Exploring the Cost Effectiveness of Land Conservation Auctions and Payment Policies

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1. Introduction

Until recently public efforts to encourage conservation on private land in many countries has primarily been through uniform payment policies. For example, in Australia the National Heritage Trust (NHT) funded at $3 billion dollars (Australian) between 2001 and 2008, distributes funds to State and local natural resource management agencies (NHT 2005). Much of NHT funding is then distributed to landholders by local agencies for efforts to undertake conservation actions. Typically this involves paying willing landholders at uniform rates per unit of input or practice. Similar payment approaches involving uniform payments are also an important feature of agro-environmental policy in Europe and the United States (Latacz-Lohman and Hodge 2003).

Auctions are increasingly used as a payment mechanism to acquire public benefits such as conservation actions that provide environmental improvements on private land and water for environmental flows. Some of the most cited examples in the literature include the US Conservation Reserve Program (CRP) (Riechelderfer and Boggess 1988), the BushTender auction that took place in Australia (Stoneham *et al.* 2003), and the drought water markets in the United States (Cummings, Holt, and Laury 2004; Howitt 1994). In these auctions, landholders offer sealed bids describing actions they are willing to take and the payment that they would require to undertake the action. Agencies then rank and select bids for funding based on some measure of cost effectiveness until a fixed budget is exhausted or a pre-set reserve price is reached.

Agencies implementing both uniform payment and auction policies face an asymmetric information challenge in that they have limited information about the economic costs or in some cases the potential environmental benefits associated with private lands being considered. This information is needed to understand the distribution of landowner reservation prices for implementation of publicly funded conservation practices. A key challenge to achieving environmental goals cost effectively with uniform payments given this asymmetric information, is setting the payment level. If the price is set too high, inefficiency results in that landholders with opportunity costs less than the payment rates will receive payments in excess of their true opportunity costs. When the price is set too high, low rates of participation can result in high agency program administration costs per unit of conservation action taken (Groth 2005).

The economic rationale for use of auctions is that they create decentralised incentives to offer bids at close to the true landholder opportunity costs, even when the implementing agency holds little information about these opportunity costs (MacAffee and McMillian 1987). There is a growing literature on the relative efficiency of various formats of auctions and the efficiency of auctions in comparison to other instruments (Milgrom 2000). Most of this literature is underpinned by a set of "benchmark model" assumptions including that: (1) bidders are risk neutral; (2) bidders have independent private values; (3) there is symmetry among bidders; (4) payment is a function of bid alone; and (5) there are no costs involved with bid construction and implementation (MacAfee and McMillan 1987). These assumptions make evaluations of auctions convenient. However, because deviation from these assumptions are typically not considered, there can be little basis for drawing broad conclusions about outcomes in real world auction environments (Rothkopf and Hastad 1994). Realistic portrayal of real world auction environments may require relaxing some benchmark model assumptions. For example, real world auction settings often involve risk averse bidders; bid values can be determined at least partially by values that are common among bidders; and in some cases there can be costs associated with the development of bids.

Latacz and Van Hamvoort (1997) provide one of the few utility theoretic models comparing optimal bid response to auctions and uniform payment policies using realistic behavioural assumptions. Their model includes bidder risk aversion and uncertainty regarding auction reservation price. They conclude that in comparison to uniform payment policies, the level of uncertainty held by bidders regarding auction reservation prices is a key determinant of the relative cost of auctions. As uncertainty converges to zero, the optimal response to auction incentives tends to converge to the optimal response to fixed or uniform price policies. Simulation analysis suggests that this can occur in repeat auctions when agencies treat information in ways that allow for bidder learning about agency reservation price (Hailu and Schillizzi 2004). A real world example is the US CRP which is an auction where the agency sets a uniform reservation bid price per acre across broad areas. Over successive rounds bidder uncertainty regarding the agency reservation price decreased until after multiple rounds, the average bid almost exactly equalled the maximum acceptable bid (Cooper 1997).

