

Designing and testing an outcome focused conservation auction: evidence from a field trial targeting ground nesting birds

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Abstract

Design of efficient and effective biodiversity incentives is hampered by information asymmetry and moral hazard (hidden action) problems amongst other issues. Incentives are typically based on changes to management or on the modelled impact of management changes. Government accepts the risk of failure but has little opportunity to manage this risk – particularly where adverse selection is involved. We describe an auction design intended to address asymmetric information, moral hazard and adverse selection concerns as well as being built around a set of key ecological requirements. The results of a field trial of the auction design are reported for an auction targeting ground nesting birds in Australia. Our results suggest that an outcome focused design is more efficient, has greater incentive compatibility, and is more acceptable to landholders than a prescriptive management based approach.

Key Words: Conservation auctions; outcome contracts; incentive compatible designs; risk preferences; information asymmetry

1. Introduction

The use of conservation auctions in a number of settings has demonstrated their potential for improving government service delivery in a manner acceptable to land managers and in a way that is compatible with existing government programs and processes. Conservation auctions are designed to efficiently allocate conservation payments through overcoming information asymmetries and encouraging competition between land managers for scarce government funds. Most programs have been based on either payments for inputs (such as fencing grants) or on modelled outcomes of proposed input changes (such as auction based mechanisms based on predictions of changes to ecological outcomes). Some provide for a mix of up-front and ongoing payments but with little consideration to linking up-front components explicitly to risk-sharing on capital investments involved in changing land management. Linking payments to appropriate performance bonuses or stewardship payments could be useful where there are extensive local knowledge (adverse selection) or hidden action (moral hazard) components that contribute towards or complicate the success of the ongoing management.

Investment in conservation of ground nesting birds such as Brolga, Bush stone-curlew and Plains wanderer offers an opportunity to test the importance of effective performance bonuses (or mixed input and output contracts). These species are in decline in the sheep-wheat belt of south eastern Australia in response to habitat modification and predator introduction. Habitat structure and content is the driving influence on potential habitat quality, and presence and breeding success provides a direct indicator of the functionality of the ecosystem with respect to other species that occupy similar habitat niches.

Conservation of these species involves some known and verifiable actions, such as earthworks and stock management to deliver the required habitat quality. There are also significant hidden actions, such as predator control and the precise timing and level of grazing. There is also unknown potential for innovation by landholders to further improve conservation outcomes of these species. Purely action-based contracts provide no formal incentives for landholders to carry out hidden actions and innovation which may contribute to conservation outcomes. However, the significant upfront costs that are likely to be involved in changing habitat

management for at least some of these species means that pure outcome-based contracts may impose unacceptable uncertainty on land managers.

One option is the design of a mixed instrument that explicitly shares risk by delivering an upfront payment through an auction combined fixed and known future payments contingent on the achievement of specified performance objectives. A competitive tender can provide an efficient means of allocating upfront payments and qualifying for future payments. A fixed bonus payment is used to promote hidden actions and innovation, and to promote the revelation of local knowledge (landholders are likely to know where these birds are likely to breed, and the bonus payments give them an incentive to offer these sites).

In this paper we describe an application of an auction with an outcome bonus targeting ground nesting birds in the Murray River Catchment in New South Wales (NSW) Australia. We provide some background on the biodiversity conservation problem, the institutional framework, and the economic characteristics of the resultant incentive design problem in the next section. In section three we describe a theoretical model encompassing land manager incentives and behaviour to describe an appropriate auction design. The performance of the resultant design in a field trial is briefly described in Section four. The implications for auction design are discussed in section five. We close the paper with some conclusions and research questions to be answered in future research.

2 Background

2.1 Ground nesting birds: describing a biodiversity conservation problem

Over the last 200 years since European settlement vast areas of Australia have been developed or otherwise impacted by agriculture. For many species the impacts of landuse change have been compounded by the introduction of foxes and rabbits amongst other introduced predator and grazing species. The combination of landuse change and introduction of feral predators has been particularly damaging to populations of ground-nesting birds including bush stone curlews, brolga and plains wanderer.

These birds which were once common in the landscape have declined to such an extent that they are now uncommon in the landscape. Recent research into the Brolga population in the catchment has identified approximately 250 birds presently existing with numbers of bush stone curlews and plains wanderers expected to be similarly low. Yet biophysical information about the necessary habitat requirements for ground nesting birds is becoming well known. For example, successful breeding of brolga pairs appears to be reliant on the presence of shallow waters with significant native vegetation cover and successful predator control (Herring 2000). Significant research has also been undertaken into the presence and habitat requirements of Plains Wanderers in the Murray catchment including habitat mapping of core and secondary habitat areas (NPWS 2002a, 2002b). The Bush stone-curlew provides a more complex management problem as the bird may be present in small remnants while relying on a larger area for its foraging needs. In the case of this species specific habitat requirements for nesting, foraging and roosting appear to be different and the proximity of suitable areas for each activity is likely to influence its abundance and distribution (DEC 2006).

In order to assessing the biodiversity value of potential conservation sites a habitat metric was defined which scored the attributes associated with high quality habitat for each of the three target species. The metric was based on the Threatened Species Assessment Tool developed as part of the Property Vegetation Planning (PVP) Developer now in use for assessing vegetation clearing applications throughout New South Wales (Briggs 2005). The habitat metric is intended to objectively assess the quality of possible conservation sites with the assumption that a better quality site implied a greater chance of successful bird breeding.

