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Design considerations of a choice experiment to estimate likely participation by north Australian pastoralists in contractual biodiversity conservation. ☆

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ABSTRACT

This paper reports on the experimental design process and considerations of a choice experiment conducted in collaboration with farmers in northern Australia. The purpose of the research is to inform the design of effective and efficient payments-for-ecosystem services schemes to safeguard north Australia's biodiversity values. It promotes the contractual provision of biodiversity conservation services by farmers, in particular pastoralists operating in Australia's tropical savannas.

The paper focuses on the discrete choice experimental (DCE) aspects. The DCE is employed to estimate farmers' preference heterogeneity for supplying ecosystem services, specifically their willingness to accept remuneration for the on-farm conservation of biodiversity, based on potential programme attributes. The design of the choice experiment draws on best practice standards (Hoyos, 2010), a recognition of the benefits of embedding design in a consultative process (Klojgaard et al., 2012) and recent advances in accounting for response certainty (Brouwer et al., 2010; Hensher et al., 2012).

DCE design decisions relating to attribute selection, attribute levels, alternatives and choice tasks are explained based on literature, focus group discussions, expert input and an iterative process of Bayesian D-efficient DCE design. Additional design aspects include measuring choice certainty and stated attribute attendance, embedding the DCE within a discrete-continuous approach, capturing relevant respondent-related attributes with socio-economic-psychological questions and scales, and devising appropriate data collection logistics.

1. Introduction

The tropical savannas of Australia cover around 1.9 million square kilometres (25% of the continent) across the north of the continent. Savanna landscapes support an abundance of endemic plants and animals, which are adapted to the harsh climatic conditions (Woinarski et al., 2007). Although savanna landscapes may appear relatively intact, their ecological condition has widely declined since European settlement (Lewis, 2002). Land use practices, in particular over-grazing, and spread of exotic plant and animal species have caused widespread environmental degradation (Woinarski et al., 2007).

Tropical savannas endure a combination of relative under-representation in the formal conservation estate and low participation of farmers in on-farm conservation. The states who share the tropical savannas, Queensland, the Northern

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Territory and Western Australia, have below-average proportions of land set aside for biodiversity conservation and protection purposes ('formal conservation estate') with 1.6, 1.7 and 1.1 per cent, respectively (compared to the national average of 1.9%, ABS, 2011a). Conservation reserves in northern Australia are also not large enough, on their own, to maintain viable populations of many endangered species and the ecological processes necessary to them in the long term (Bennett 1995). On-farm biodiversity conservation is therefore an important element of a strategy for safeguarding north Australia's natural heritage. A majority of farmers in the three states/territories report having native vegetation on their holdings and report protecting at least some of it (ABS, 2011b). However, in the natural resource management regions which cover the tropical savannas, no more than 41% of farmers protect native vegetation (ABS, 2011b).

"The contributions of all property holders and managers are needed to maintain the North's natural values" (Woinarski et al., 2007, p. 88). The primary land use of Australia's tropical savannas is extensive beef production. Individual beef grazing enterprises are up to 24 000 km^2 in size and carry up to 65 000 head of cattle (Bortolussi et al., 2005). Nowhere is conservation action more critical than on farms that cover vast tracks of land with high ecosystem values, as one farmer's land use decisions can have implications for soil, water and biodiversity conditions at the regional scale.

There have been a succession of biodiversity conservation programs in Australia over recent decades, but most have been shown to be 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 programme and contract design and administrative features influence participation. This research generates such understanding by exploring how programme attributes relate to farmers' willingness to participate in contractual on-farm biodiversity conservation, and how much land and what type of land they would subscribe under what conditions.

This paper describes the design process of a choice experiment as the principal method for generating data which can answer the research questions. Initial design considerations are presented, results of the DCE pre-test and pilot test (completed in late 2012) shown and the updated design discussed. The DCE is embedded in a larger socio-economic survey of farmers so that choice decisions may be linked to social, psychological and economic models of decision making. The paper is targeted at applied choice modellers, particularly in the field of environmental management, and helps address the paucity of literature which illustrates the multitude of choices the analyst has to make when designing a choice experiment.

2. Willingness to accept approach

Exploring agents' behaviour in novel markets, in this case the question about participation in on-farm biodiversity conservation for money, poses a range of methodological challenges (Rolfe et al., 2004) and due to the absence of market observations a stated preference approach is required, such as a choice experiment (CE). CEs have become the method of choice to generate understanding which can support the design of new agricultural markets (Lusk and Hudson, 2004; Rolfe et al., 2008; Windle and Rolfe, 2005).

This application of CE explores the potential supply of an environmental service by farmers and has been used previously in the design of payments for ecosystem service programs (Beharry-Borg et al., 2013; Broch et al., 2013; Christensen et al., 2011; Espinosa-Goded et al., 2010; Kaczan et al., 2013; Ruto and Garrod, 2009). North Australian pastoralists have exclusive property rights over their land, associated with land title, and are being asked to voluntarily give up elements of that property right in return for remuneration, making willingness-to-accept (WTA) the correct conceptual construct to use (e.g. Broch et al., 2013; Carson et al., 2001; Kaczan et al., 2013). While WTA applications have been shown to be prone to strategic bias when compared to willingness to pay applications (Grutters et al., 2008; Horowitz and McConnell, 2002; Mitchell and Carson, 1989), CE is arguably less prone to such bias than other stated choice methods (Burton, 2010). Respondents can be expected to have a high degree of task familiarity, which is important for reducing bias in stated preference studies (Schläpfer and Fischhoff, 2012), as farmers are familiar with the concept of receiving payments for the provision of environmental services through a series of government programs in recent decades, including grants, auctions and cost-sharing programs.

CE elicits WTA indirectly, by asking respondents to choose between cleverly designed alternatives. CE assumes that peoples' preferences are revealed through the choices they make. The method integrates concepts of conjoint analysis and discrete choice theory (Louviere and Hensher, 1982; Louviere and Woodworth, 1983). Respondents are presented with repeated samples of hypothetical scenarios (choice tasks) drawn from all possible choice tasks according to statistical design principles (Ryan et al., 2008).

3. Design of the discrete choice experiment

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). This premise of general utility theory, when applied to agricultural producers, offers an alternative to the profit maximisation paradigm, particularly in the presence of risk (Barry et al., 2009; Bond et al., 2011; Lin et al., 1974; Robison, 1982).

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