Latacz and Van Hamvoort (1997) also conclude that when levels of uncertainty are very high auctions can lead to inefficient outcomes. In the words of the authors "*performance measures [of auctions] may even fall below the level of the offer [fixed payment] system*". The potential for reduced efficiency arises because the optimal bid level is an increasing function of uncertainty regarding agency bid acceptance reservation price. Both auction theory (Milgrom 1989) and experimental economics findings (Ward, Connor and Tisdell *forthcoming*; Cummings, Holt, and

Laury 2004) suggest that when there is considerable uncertainty, especially with discriminant price auction formats, strategic rent-seeking behaviour can arise. Latacz-Lohman and Van Hamvoort (1997) show that auctions can provide the greatest reductions in costs when agencies have very little *a priori* information regarding bidder opportunity costs. In contrast the benefits of auctions can be modest when compared to uniform payment policies that involve some degree of payment level discrimination. This can be done, for example by setting differing payment levels for groups of landholders with observable attributes correlated with their opportunity costs (Latacz-Lohman and Van Hamvoort 1997).

While much of the conservation auction literature compares auctions with uniform payment policies (e.g. Stoneham *et al.* 2003), there are other private land conservation policies in practice that are worthy of comparison. In the Onkaparinga, the case study examined in this paper, the policy in place prior to the auction was an input payment scheme which involved strategic use of information by the agency in an attempt to reduce the payments made to the landholders. As is often the case with input payment schemes, the Onkaparinga landholders received payments for purchased inputs according to a schedule of payments developed by the agency. While many of these inputs involved chemicals, equipment and other tangible inputs, the largest costs associated with conservation actions were labour inputs. In contrast to most input payment schemes, the rates for contributing in-kind labour in the Onkaparinga were determined through bilateral negotiation between agency officers and the landholders. Any landholder willing to accept the final terms offered by agency officers through the negotiation had their bids accepted until the annual agency budget for conservation improvements was exhausted.

The standard paradigm used in economics to consider outcomes of bilateral negotiation involves cooperative game theory (Nash 1950); non-cooperative game theory with complete information (e.g. Rubenstein 1982) and non-cooperative game theory with incomplete information (e.g. Crampton 1984). The essential characteristic of game theoretic outcomes of bilateral negotiations is that they involve some splitting of the gains from trade (Rasmusen 1995). Where bargaining is costly, as it typical in most real world settings, both parties have incentives to increase their own share at the expense of the other party. However, there is also incentive to resolve bargaining because if negotiation fails all potential gains are lost, and costs of protracted negotiation can significantly erode gains from trade (Kennan and Wilson 1993).

The game theory of bargaining leads to a general conclusion that a negotiation mechanism will tend to result in some splitting of rent payments among landholder and the agency implementing the payment program. However, game theory alone offers little basis for empirical quantitative prediction of actual rent splitting. Further, there is little, if any conceptual work in the literature that offers a theoretical basis for comparison of the relative efficiency of bargaining in comparison to auction price setting mechanisms. Because the performance of conservation auctions in comparison to payment policies cannot typically be judged conclusively based on theory alone, there is need for empirical assessment. In particular more analysis is needed of alternative strategic uses of information by agencies in payment and auction policy.

This article joins previous work on empirical assessment of the cost effectiveness of land conservation auctions and payment policies including Stoneham *et al.* (2003) and White and Burton (2005). Both studies estimate savings relative to uniform price comparison policies involving no strategic use of information to reduce rent seeking. This article contributes to the literature by assessing the cost of auction and payment policy alternatives that use varying levels of information strategically to reduce rent payment and to prioritise funding based on environmental value.

The Catchment Care Australian conservation auction implemented in 2004 is evaluated. A quantitative analysis is presented of the cost per unit environmental benefits achieved relative to four alternative non-auction payment policies: (a) the negotiated payment policy similar to the one that was in place prior to the auction, (b) a uniform payment policy, (c) a uniform payment policy with offers chosen selectively based on environmental value, and (d) a negotiated payment policy with offers chosen selectively based on environmental value.