The habitat metric was supported by the development of habitat quality benchmarks which set out the performance requirements were developed for the three focal species targeted in this project. The habitat benchmarks are performance goals for annual management which is critical to breeding success in ground-nesting bird populations. A photographic guide has been prepared for each species in order aid landholders in assessing their paddock condition (NPWS 2002a, Tack 2007, Herring 2007).

firewood collection, and any rehabilitation activities. Hidden actions are primarily predator control and in the case of bush stone curlews the potential for artificial introduction of target species. Appropriate levels of observable management actions may be detailed, ongoing and difficult to monitor generating a significant hidden action problem. There is unknown potential for innovation by landholders to further improve conservation outcomes of these species. Given limited data on bird populations, distributions and habitat requirements, it is also likely that landholders, by virtue of having observed the history of birds on their land, will have private knowledge about the likely habitat value. Hidden information as well as hidden action issues therefore need to be considered in instrument design.

The contribution of this analysis to the literature is to consider how the combination of hidden actions, hidden information, and potential landholder risk aversion affect the choice of the optimal reward level in a multiple unit auction. In the basic model of hidden actions with no uncertainty, monitoring costs or monitoring errors, pure outcome based payments are most efficient. If uncertainty in production exists, the standard moral hazard result is that, for a risk neutral agent, the optimal level of effort can still be induced by the correct payment schedule provided outcomes are correlated with effort. Ex-ante payment can be used to extract any rents from the agent. However if agents are risk averse, it becomes more expensive to provide them with the incentives via outcome payments. In this situation a mixture of upfront payments and outcome payments form the optimal contract.

Extensions of the moral hazard model to include adverse selection issues are summarised in Laffont and Martimort (2002). In general they find that the contract design implications depend on the timing and structure of the specific problem. The problem of agri-environmental instrument design in the presence of both moral hazard and adverse selection issues have been extensively studied (see Fraser, 2002; Hart and Latacz-Lohmann, 2005; Ozanne and White, 2007). The framing of these analyses differ from the current problem in several respects. Notably the production of the environmental good here is considered to be a function of both observable and hidden inputs. The nature of the adverse selection and moral hazard issue, and the type of mechanism under consideration also differ. In particular the moral hazard problem in this literature is typically defined as a compliance problem, whereas here the focus is on setting the incentive levels that will induce the efficient level of hidden actions.

The policy under consideration here is a variation of a multi-unit auction. Auctions of conservation contracts have been studied by Latacz-Lohmann and Van der Hamsvoort, (1997), Stoneham et.al. (2003), and reviewed by Latacz-Lohmann and Schilizzi (2005). Latacz-Lohmann and Van der Hamsvoort consider the impacts of risk aversion on agents bidding behaviour for contracts on input restrictions. The current study extends this work by considering the possibility of being able to contract on environmental outcomes, and therefore motivate the hidden actions that are important in achieving them. Auctions of procurement contracts where there are both adverse selection and moral hazard issues have been studied by McAfee and McMillan (1986), and summarised by Laffont and Tirole (1993). The McAfee and McMillan model considers procurement of a single good from multiple bidders who may have differing costs. They focus on the question of what share of realised cost the optimal contract should pay. Their analysis describes how the contract choice involves trade-offs between sharing risk, revealing expected cost information, providing profit margins to encourage competition, and providing incentives to motivate hidden action.

The problem analysed here differs from the McAfee and McMillan analysis in several ways. The selection of multiple sites introduces an additional trade-off between providing landholders with stronger incentives and funding more bids. In addition, in the current problem, effort is expended before the uncertainty is resolved. This means that uncertainty will manifest as a failure to meet the outcome rather than as a cost overrun. This affects the contract design options and the nature of the adverse selection problem. Specifically, the sharing of cost overruns is no longer the key contract design issue. In addition, since cost overruns are no longer shared, selection of low cost providers is no longer an asymmetric information problem in the sense that the principle is not purchasing a contract with cost risk elements. Rather, hidden information problems relate to errors in the ability of the principal to assess the quality of the sites for bird breeding purposes. That is landholders may have private knowledge about the likelihood of bird presence and breeding that they can use to their advantage.

3 Auction design

We consider the problem of a CMA (the principal) who is trying to maximise the overall breeding success of a bird species with a fixed budget. The analysis focuses on comparing a mixed tender (bid payment plus fixed outcome payment conditional on achieving outcome standards) with input and output contracts.??? We define a bird production function in order to consider the problem of landholders (agents) which is to choose a bid and a level of effort to put into hidden actions in order to maximise the benefits they receive from the scheme. Following this we consider the problem of the principal. We begin by considering the problem of risk neutral agents with no hidden information problem. We then consider the impact of risk averse agents and hidden information.

