399 ***	0.0310
YEARS	0.0306 ***	0.0056	0.0829 ***	0.0136
FLEX	0.9955 ***	0.2623	1.6169 ***	0.3744
MONITOR	0.3563	0.2638	0.8896 **	0.3515
Non-random parameters				
HEADPKM2	-0.0433 ***	0.0138	-0.0859 ***	0.0272
BIO-ATT	0.6372 ***	0.1472	0.6770 **	0.2844
PES-ATT	0.3514 ***	0.0885	0.6360 ***	.1927
ASC	4.0508 ***	0.7120	4.6347 ***	1.4383
Model statistics				
Observations	1643		598	
Log likelihood	-1521		-566	
AIC/N	1.873		1.945	
McFadden Pseudo	0.3323		0.3177	
X^2	1514		527	

Note: SE = Standard error; ASC = alternative specific constant

***, **, * → significance levels at 1%, 5% and 10%, respectively

The alternative specific constant was large and highly significant for both models, reflecting a strong status quo effect or a general reluctance by the graziers and pastoralists to participate in contractual biodiversity conservation. The 'none' option was the preferred option in 36.7 % of choice tasks and 8.1 % of respondents answered 'none' in all their choice tasks. This may explain the more pronounced attribute coefficients in the 1st preference model compared to the best-worst specification. The status quo preference was explained by qualitative data gathered, whereby many respondents recognised the income diversification potential but voiced a number of concerns they had about conservation contracts. Concerns included institutional risk *'what may be voluntary now may become compulsory later'*, environmental risk *'fences may get washed away during floods and the cattle get in—we may not know or may not be able to do anything about it for weeks'* and financial risk associated with long contract lengths *'in 20 years cattle may be worth a whole lot more than now'*.

Land productivity, as measured by stocking rate, was found to significantly and negatively influence the participation choice in both models. Both models found respondents' level of personal interest in biodiversity to be a significantly and positively correlated to stated participation as was a positive attitude towards financial incentives as a policy instrument.

The willingness-to-accept estimates for the choice attributes were calculated for both models using the mean parameter coefficients with confidence intervals estimated using the Krinsky and Robb (1986) procedure (Table 5). The 1st preference model gave slightly higher WTA estimates associated with production opportunity costs caused by conservation requirements. Allowing flexibility of contract conditions reduced WTA by around $6 to $7 per hectare and year.

Table 5: WTA estimates and confidence intervals for the 1st preference model ($/ha/a)

Attribute	Summary description	Model 1: 'best-worst'		Model 2: 1st preference	
		Mean WTA	95% confidence interval	Mean WTA	95% confidence interval
TOTAL	Implementing a conservation strategy that requires cattle to be excluded from contract area for the duration of the contract	9.63	(6.12—12.86)	11.08	(7.45—14.47)
LONG	Implementing a conservation strategy whereby the contract area is spelled every year for an extended period of time resulting in up to 50% loss of cattle production from that area	0.95	(-1.60—3.21)	3.45	(0.71—5.95)
YEARS	Adding one year to the contract duration	0.40	(0.31—0.41)	0.41	(0.31—0.53)
FLEX	Introducing into contracts the possibility that a grazier can negotiate to suspend the contract in 'exceptional circumstances' but no more than 1-in-5 years	-7.37	(-10.83— -4.62)	-5.90	(-8.54— -3.47)
MONITOR	Moving from an external monitoring system to monitoring being undertaken by the grazier (with occasional spot-checks)	2.16	(0.31—4.20)	1.17	(-0.52—3.02)

Latent class model

To further explore heterogeneity of preferences among respondents, latent class (LC) models were also developed. LC models assign respondents into behavioural groups or latent classes, thus accounting for taste differences or different types of decision heuristics (Beck *et al.* 2011). Preferences are assumed to be homogenous within each latent class differ between segments (Colombo et al. 2009). Determining the final number of classes is an iterative process, combining quantitative measures of model fit and meaning in a given context (Beck *et al.* 2011). A variety of LC models were tested for the best-worst and 1st preference data, including the attributes and covariates found to be significant in the RLP (Magidson and Vermunt 2004). Estimates for the Akaike information criterion (AIC) are summarized in Table 6.

Table 6: Latent class model comparison based on goodness of fit (AIC/N)

Number of classes	Best-worst scaling (1643 observations)	First preference (598 observations)
2	1.887	2.132
3	1.864	2.036
4	1.852	1.977
5	1.836[1)]	1.938

1) Contained an insignificant class

According to the AIC the LCMs based on best-worst scaling data appeared superior, upon detailed inspection the first preference models delivered a more compelling narrative, and the extended 4-class model is used to illustrate different preference structures among graziers and pastoralists (**Error! Not a valid bookmark self-reference.**).