2. The Catchment Care auction and input payment policies

Catchment Care (Bryan *et al*. 2005a; Bryan *et al*. 2005b) was developed in the Onkaparinga catchment in South Australia and administered by the Onkaparinga Catchment Water Management Board (or *the Board*). Catchment Care was a sealed bid, first price, discriminant auction. Landholders submitted bids to the Board proposing a suite of conservation actions and a price. Bids are then assessed based on an environmental benefits index (EBI) score calculated using a process specifically developed for the auction. There were two key considerations with respect to information revelation by the agency in auction design. Firstly, information sharing was deemed necessary to avoid the possibility of low participation rates resulting from uncertainty regarding the land management options and bid preparation. To address this, visits by agency officers to the landholders took place and information and materials about the auction, environmental values, and potential environmental impacts and potential solutions relevant to the properties were presented. This information was vital in the landholder preparation of an auction bid. Secondly, to reduce potential for strategic rent seeking, the environmental benefit index scores of bids and methods of calculating environmental benefits were not revealed to the landholders.

The EBI is based on a risk analysis framework (Standards Australia 2006). In this framework, environmental benefit is a function of the inherent environmental value of the site, threats active at the site, the expected amount of threat reduction that would be achieved by landholder actions proposed in bids, and the size of the area targeted for action. A risk score was calculated for sites by multiplying environmental value and threat scores both recorded during field-based site assessment. Environmental value indicators include geomorphological type, degree of hydrological disturbance, and the condition of remnant vegetation. Threats include bed and bank instability, existence of dams and off-takes, habitat patch size, weed presence and proportional cover, and grazing pressure. Sites of high environmental value that are subject to more severe threats have the highest risk score (see Bryan *et al*. 2005a).

In the Catchment Care framework, landholder actions as proposed in the bids can be expected to reduce the level of threats operating at a site. The level of threat reduction expected to be achieved by the landholder actions was scored by field officers using an expert panel workshop approach. The *impact* of landholder actions is then calculated as the product of the amount of threat reduction achieved by landholder actions and the risk of the site. The bids that offered the highest levels of threat reduction at sites at highest risk received the highest impact scores, and are thus the most attractive to the funding agency.

The EBI was calculated by multiplying the impact score by the area of proposed actions. The cost effectiveness of bids was then calculated by dividing the Environmental Benefits score by the cost of the bid to the Board. Bids were then ranked in order of cost effectiveness and selected for funding in order of cost effectiveness until the available funds are exhausted.

As mentioned above, prior to implementation of the auction the policy for conservation services in the study area was an input payment scheme. A unique feature of this pre-existing policy was that, while payment rates for commercially purchased inputs were uniform, the payments for in-kind labour contributions were determined through bilateral negotiation between agency officers and landholders. A distinct feature of this policy (and most other payment policies) is that the labour bids were considered as offers arose without first gathering all offers and then using a systematic selection process to select a subset of these offers. This "as they arise" policy is in contrast to the typical conservation auction process in which all bids are collected and then a subset is systematically selected on the basis of cost effectiveness using the benefits index and the agency budget.

3. A comparison of the cost effectiveness of the conservation payment policies

3.1 The Catchment Care auction

The Catchment Care auction was a sealed bid first price discriminant auction and is thus very similar to the BushTender Auction in Victoria. Conceptually, the bid selection process involved can be characterised as an attempt by the agency to minimise the cost of paying landholders for conservation actions on private land. Given a population of eligible participants some submit bids. Each bidder, i, names a conservation action and an associated price, B_i. In addition, each bid can be thought of as having an environmental benefits index value, E_i. For auctions such as Catchment Care and Bushtender, E_i is known to the agency and is used to evaluate the bids. With other possible auction or payment policies, however, no EBI is used by the agency to evaluate bids and thus the values of E_i associated with bids are unknown to the agency. This would be the case, for example, with a uniform input payment policy involving no attempt to differentiate amongst bids based on differences in environmental value. It could also be the case for an auction involving selection of bids based on cost per unit input or practice; but again with no attempt to differentiate amongst bids based on differences in environmental value.

The bid selection algorithm used by the agency for the Catchment Care auction case study can be written as:

$$\max \sum_i I_i E_i \text{ subject to } \sum_i I_i B_i = CB, \qquad (1)$$

where I_i is a set of choice binary variables taking a value of 1 for each bid that is selected and 0 for each bid that is not, and CB is the agency conservation budget.