3.1 The bird production function

It is assumed that each specified site can support a single breeding event per season. The probability of a successful outcome (denoted by $s_i = 1$) is given by $\pi_i(s_i = 1) = \pi(q_i, k_i, \theta_i)$, where q_i is a measure of intrinsic site quality. This is determined by the extant characteristics of the biodiversity on a site and is outside the control of the landholder. The agent is aware of the absolute value of q_i , however we assume the value of q_i relative to other sites is only known to the principal. k_i is the site condition, it is defined as an observable, verifiable state variable that is a function of landholder investments in the site. We represent input contracts by assuming that a certain site condition \bar{k} is enforced in the contracts. θ_i refers to ongoing management or hidden actions, such as predator control.

3.2 Agents problem

The timing of the problem is as follows. First the principal announces a outcome price (R) (also called the reward) and asks for tender submissions. The landholders (agents) then calculate their planned level of effort (θ) by solving the production problem specified below, and submit bids with price b_i that will maximise their expected returns. The bid defines the payment made to landholders who are successful in the tender and meet the minimum site condition standard. It is assumed to be set by a single round price discriminating auction. By construction the bids will

be decreasing functions of site quality (q_i). The principal then chooses a maximum successful bid \hat{b} (or equivalently a minimum successful site quality, \hat{q}) which allows the total cost of the scheme to fit within the program budget (B). The principal will evaluate the bids according to their expected cost of achieving breeding success. The expected bid cost (bc_i) is defined by the formula:

$$bc_i = \frac{b_i}{\tilde{\pi}} + R,$$

Where: $\tilde{\pi}$ is the principal's assessment of the probability of breeding success determined by the extant quality of the site.

If we assume a pool of agents whose behaviour is defined (for now) by assuming they are risk neutral profit maximisers with costs of the form:

$$c_i(k, q_i, \theta_i) = g(k, q_i) + h(\theta_i),$$

then the first order condition for the bid choice are given by (Latacz-Lohmann and Van der Hamsvoort, 1997):

$$b_i = -\{R\pi(q_i, \bar{k}, \theta) - c_i(k, q_i, \theta_i)\} + \tilde{\pi} \frac{(1 - F(bc_i))}{f(bc_i)}$$

Indicating that the bid is equal to the expected cost of participation plus a premium based on information about the expected bid distribution. In this specification the bid premium is also affected by the assessed production value. The first order conditions reflect a two step optimisation structure to the problem. Effort depends only on the size of the reward, as it is decided only after a successful bid is made, it is therefore independent of the chance of winning the auction and size of the bid. The structure of the agents behaviour can therefore be written as:

$$\theta^* = \theta^*(R, q_i, \bar{k})$$

$$b_i^* = b_i^*(R, c(\bar{k}, q_i, \theta^*(R, q_i, \bar{k})))$$

3.3 Principal's Problem

The CMA (the principal) wishes to maximise the overall breeding success; subject to constraints on its budget, information, and the likely behaviour of agents. To do so the principal can choose an outcome reward, R and a minimum site

condition \bar{k} . To simplify the analysis assume that the landholder can achieve \bar{k} with certainty. Only those that sign up for the scheme can be eligible for the bonus. We specify the problem as one of choosing a minimum successful initial bid quality \hat{q} that corresponds to a maximum successful bid $\hat{b}(\hat{q})$. The principal's problem can be written as

$$\begin{aligned} & \text{Max}_{R, \hat{q}} \int_{q=\hat{q}}^{q=1} N\pi(q, \bar{k}, \theta) p(q) dq \\ & \text{st} \\ & N \int_{q=\hat{q}}^{q=1} b_i^*(q, R) p(q) dq + (R)N \int_{q=\hat{q}}^{q=1} p(q) dq \leq B \\ & (b_i^*, \theta_i^*) \in \arg \max \{ b_i - c_i(\bar{k}, q_i, \theta_i) + R\pi(q_i, \bar{k}, \theta) \} (1 - F_i(b c_i)) \end{aligned}$$

That is, maximise the overall breeding success, subject to the budget constraint and the bidding and effort behaviour of the participants. The budget constraint limits total expenditure which is the expenditure on bids and rewards times the number of successful applicants. We assume that the budget constraint must be set conservatively, that is assuming all bids have successful breeding (though it is relatively easy to consider an expected success rate). The optimising behaviour of agents defines the agents bid and effort as a function of the reward and the initial site quality. The properties of the solution can be analysed by substituting the agents bidding behaviour into the budget constraint, solving the budget constraint for \hat{q} and substituting this into the objective function. This defines the objective function as a function of the reward level, account for the impact of changing the reward on the number of bids that can be funded and landholders behaviour.

Simulation results

We illustrate the conclusions via a parameterised version of the model.¹ Figure 2 illustrates the effects of changing the reward level. Note that the maximum outcome is (approximately) where the maximum bid is zero. At this point the outcome payment is providing the main price signal, and therefore produces an efficient mix of land and effort. This result is only approximate as the distribution of site quality across landholders affects the optimal outcome payment. Also note that the number of successful bids declines more slowly at higher reward levels. In addition to the

¹ Simulations were undertaken in Microsoft Excel.

response of bid prices to the reward identified above, the cost function curvature conditions ($c'' > 0$) mean that at higher reward levels an increase in reward induces a smaller effort increase. This inelastic response at high reward levels means that less of the extra reward money is spent on increasing effort and more is producer surplus, and this is recycled into lower bids. The practical implication of this is that if the optimal effort level is expected to be at an inelastic part of the response curve, then setting the reward on the high side is a safe bet. In contrast setting the reward too low produces a steep decline in net benefits as the level of effort is below optimal, and the budget is spent instead on adding more low quality sites. Therefore, in setting the reward, there is a combined effect of the reward on site quality and effort that, given uncertain cost estimates, favours setting higher reward levels.