Table 7: Latent class model results for 1st preference data

	Class 1			Class 2			Class 3			Class 4		
	Coefficient		SE	Coefficient		SE	Coefficient		SE	Coefficient		SE
Attributes												
TOTAL	-2.231	***	0.728	-3.590	***	0.360	-1.695	**	0.594	-0.890		0.689
LONG	-1.838	**	0.758	-0.433		0.763	0.398		0.802	-0.172	*	1.002
PAY	0.236	***	0.055	0.113	***	0.300	0.333	***	0.053	0.263	***	0.061
YEARS	-0.230	***	0.051	-0.380	***	0.100	-0.145	***	0.026	-0.025		0.023
FLEX	1.774	***	0.570	1.700	***	0.340	0.276		0.336	1.606	***	0.420
MONITOR	-0.632		0.493	-0.244		0.246	0.310		0.312	-0.608		0.395
Covariates												
HEADPKM2	-0.242	**	0.103	-0.033	**	0.014	-0.362	***	0.105	0.106		0.083
BIO-ATT	0.272		0.328	-0.569		0.388	0.352		0.521	0.932		0.574
PES-ATT	0.176		0.219	0.196		0.262	2.581	***	0.658	8.000	***	0.264
ASC	0.540		2.024	-2.497		1.852	7.911	**	3.312	8.070	***	2.385
Membership probability	0.216	***	0.046	0.272	***	0.048	0.269	***	0.056	0.244	***	0.052
Model statistics												
Observations	598											
Log likelihood	-548											
AIC	1182											
McFadden Pseudo R^2	0.339											
X^2	562											

Note: SE = Standard error; ASC = alternative specific constant

***, **, * → significance levels at 1%, 5% and 10%, respectively

The membership probability is very similar for the four classes, ranging from 22 to 27 %. The level of stewardship payment *Pay* was significant at $p < 0.01$ for all four classes, indicating the central role of the stewardship payment in respondents' utility function and decision making. *Monitor* was not found to be significantly influencing choices in any of the four classes, indicating that preferences for either self-monitoring or external monitoring were evenly distributed in all classes.

Classes 1 and 2 were similar in that both had a non-significant ASC meaning that members were guided in their decisions by consideration of the contract benefits in relation to land productivity for cattle production. *Flex* had a large and highly significant coefficient. The key difference between the two classes was that class 1 attributed a higher preference for financial dimensions—conservation payment relative to land productivity—compared to other contract attributes. Class 2 was more sensitive to contract length and attributed higher dis-utility to total exclusion of cattle, but not long spelling each year.

Classes 3 and 4 had very large and significant ASC values, indicating an inherent reluctance to participate in contractual biodiversity conservation. Stated participation in contractual biodiversity conservation was significantly associated with a positive attitude by class members of financial incentives. The level of conservation payment was very important, particularly for class 3 which was very conscious of the beef productivity of the land and associated opportunity costs. Class 3 also had a strong preference for shorter contract periods while class 4 was relatively unconcerned about the conservation requirements or contract duration and more interested in the stewardship payment and contractual flexibility.

Discussion

The research presented in this paper is based on a sample of 104 north Australian graziers and pastoralists. While the sample may appear small in absolute terms it is large in relative terms as respondents collectively manage approximately 250,000 square kilometres of land, or approximately one quarter of the study area. The sample also succeeds in capturing the heterogeneity of business and socio-demographic conditions of pastoral enterprises across the tropical savannas.

RPL models were developed for the best-worst scaling data as well as the 1st preference data. The models yielded similar but not identical results and different WTA estimates for a number of attributes. Differences in estimates between the two elicitation methods have been reported in the literature (Louviere and Islam 2008). In this case, there was virtually no difference for *Years* but differences were particularly large for some qualitative variables (up to 73% for some significant qualitative variables). The likely reason is lack of consistency in choices in best-worst scaling tasks (Giergiczny *et al.* 2013). This is corroborated by the author's observation of many respondents struggling to complete the final scaling question in each choice task. Compounding this matter is the strong status quo effect, which can only be truly tested on the 1st preference choice, which makes it is probable that the model coefficients derived from best-worst scaling misrepresent preferences on key attributes, trade-offs and preference heterogeneity. Given that the 1st preference data produce compelling models, there is no need to rely on the augmented choice data.

The model results about attribute preferences are consistent with the literature reporting choice experiments of farmers' stated participation in environmental services programs elsewhere.

Pastoralists and graziers require a greater monetary incentive to sign up to longer contract periods or alternatives causing higher opportunity costs, and they prefer flexibility (Windle and Rolfe 2005; Ruto and Garrod 2009; Espinosa-Goded *et al.* 2010; Christensen, T. *et al.* 2011; Peterson *et al.* 2011; Yu and Belcher 2011; Broch and Vedel 2012; Jaeck and Lifran 2014b).

Interestingly, the research did not find any statistically significant influence of where the pastoral properties were located (by state), what size they were, whether they were family operated or corporation owned, or based on age of respondent. The principal reason for heterogeneity among respondents was extent of status quo preference, driven by attitudes towards these types of contracts and perceived risks of engaging in conservation contracts. Other than that, choice decisions followed a clear rationale, in that options were evaluated relative to land productivity (opportunity cost) and in a business-oriented attribute preference and trade-off space.

Concluding comments

The choice modelling results presented here are the first of a series of results to be produced from a choice experiment with graziers and pastoralists in northern Australia. The results establish a narrative that decisions about participation in contractual biodiversity conservation are rationally derived and driven by clear but heterogeneous preferences and trade-offs between contract attributes in relation to current land productivity from cattle production.

The choice tasks collected additional information, which will be analysed in further modelling to be conducted. In particular, information about choice certainty can improve predictive ability of models (Hensher *et al.* 2012) and the continuous choice dimension (Greiner *et al.* 2013) can be subjected to Tobit modelling and other methods of investigation to support estimation of a supply function of potential private conservation area across northern Australia.

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