The outcome of this auction was that 29 bids were submitted by private landholders and ranked on environmental benefits per dollar bid. 17 bids were funded. The bid offer curve resulting from the auction is shown in Figure 1. The actual expenditure level of $139,278 did not exactly meet the budget constraint as a result of the discreet or “lumpy” nature of the bids. The total estimated environmental benefit associated with this expenditure was 20.9 million environmental benefit units.

Figure 1 about here

3.2 Comparison payment policies

Ideally, a comparison of auction and other policies would be on the basis of environmental benefits and costs for the actual participants in comparison payment policies. It was not possible to provide such comparison because information would be required from at least a sample of prior payment policy participants on payment levels, actions taken and EBI scores. In this case (and presumably for other auctions), the agency kept records of payment levels and actions taken for past payment policy. However, no EBI scores exist for the prior program. Given the lack of environmental benefits information for observed responses to past payment programs, past auction evaluations have constructed estimates of response to alternative policies using data from auction response. Here we compare actual auction outcomes to estimated responses to alternative policies. This involves using information on cost per unit input from the actual past payment program in the study area and response data from the actual auction.

Here the auction outcome is compared to estimated outcomes of four alternative payment policies: (a) a uniform payment; (b) a negotiated payment; (c) a uniform payment policy with offers chosen selectively based on environmental value; and (d) a negotiated payment policy with offers chosen selectively based on environmental value.

3.2.1 *Esimating uniform and negotiated payment policies with Monte Carlo simulation*

Conceptually, the uniform payment policy was modelled to represent an agency setting a price per unit input at a uniform level, P, for all potential participants. No attempt is assumed to price discriminate based on differences in opportunity cost or environmental benefits associated with each landholder. Participant *i* who can offer conservation action at an opportunity cost (OC_i) less than the uniform payment level ($OC_i \leq P$) is assumed to be willing to accept the payment. The non-systematic nature of bid selection in such a payment policy is represented by assuming that bids are funded in the order that they arise and that this does not result in systematically selecting bids based on differences in opportunity cost or environmental benefit. Given the further assumption that there is a budget constraint (*CB*) such that not all bids can be accepted, bid selection can essentially be considered using a random draw from the population for whom $OC_i \leq P$ up to the budget limit *CB*. For these assumptions, the expected environmental benefit is $E(E_i)$ for all I_i such that $OC_i \leq P$.

The cost of this uniform input payment policy was estimated with Monte Carlo simulation by randomly drawing 100 samples from the population of the 29 bids submitted to the actual auction. Bids at costs exceeding the costs of inputs used in the prior payment program were rejected and other bids were assumed to be paid at the prior payment program rates per unit input, even if bids were for less than this cost. The number of landholders varied in each draw (as shown in results Table 3 below) because each sample was chosen such that the cumulative cost of including another randomly selected landholder from the 29 bidders would violate the actual auction budget constraint (*CB*). The average cost and the environmental benefit level for the 100 samples were computed. These averages were then used to compute the expected environmental benefit per dollar expenditure of the uniform input payment program.

The payment program in place prior to the auction involved bilateral negotiation between the agency and landholders to reduce payments. To estimate the cost of the policy, it was assumed that conceptually, all potential participants who can offer conservation action at opportunity cost less than uniform payment price ($OC_i \leq P$) would. It is further assumed that rather than offering all bidders a uniform price P, a different price $C_i \leq P$ is negotiated by the agency with each bidder. As with the uniform payment policy, it is assumed that bids are funded in the order that they arise without efforts to differentiate based on expected opportunity cost or environmental benefit. It is further assumed that there is a budget constraint such that not all bids can be accepted, so that bid selection can be represented as a random draw from the sub-population for whom $OC_i \leq P$ up to a budget limit CB. A key assumption underlying the estimation of the costs of this policy is based on the theory of bilateral bargaining where the negotiated price, C_i will always be less than or equal to the uniform price P.