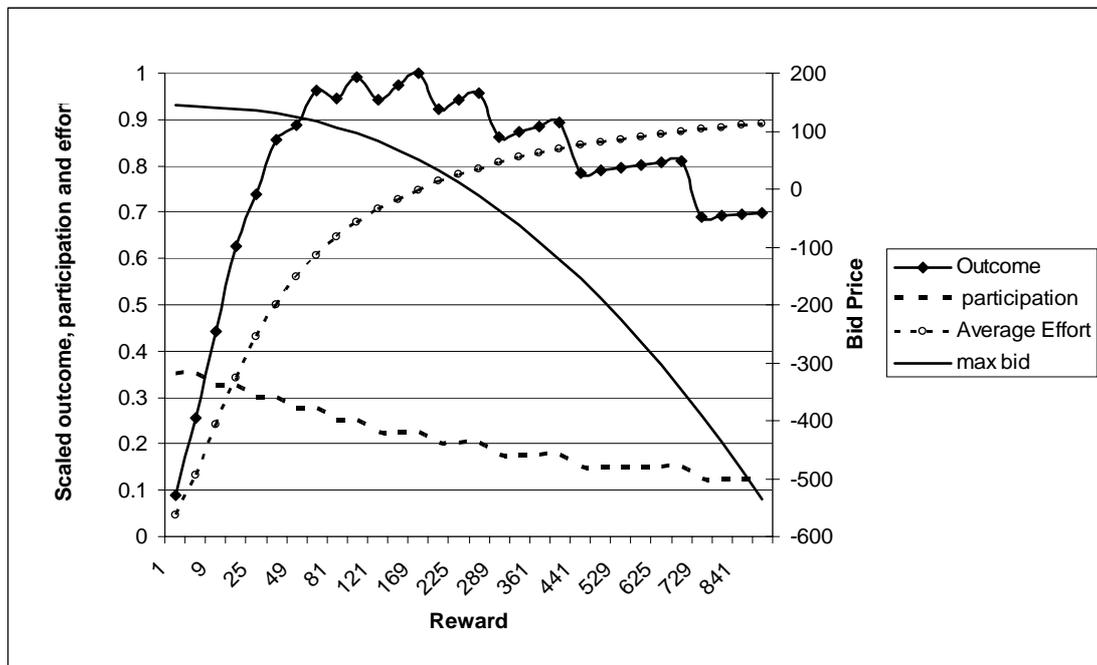


Figure 2: Simulated results for the breeding outcome, fraction of successful tenders, average effort and maximum successful bid as a function of the outcome payment

3.4 Risk averse agents

Landholders are often considered risk averse (Latacz-Lohmann and Van der Hamsvoort, 1997) so it is important to consider the implications for instrument design. We focus on the fact that the reward payment is uncertain. Following (Latacz-Lohmann and Van der Hamsvoort, 1997) we consider the decision of risk averse land owners who value an uncertain reward by calculating the expected pay-off

and deducting a risk premium (RP). The risk premium is a function of the reward and a subjective assessment of the probability of success. That is

$$RP = RP(R, \pi(q_i, \bar{k}, \theta_i))$$

Substituting into the agent's problem we find that the effect of the risk premium on bidder behaviour is given by the first order condition:

$$(1 - F_i(bc_i)) - \{b_i - c_i + (R - RP)\pi\} \frac{1}{\pi} f_i(bc_i) = 0$$

The direct effect of the risk premium on the bid is therefore to reduce the perceived value of the reward and therefore require a higher bid price in order to participate. Indirectly risk aversion also affects the bid via its impact on effort and expected outcome.

3.5 Hidden information

The principal will in general only be able to measure and model the value of a site as habitat imperfectly. Landholders, by virtue of having observed the breeding history on their land may well have private information about the potential breeding success. If site quality q_i is known to the agent but the site quality is assessed by the principal to be:

$$\tilde{q}_i = q_i(1 - e_i)$$

And the principal's estimate of the chance of successful breeding, given a site assessment of \tilde{q}_i is:

$$\tilde{\pi} = \pi(\tilde{q}_i, \bar{k}, \theta^*(\tilde{q}_i))$$

The relevant first order condition, defined in terms of the bid cost is:

$$bc_i = \frac{c_i(k, q_i, \theta_i)}{\tilde{\pi}} + R \frac{(\tilde{\pi} - \pi)}{\tilde{\pi}} + \frac{(1 - F(bc_i))}{f(bc_i)}$$

In this interpretation, the expected bid cost that landholders charge will equal the costs adjusted for expected production plus the reward times the scaled error in assessed production, plus the bid premium. Intuitively if the landholder knows birds are present (for any given assessed site quality) then he will assign a higher likelihood

of reward (R) and a lower bid. Therefore hidden information is likely to enhance the effective reward to participants.