The Monte Carlo simulation used to estimate the cost of the negotiated input payment policy involved randomly drawing 100 samples from the population of the 29 bids submitted to the actual auction. Bids at costs exceeding the standard costs of inputs used in the prior payment program were rejected. Other bids were assumed to be paid at the prior payment program rates per unit input discounted by the average cost reduction that resulted from negotiation for a sample of 100 bids from the prior payment program. The size of the sample in each draw varied because bids were drawn until the cumulative cost of including another randomly selected bid would violate the actual auction budget constraint.

The validity of these estimators of the cost effectiveness of a uniform and negotiated input payment policy are predicated on several assumptions. The first is that the population of individuals who would self-select to participate in the payment policies is the same as the population that self-selected to participate in the auction. The second is that the process of selecting program participants can be simulated as random selection from the population of those who submitted discriminant price auction bids. The third is that those who offered to participate in the auction would also be willing to participate in the payment program as long as the payment level offered is greater than or equal to the auction bid level offered. Implications of violations of these assumptions are considered in the results discussion section below.

3.2.2 Estimating cost of uniform and negotiated payment policy with offers chosen selectively based on environmental benefit

The payment policies discussed to this point assumed no systematic selection of bids based on their associated environmental value. An alternative is a policy that offers fixed payment levels, but the selection of offers is based on their environmental value.[1] In this scheme, fixed payments are offered to landholders for specified environmental action. The administering agency then evaluates the environmental benefits of all offers and funds offers in order of their estimated environmental benefit until allocated funds are exhausted.

Conceptually, the form this policy takes in this paper is similar to the UK Conservation Sensitive Stewardship Scheme (Groth 2005) in that systematic selection of offers to participate in a payment scheme is assumed. Implementation would involve site visits to landholders to discuss fundable actions, making a plan, evaluating environmental benefits using the same approach used in the Catchment Care auction and costing the plan based on standard uniform payment rates. Landholders would then submit offers, offers would be ranked on the basis of environmental benefits per dollar offered and offers funded until allocated funds were exhausted.

[1] The United Kingdom Conservation Sensitive Stewardship Scheme is an example (Groth, 2005).

This policy is modelled mathematically with an offer selection algorithm that looks very similar to the actual auction bid selection algorithm presented above:

$$\max \sum_i I_i \, E_i \text{ subject to } \sum_i Ii \, L_i \, P \;= CB. \qquad (2)$$

As above, I_i is a set of binary variables taking a value of 1 for each offer that is selected and 0 for each offer that is not. Li is the input level associated with the bid. As in the auction the goal of the agency is to choose the combination of bids that offer greatest environmental benefit per dollar expenditure. The main difference between this policy and the auction is that all offers would be funded at a standard and uniform payment level per unit input, P whereas in an auction each participant chooses a bid level B_i. The cost of this policy was modelled by costing all 29 bids submitted to the auction at the uniform input prices used in policy prior to the auction. Then offers were selected in order of cost effectiveness up to a budget constraint equal to the level of actual auction expenditure.

The final counterfactual policy considered also assumes systematic selection of offers to participate in a payment scheme, but in addition negotiated input prices are assumed. Implementation would involve site visits to landholders to discuss fundable actions, making a plan, evaluating environmental benefits using the same approach used in the Catchment Care auction. However, rather than offering standard uniform payment rates it was assumed that payment rates would be determined by bilateral negotiation. Landholders are assumed to submit offers that are then ranked on the basis of environmental benefits per dollar offered, and offers are funded until allocated funds are exhausted.

Again this policy is modelled mathematically with an offer selection algorithm that looks similar to the actual auction bid selection algorthim:

$$\max \sum_i I_i\, E_i \text{ subject to } \sum_i IiL_i C_i = CB. \quad (3)$$

The main differences between this policy and the auction is that the payment level depends on the input level, L_i and a negotiated payment level per unit input, C_i. The cost of this policy is modelled by costing all 29 bids submitted to the auction at average negotiated price per unit input in the prior negotiated payment policy. Resultant offers were then selected in order of cost effectiveness up to a budget constraint equal to the level of actual auction expenditure.

4. Results

The results of the auction and the four counterfactual comparison policies considered are summarised in Table 1. Note that in each comparison the same level of program budget was used across the comparison of policies.

Table 1 about here

The uniform input payment and negotiated payment policies (without systematic selection of offers based on environmental value) were estimated with Monte Carlo analysis. Results of these analyses are summarised in Table 2. In comparison to the auction policy, the estimated average environmental benefit of the uniform input policy was 11.7 EBI which comprised about 56% of the benefits attained through the auction with the same level of overall expenditure. As can be seen in Table 2 the level of environmental benefit estimated to result from this policy varied significantly across Monte Carlo draws. For example, estimated benefit for the draw with the greatest EBI (20.4 million) was very near to the level achieved by the actual auction, while the draw with the least EBI (3.7 million) resulted in less than 1/3 of the average estimated environmental benefit.

The negotiated input policy considered here was similar to the payment policy implemented prior to the auction. Estimated average environmental benefit of this policy was 14.3 EBI or about 68% of the benefits attained through the auction. Again as shown in Table 2, the level of environmental benefit estimated to result from this policy varied significantly across Monte Carlo draws. Draws with the greatest and 95th percentile draws had estimated EBI levels very similar to the level achieved by the auction. In contrast, the draws with least and 5th percentile environmental benefit had EBI scores of less than half of the average for this policy. An additional finding of note is that on average, a greater number of bids could be expected to be funded with the negotiated payment policy.

Table 2 about here

The environmental benefit of the uniform and negotiated input payment policies with systematic selection of offers based on environmental benefit were estimated with optimisation. For the uniform payment policy with systematic EBI based selection of offers, estimated benefit was 19.9 EBI or about 95% of the benefits attained through the auction. The estimated environmental benefit of a payment policy involving both negotiated input payment and systematic selection of offers based on environmental benefit is 20.4 or about 98% of the benefits attained through the auction assuming the same level of overall expenditure.

The outcomes of the uniform and negotiated payment comparison policies with offer selection based on the same EBI used in the auction are shown graphically in Figure 2 along with the actual auction outcome. The figure illustrates that the observed small difference between the policies in the level of estimated environmental benefit assuming equal levels of expenditure can be attributed to the steeply increasing cost of supply in this expenditure range. The steeply increasing supply curve also means that cost differences between policies are more pronounced when the cost of achieving a fixed level of EBI with the auction and the alternative payment policies. This is illustrated in Figure 2 for the cost of achieving the auction outcome level of 20.9 million EBI. With a negotiated payment policy and EBI based offer selection the estimated cost of achieving 20.9 million EBI is $165,397 or 118% of the actual auction cost. The cost of achieving the auction EBI outcome with a uniform payment policy and EBI based offer selection is estimated at $209,307 or 150% of the actual auction cost.

Figure 2 about here

5. Discussion

The results of this analysis suggest that the estimated cost savings achievable with the discriminant price auction for conservation contracts depends on the policy to which the auction outcomes are compared. In this study, the auction outcome is compared to a uniform input payment policy with no effort employed by the agency to reduce rent seeking, and no effort to select projects based on environmental cost effectiveness. Only 56% of the environmental benefit level achieved with the auction was estimated to result for the same expenditure level. These findings are similar to those of Stoneham et al (2003) and Burton and White (2005) who both estimated substantial savings from discriminant auctions when compared to payment policies not using information strategically to reduce agency cost.

However, a reduced level of savings could result from the discriminant price auction if a negotiated input payment policy was chosen as the comparison benchmark. The negotiated input payment policy as modelled here represents an interpretation of the input payment policy that was in place in the study area prior to the discriminant price auction. With this negotiated payment policy, 68% of the environmental benefit achieved with the auction was estimated to result. The finding that auction cost savings are likely to be greatest when compared to policy alternatives involving little effort to discriminate amongst offers based on differences in landholder opportunity costs confirms the findings by Latacz-Lohman Van Ham Voort (1997).