3.6 Conclusions for auction design

The objective of this analysis is to guide the design of tender based mechanisms where hidden actions as well as variable site qualities affect the environmental outcome, in this case bird breeding. Four conclusions emerge for the auction design employed:

1. Efficiency requires that setting the fixed component of outcome prices at a level that upfront bid payments are anticipated to be small (approximately zero);
2. The cost of setting the outcome payment level too high is less than the costs of setting it too low. Higher rewards mean fewer participants but participants that are involved are more highly motivated and have higher quality sites. Conversely setting outcome payments too low results in accepting more low quality sites and landholders providing less effort. There is also less revenue recycling at low outcome payments, as a greater fraction of the marginal payment is spent on effort.
3. Hidden information results in landholders with birds present submitting lower bids for any given site quality. These bids appear as better value bids and effectively increase landholder reward.
4. Risk aversion has compensating effects and it is not at all clear that it will immediately lead to a significant bid premium. On the one hand risk aversion results in a risk premium that reduces the incentive value of the uncertain outcome payment. Risk aversion therefore reduces effort. However risk aversion has a second, compensating effect: it induces agents to increase effort in order to reduce the uncertainty of the outcome payment.

These four principles were incorporated into the auction trial that is described in some detail in the next section.

4 Auction performance

4.1 Overview of the tender

Implementation of the auction design commenced in July 2007 through a structured enrolment process as follows:

- Communications strategy combined with a call for expressions of interest;
- Invitation to participate in an explanatory workshop and simulation game;
- Site visits to assess site quality and discuss site management;
- Bid submission;
- Contract offer or rejection letter; and
- Monitoring site visits to landholders awarded contracts.

The communications phase generated expressions of interest from forty one landholders. Thirty two landholders attended workshops that outlined the structure of the program and provided information on the conservation requirements of bird species. In total twenty five workshop attendees completed a survey on landholder attitudes towards different aspects of tender design including outcome monitoring and outcome linked payments. Tenders were submitted for twenty three sites from seventeen separate landholders. Submission of a tender required completion of an additional survey that covered landholders land uses, socioeconomic profile, biodiversity conservation management history and attitudes, and history of bird presences. The tender evaluation process resulted in twenty applications from fourteen landholders being accepted. These figures exceeded participation targets for the tender. The first year site visits to evaluate the habitat benchmarks for Stone curlews and Plains wanderer site visits occurred in February 2008. The first set of site visits to assess compliance with broilga habitat benchmark and bird presence benchmarks will occur in September 2008.

We discuss the impact of outcome focused contracts on the performance of the auction in three sections:

- (i) The impact of the contract on the number and type of sites offered, that is the revelation of private (asymmetrically held) information about biodiversity assets;

- (ii) Landholders choice of contract and bid values for input and outcome focused contracts; and
- (iii) The evaluation of habitat benchmarks and landholder management activities from the February 2008 site inspections.

4.2 Revelation of landholder information on biodiversity assets

Analysis of the effectiveness of outcome focused payments in attracting appropriate landholder and site applications can not be directly addressed because the single scheme offered input and outcome focused contracts. Contrasting the profile of the enrolled landholders with the regional landholder populations was also not possible within the scope of this study. However some anecdotal evidence about the effectiveness of outcome focused schemes in attracting the appropriate landholders is available.

The tender exceeded participation targets for each phase of the tender processes. These targets were based on participation levels in previous input focused tenders and estimated requirements for effective competition. The survey responses of the seventeen landholders who submitted tenders indicate that:

- Sixteen landholders indicated that finances were a constraint on conservation;
- Three landholders indicated they would like more off-farm income;
- Ten landholders agreed they could advise their neighbours on how to manage biodiversity on their property;
- Twelve landholders indicated that they already managed the site to protect ground nesting birds; and
- All but one landholder indicated that they had previously carried out some conservation activities such as weed and pest control on the site.

The scheme therefore appears to target landholders for whom the financial incentives are important; who have high private values for managing for the birds; and who have knowledge of the necessary management requirements. The call for expressions of interests also resulted in landholders applying who revealed there were locations with bird populations that were previously unknown to the Catchment management authority. It also revealed new locations of birds in known habitat, and one landholder undertaking a Bush stone curlew breeding program.

In contrast, for one bird species, the Plains wanderer, threatened species legislation had been strongly articulated in recent years. This legislation effectively imposes costs on landholders who reveal that populations of birds are present on their land. It therefore provides an incentive not to reveal private information about the birds. Uncertainty about the future implementation and interpretation of threatened species legislation may have affect landholders views about the merits of revealing information within the current scheme. While there were several request for information about the Nest Egg tender from landholders regarding Plains wanderers there was only one tender application from this group. The contrast with Stone curlew landholders indicates that the incentives provided to landholders regarding disclosure of private information on bird populations is important.

4.3 Landholder bid values for outcome focused contracts.

All participants were required to enter a preferred contract option and bid as well as specifying a bid for the non-preferred option.² All seventeen landholders who submitted tenders elected to use the outcome focused contract. This result indicates that landholders are willing to enter into conservation contracts where a component of the payment is linked to achievement of conservation outcomes. In these contracts the outcome linked payments represented on average 33% of the total payment. Since the outcome payments were fixed in this tender the percentage of total cost varies with the tender bid, from a minimum of 8% to a maximum of 91%.