Another important finding is that most of the savings resulting from the discriminant price auction could be attributed to the use of the environmental benefits index in project ranking and selection. This is evident through comparison of the results of the uniform payment policies with and without selection based on environmental benefits. Without selection of offers based on environmental benefits the uniform payment policy was estimated to result in 56% of the environmental benefit achieved by the auction. When selection of best environmental benefits offers were used as first priority for payment up to a budget limit, the uniform payment policy was estimated to produce 95% of the benefit of the auction. This leads to the conclusion that most of the economic benefits of implementing the auction can be attributed to the ability of the agency to select the bids that provide the highest environmental value per dollar. This is a benefit gained largely through the use of an environmental benefits index to prioritize bids rather than the incentive for truthful revelation of opportunity cost inherent in to the auction mechanism.

A further key finding is that the negotiated payment policy combined with a systematic selection of offers using the EBI was estimated to achieve very nearly the same level of environmental benefit as the auction for the same expenditure level. This leads to the suggestion that, at least for this case study, auction and negotiation mechanisms appear to be nearly equally effective at revealing opportunity costs.

While this comparative analysis provides some insights into the economic efficiency of various conservation schemes, there are short comings in this present and other past analyses. Perhaps the greatest limitation in this study and the other extant analyses of Australian conservation auctions (e.g. Stoneham *et. al,* 2003; White and Burton, 2004) is that comparison of the environmental benefit and cost outcomes arising from the auctions to “real” outcomes of comparison policies has not been possible to date. This is because information on the EBIs for past payment programs does not exist - the EBIs needed to rank bids simply did not exist prior to the introduction of the auctions. Given the lack of EBI scores for observed responses to past payment programs, the alternative is to construct estimates of responses to alternative policies using data from the actual auction responses. That is the approach taken in this present study.

There are likely to be differences in the propensity of landholders to participate in conservation auctions or input payment schemes that cannot be addressed using hypothetical simulation of responses to these policies. The implications of differences in participation in various policy mechanisms are not yet understood but may be significant. For example, officers of the agency that implemented the Catchment Care auction believed that the limited time period associated with the auction and the delay until auction outcomes were announced may have limited enrolment relative to the prior negotiated input payment program. This latter program allowed landholders to submit project proposals whenever they were ready and able. This negotiated program also allowed landholders to learn quite rapidly if their proposals were worthy of selection since there was no need to collect all of the bids at one time to conduct the ranking exercise.

Additionally, there may be substantial unaccounted differentials in the levels of moral hazard associated with alternative policy approaches. For example, agency officers who ran the auction believed that the prior input payment program left them more latitude to select against landholders who they believed were more likely to default on provision of works or poorly execute agreed activities. Again limitations in data precluded a full examination of this potential. Clearly, there is need for more and more rigorous evaluation of how levels of moral hazards and adverse selection vary depending on policy approach. This suggests that there is need for rigorous experimental design of strategies to evaluate future market based instrument trials to allow statistical evaluation of differences in behavioural responses across various formats of auctions and payment schemes.

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Table 1: A summary of estimates of the cost effectiveness of the auction and various payment policies in the Onkaparinga Catchment.

Policy	Cost ($) of achieving the auction level of environmental benefits	Level of EB (millions) achievable with auction level of expenditure	$/1000EB	Policy cost/EB as % of actual auction cost/EB
Discriminant price auction (Catchment Care)	139,278	20.9	6.6	
Uniform input payment policy		11.7	11.9	56%
Negotiated input payment policy		14.3	10.3	68%
Uniform input payment policy with selection of offers based on EB		19.9	7.0	95%
Negotiated input payment policy with selection of offers based on EB		20.4	6.8	98%

Table 2: Uniform and Negotiated Payment Policy Monte Carlo Simulation Results

uniform payment policy

	Cost	EBI score	offers funded
Mean	143,208	11,741,967	16.53
Stdev	5,789	3,961,244	2.15
Max	149,955	20,425,584	22
Min	123,628	3,682,668	12
95th percentile	149,733	18,749,576	21
5th percentile	130,306	5,487,230	14

negotiated payment policy

	Cost ($)	EBI score	offers funded
Mean	144,413	14,096,114	19.13
Stdev	4,751	3,669,635	2.01
Max	149,984	21,104,881	24
Min	128,777	6,873,143	13
95th percentile	149,587	19,702,339	22
5th percentile	132,306	7,240,119	16