Based on landholder stated bids for input focused contracts, the expected total cost of the outcome focused bids is on average \$4,047 or 23% cheaper than the income focused bids. Figure 3 presents the landholders bid data for both contract types as marginal cost curves. The cost of the outcome contracts includes the expected payments of bird bonus payments based on historical bird observation frequencies.

² This process is loosely equivalent to a contingent valuation exercise for the non-preferred contract option.

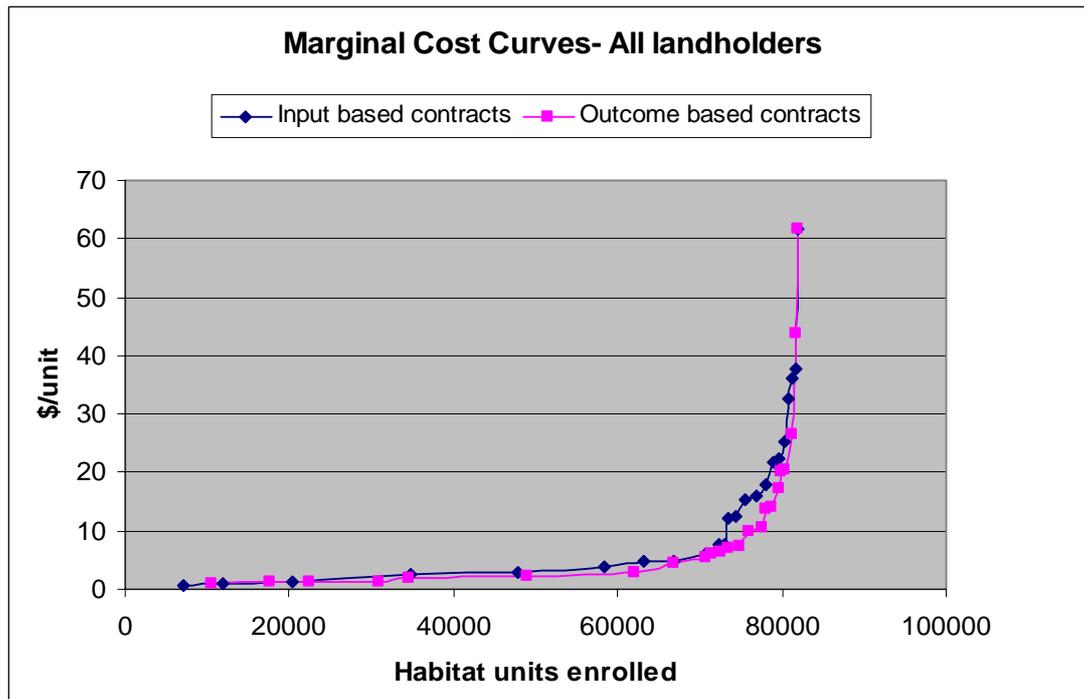


Figure 3: Marginal Cost Curves for Input and Outcome Focused Tenders

While the curves appear to be similar, this partly reflects that very low priced bidders and very high priced bidders were indifferent between the two contracts offered, combined with a sharp kink in the curve reflecting the skewed distribution of bids with a relatively small number of high cost bids being submitted. There is notable difference between the two curves just below 80,000 habitat units where the marginal cost begins to increase sharply. The cumulative difference between the curves is relatively large. Figure 4 shows the difference in the total costs of purchasing a specified number of habitat units under input and outcome focused contracts. For the lowest three bids, the input contracts are in fact cheaper. However for the remainder of the range of habitat units, the total cost is on average 33% cheaper if outcome focused contracts are used instead of input focused contracts.

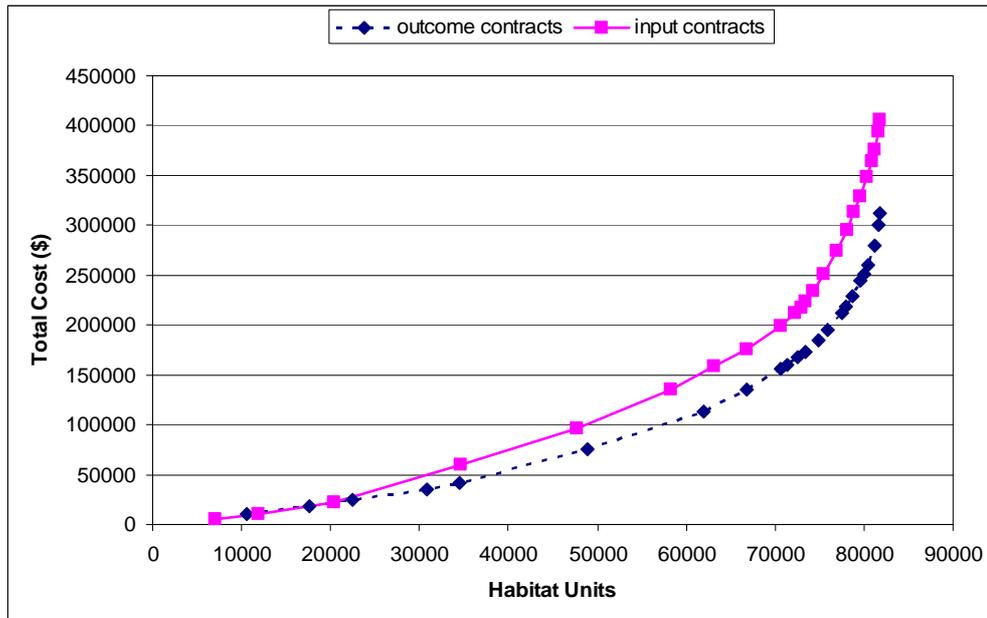


Figure 4: Total costs of purchasing habitat units via outcome and input focused contract.

For the bid selection rule used in the trial, (that resulted in just under 80000 habitat units being purchased) the outcome focused contracts produce an expected saving of at least 33% compared with the use of input focused contracts.

We expected that differences in the costs of input or outcome focused contract preferences to be driven by factors affecting landholders' evaluation of risk preferences and management costs. The small sample size limits detailed analysis of the drivers of cost differences; however the type of landholder appears to be significant in explaining the preference for contract type. Landholders were classified as either commercial agricultural, producers or as lifestyle (non-commercial) landholders on the basis of off-farm income, property size and retirement status. In total eleven landholders were classified as commercial agricultural producers. Commercial agricultural producers required a larger premium than non agricultural landholder in order to enrol in input focused contracts. For the 18 commercial landholder tenders, outcome contract bids were on average 33% (or \$5,781) cheaper than their input contract bid. In contrast three of the five landholders classified as non-commercial submitted the same upfront bid payment for the outcome and input focused tender. This suggests that either the bonus payments were not of value to these landholders or, as is perhaps more likely, that they simply forgot to factor in the value of the bonus when calculating bids. The average premium of the remaining two

non commercial landholders was \$2,356 or 8% of their average input bid value. This difference between commercial and non-commercial landholders is statistically significant based on a two sided t-test ($p=0.015$)

Follow up phone interviews with commercial land holders with large bid discrepancies indicate that the preference for outcome contracts is due to a mix of risk and flexibility as discussed further below.

The influence of other landholder characteristics on bid preferences was explored with simple linear regression models. However no other statistically significant relationships were identified for the list of variables discussed in the methods section. This is perhaps unsurprising given the small sample size and the complexity of the potential explanations of bidding preference.

4.4 Evaluation of habitat benchmarks and landholder management activities

The first round of site inspection to assess compliance with habitat benchmarks indicated that 12 of the 14 landholders (bush stone curlew and plains wanderer habitat only) had achieved the benchmark standard and carried out a range of conservation activities such as pest control, that were not mandated by the contract but are likely to be necessary in order to maintain bird populations and achieve the bird bonus payments.

The two non compliant landholders appear to have made a deliberate choice to forgo the first year outcome payments and focus their utilisation of the site on grazing during the ongoing drought conditions.

In general then the outcome payments appear to be motivating hidden action. The non compliance case can perhaps be viewed as evidence of the outcome focused payments permitting flexibility in farm management. The desirability of this will depend on the impact on conservation values of changes in management over time.

5 Discussion

The results presented above indicate that it was feasible to implement a tender for outcome focused contracts for ground nesting bird conservation; that these contracts are more acceptable to landholders than a prescriptive management based

contract; and that this resulted in a tender that is cheaper than one using an prescriptive management based contract.

Outcome focused contracts are feasible in the sense that it was possible to define benchmarks for habitat and bird outcomes that could be used as the basis of payment.

The acceptability of outcome focused contracts to landholders was demonstrated by the fact that all landholders who submitted tenders elected for a contract where some of the payment was linked to them meeting conservation outcomes when an equivalent input focused contract was available. This result is significant as there were concerns that landholders would be unwilling to take on the risks of non-payment necessarily associated with outcome focused conservation contracts. A theoretically important barrier may therefore not be significant in practice. Note that while we have referred to outcome focused contracts, the landholders were actually offered a mix of up front and outcome linked payments. The upfront payment was on average 66% of the total payment.

We estimate that the use of outcome focused contracts reduced the total costs of the tender by approximately 33% in comparison with an input focused contract. Note that this is not a complete analysis of the effectiveness and efficiency of the outcome payments. The effectiveness of outcome focused contracts will be improved by motivating hidden actions, in this case to control feral predators more effectively than would be achieved by the input focused contract; and by encouraging innovation. Efficiency may also be improved by the contracts allowing innovation in how landholders mix production and conservation, and by only paying for actual outcomes. The impact of the outcome focused scheme in attracting appropriate landholders may also be important.

Our ability to analyse the reasons for contract preferences was limited by the small sample size. However commercial landholders appear to have stronger preference for outcome focused contracts than lifestyle landholders. Reasons given for this are important in understanding why outcome payments are valued. The following discussion of the reasons for the preference for outcome focused contracts is based on interviews with commercial landholders enrolled in the trial. The main reasons given for preferring outcome focused contract related to the risk of

conservation to farm viability and the related need to maintain flexibility in production practices. The role of risk and flexibility appear to have different effects are different stages of the tender process. These effects can perhaps be characterised as follows.