Figure 1: Bid offer curve result of the Catchment Care auction

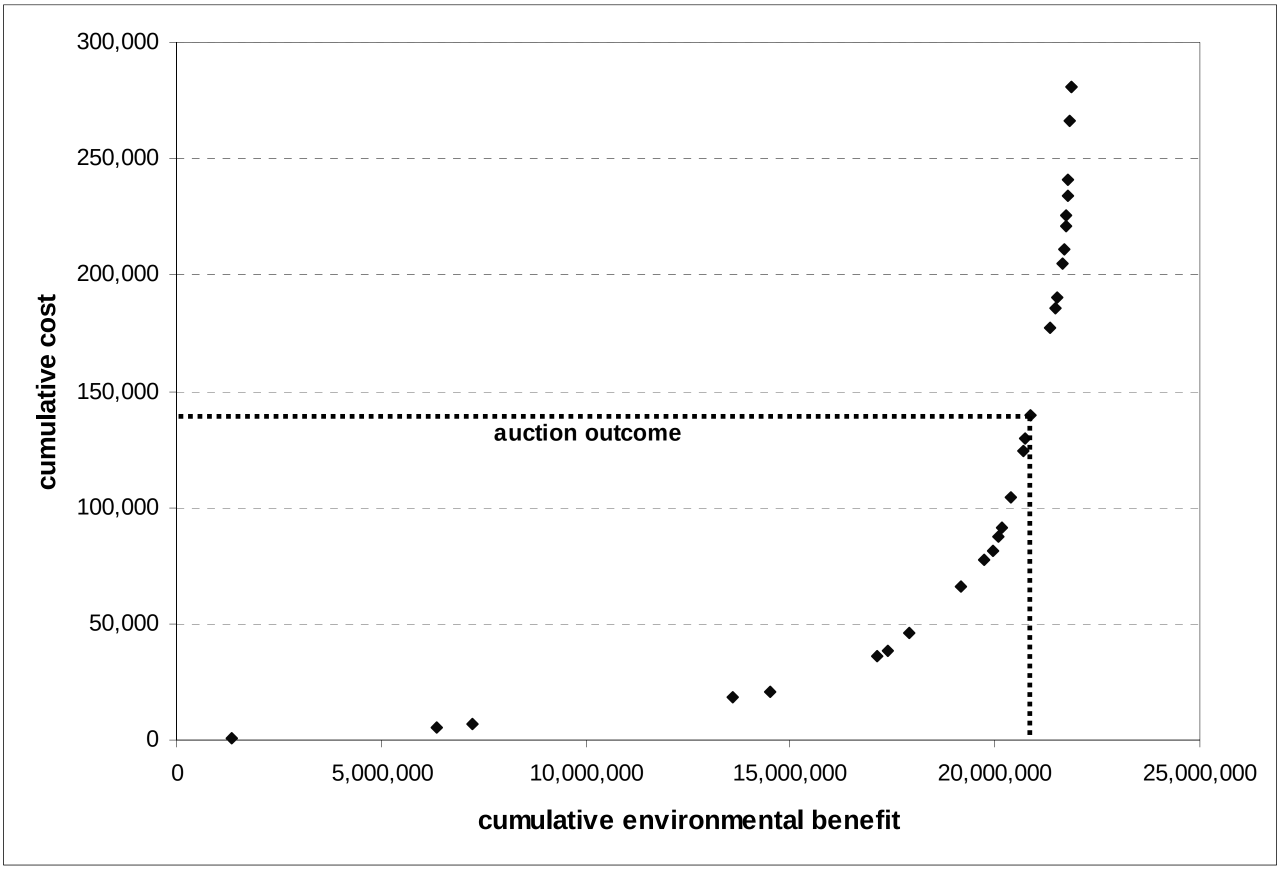

Figure 2: Outcome of Auction, Uniform and Negotiated Payment with EBI based offer selection