In the initial step, landholders decide if they should engage in the scheme. The threat of the contract to the viability of future farming operations is a key consideration at this stage. That is, before evaluating any benefits of a conservation contract, they focus on the potential financial down sides to the contact, specifically concerns that it may affect the viability of their business: As one landholder stated:

“Conservation work is important but care must be taken to remain in a viable business during the process”

Engagement of commercial producers may therefore be improved by outcome focused contracts as they make clear what the maximum liability associated with the scheme is likely to be. This more likely to lead to landholders investing time into considering the scheme.

When deciding on a bid price, the viability of future farming operations is still a key consideration. If this condition is met, landholders appeared to use a widely different criteria to evaluate the tender. The extent to which conservation is viewed as a business proposition seems to vary between landholders and depend on the particular issue. For instance:

“I am interested in conservation but also in finding a financially rewarding balance for our investment and amount of labour input.”

However keeping future management options open appears to be important for commercial agricultural producers. For example:

“(I value..) My ability to be able to continue farming the rest of farm without "Big Brother" telling me what I can do or not do. My family would like to continue working this property in the same manner as they have been doing taking into account of changing practice of new technology”

Flexibility in the timing of the use of resources within a season also appears to be important. Two landholders expressed concern about input focused contracts requiring labour commitments during times of critical farming activities. There were also concerns that unwarranted activities would need to be undertaken.

Future work in the trial will focus on landholder behaviour and conservation outcomes under the outcome focused contracts. The initial site inspection revealed that the outcome payments appear to be motivating the required management activities. The extent to which they encourage innovation, and the importance of any innovation remains to be seen.

6 Conclusions

The results from a trial of a conservation tender with a mix of upfront payments and outcome focused payments indicate that such schemes are feasible, attractive to landholders and can lead to significant cost savings for public agencies. As such the linking of payments to conservation outcomes deserves further consideration. They have potential applications to a wide range of conservation problems where hidden actions, innovation in conservation management and flexibility in agricultural management are important. Further innovation in the structure of conservation incentive schemes with outcome focused elements is also likely to prove useful. Improved understanding of the relative importance of the different factors that make outcome focused contracts valuable would provide a basis for more effective conservation policies.

REFERENCES

- Briggs, J. "Threatened Species Assessment Tool, Version 1-7, An assessment tool for use in the NSW Property Vegetation Plan, Developer, Operational Manual", Department of Environment and Conservation, Sydney, 2005.
- Department of Environment and Conservation NSW , "NSW Recovery Plan for the Bush Stone-curlew *Burhinus grallarius*." DEC, Sydney, 2006.
- Fraser, Rob. "Moral Hazard and Risk Management in Agri-environmental Policy". *Journal of Agricultural Economics* 53(2002): 475-487. .
- Grafton, R. Q. Evaluation of round one of the market based instrument pilot program, Report to the National Market Based Instrument Working Group. 2005.
- Hart, Rob and Latacz-Lohmann, Uwe. "Combating moral hazard in agri-environmental schemes: a multiple-agent approach". *Eur Rev Agric Econ* 32(2005): 75-91.
- Herring, M. "Ecology and conservation of the Brolga and other threatened waterbirds in southern NSW and northern Victoria", Honours thesis, Charles Sturt University - Albury NSW. 2000
- Herring, M. "Brolga Breeding Habitat Managing Wetlands on your Farm." Murray catchment Management Authority, 2007.
- Laffont, Jean-Jacques and Martimort, David. *The Theory of Incentives: The Principal Agent Model*. 2002. Princeton and Oxford, Princeton University Press.
- Laffont, Jean Jacques and Tirole, Jean. *A Theory of Incentives in Procurement and Regulation*. 1993. Cambridge, Massachusetts London, England, The MIT Press.
- Latacz-Lohmann, Uwe and Schilizzi, Steven. Auctions for conservation contracts: A review of the theoretical and empirical literature. 2005. Report to the Scottish Executive Environment and Rural Affairs Department
- Latacz-Lohmann, U.L. and C. Van der Hamsvoort. "Auctioning Conservation Contracts: A Theoretical Analysis and an Application ." *American Journal of Agricultural Economics* 79(1997):407-718.
- McAfee, R.P. and J. McMillan. "Bidding for contracts: a principal-agent analysis." *Rand Journal Of Economics* 17(1986):326-338.
- NSW National Parks and Wildlife Service. "Plains Wanderer Habitat Management Guide." NSW NPWS Sydney, 2002a
- NSW National Parks and Wildlife Service . Plains-wanderer (*Pedionomus torquatus*) Draft Recovery Plan, NSW NPWS Sydney.2002b
- NPWS "Plains-wanderer habitat management guide. A photographic guide for visually assessing the grassland structure of Plains-wanderer habitat." NPWS Western Directorate Threatened species Unit, 2002.
- Ozanne, A. and B. White. "Equivalence of Input Quotas and Input Charges Under Asymmetric Information in Agri-Environmental Schemes." *Journal of Agricultural Economics* 58(2007):260-268.
- Stoneham, G., V. Chaudri, A. Ha, and L. Strappazon. "Auctions for conservation contracts: an empirical examination of Victoria's Bush Tender Trial." *The Australian Journal of Agricultural and Resource Economics* 47(2003):477-500.
- Tack, E. " Bush Stone-curlew habitat Management Guide. A guide for managing vegetation for Bush Stone-curlew habitat." Murray catchment Management Authority, 2007.