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Using Field Experiments to Explore the Use of Multiple Bidding Rounds in Conservation Auctions

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Abstract

Conservation auctions such as the Conservation Reserve Program in the United States and the BushTender Program in Australia have been used to identify landholders who can provide on-farm conservation and biodiversity protection actions at lowest cost. These conservation auctions are typically framed as closed, discriminatory, single round, first-price auctions, and are based on the assumption that landholders will offer bids determined by their 'independent private values'. However bid values may also be influenced by other factors such as concerns about 'winner's curse', a desire to capture economic rent, and premiums for risk and uncertainty factors. Sealed, single round auctions may exacerbate information gaps and uncertainty factors because of the limited information flows compared to traditional market exchanges and open, ascending auctions. In this paper, the cost-efficiencies of a multiple round auction for landholder management actions are explored with the use of field experiments. Results suggest that multiple round auctions may be associated with efficiency gains, particularly in initial rounds. However, multiple round auctions can also involve higher transaction and administration costs, so the net advantages need to be assessed on a case by case basis before these are used to purchase environmental services.

Key words: conservation auctions, multiple bidding rounds, field experiments

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Using Field Experiments to Explore the Use of Multiple Bidding Rounds in Conservation Auctions

John Rolfe[1] and Jill Windle[2,*]

1. Introduction

Conservation auctions such as the Conservation Reserve Program in the United States (Kirwan et al., 2005) and the BushTender Program in Australia (Stoneham et al., 2003) have been used to identify landholders who can provide on-farm conservation and biodiversity protection actions at lowest cost. Under the programs, landholders are invited to submit tenders specifying their proposed actions and bid levels, and a subsequent evaluation process identifies the biodiversity benefits involved and the most cost-effective proposals. Use of these mechanisms reflects growing interest in the adoption of market-based instruments to improve natural resource management and environmental outcomes (Latacz-Lohmann and Van der Hamsvoort, 1997, 1998; Cason and Gangadharan, 2004).

Competitive auction mechanisms have two theoretical advantages over fixed rate conservation payments. Auction prices are more likely to reflect the marginal value of the resources being used to produce the good or service, and, as the mechanism introduces an element of competition between producers, the scope for rent seeking behaviour is reduced (Latacz-Lohmann and Van der Hamsvoort, 1998). These advantages mean that competitive bidding, as compared to fixed rate payments, can significantly increase the cost-effectiveness of conservation contracting on private land (Latacz-Lohmann and Van der Hamsvoort, 1997, 1998).

Auction theory indicates that discriminatory, single round mechanisms may be the most efficient form of a competitive tender (Latacz-Lohmann and Van der Hamsvoort, 1997; Milgrom, 2004). The selection of discriminatory rather than uniform-price bids means that bidders would not receive any surplus on top of their bid amounts, while having only a single round means that bidders have incentives to reveal their true opportunity costs as they only have one bid opportunity. The performance of conservation tenders such as the Conservation Reserve Program and BushTender have been in the form of discriminatory, first-price, sealed bids, with a single round of bidding. While the BushTender Scheme was a single program, the Conservation Reserve Program has had regular sign-ups since its introduction in 1985.

The designer of conservation auctions often has to grapple with issues that are subtly different to those involving more familiar consumer goods. One issue is problems of asymmetric information, where both the seller and the purchaser of a conservation action do not have accurate information respectively about the public benefits of conservation programs or the opportunity costs of providing the conservation actions (Cason and Gangadharan, 2004). Because both types of information are necessary to find the efficient level of conservation provision, problems of asymmetric information limit the potential application of market mechanisms. Another issue that may impact on the design of conservation auctions is the limited number of participants, with many programs involving a single (government) buyer and a small number of sellers. The lack of familiarity, knowledge and interest in

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conservation tenders can also be a factor affecting design and performance. Unlike simultaneous trading mechanisms in many commercial markets and open-bidding English auctions, where information is transferred about the willingness of other bidders to pay for the good of interest, conservation auctions are rare, specialized and have limited information flows.

A number of auction mechanisms that have appeared to be theoretically and normatively correct have failed in application (Klemperer, 2002; Chakravati et al., 2002), indicating the need to road test mechanisms with human interactions (Cason and Gangadharan, 2004) and to link behavioural reality with normative theories (Cheema et al., 2005). Auctions in the environmental area are still relatively untested, so data from field trials is scarce (Cason and Gangadharan, 2004). Given the importance of auction design that is tailored to specific situations and the need to check theoretical predictions against interactions with individual participants, there has been developing interest in testing auction mechanisms with different types of experimental methods before full application (Shogren et al., 2000; Cason and Gangadharan, 2005). In the same way that flight engineers use wind tunnels to test airplane design, the experimental economics discipline provides methods to test the economic design of auction methods and confirm whether theoretical predictions are appropriate guides to real human behaviour (Shogren, 2004).

There are two broad forms of experimental procedures available to test the field applications of conservation auctions. The first are laboratory experiments, where the tradeoffs are tightly controlled and carefully defined to subjects. University students are often involved as participants, and potential monetary payments from the workshop are typically used as incentive mechanisms. The second are field experiments, where actual or simulated farms are used, farmers are involved as participants, and a variety of different incentive mechanisms may be used.[3] Laboratory experiments have advantages of being tightly controlled, and can provide insights into human behaviour when the endowments or rules of engagement are changed (Roth, 2002; Cason et al., 2003). Field experiments have more confounding variables involved, but provide more direct feedback on how landholders of interest would behave if different forms of conservation auctions were introduced (List and Shogren, 1998; List and Lucking-Reiley, 2002).

The focus of this paper is reporting the use of a field experiment to explore one issue in conservation auctions: the potential use of multiple bidding rounds instead of single bidding rounds. There are several reasons for conducting the experiment. There may be design advantages in holding multiple rounds when bids from landholders need to be coordinated. There are normally multiple bidding rounds in experimental economic laboratory tests, where there are arguments that repeated rounds help participants to learn, help to give them market feedback, and help them to understand that they should reveal their true opportunity costs (List and Shogren, 1999; Cason and Gangadharan, 2004; Bernard, 2005). However, multiple bidding rounds incur higher administrative and transaction costs (Cason and Gangadharan, 2004), and incur risks of strategic behaviour (Latacz-Lohmann and Van der Hamsvoort, 1997).

Current conservation auctions tend to have only single rounds, raising questions about whether it would be more efficient to move to multiple bidding rounds. Evidence from the longest running conservation auction, the Conservation Reserve Program, suggests that when a single round auction is repeated over time (i.e. a single round, multiple stage auction), Bayesian learning will reduce cost-efficiencies (Reichelderfer and Boggess, 1988). Once each stage of the auction is completed, information becomes available about the winning bids and bidders in subsequent stages are able to use this information in their bid formation. In a multiple round, single stage auction, bidders are able to gain some market information

[3] A more general bibliography of framed field experiments is provided by John List at www.arec.umd.edu/fieldexperiments/framed.htm

between rounds, but do not know the prices of the final winning bids. While price increases were observed in the first rounds of the Conservation Reserve Program (Reichelderfer and Boggess, 1988), bids in the Georgia Irrigation Reduction Auction decreased over five rounds even though laboratory experiments had predicted increases (Cummings et al., 2004). The complexity of information and variation in management plans may make it very hard for landholders to behave strategically in actual case studies (Latacz-Lohmann and Van der Hamsvoort, 1997).

Here, field experiments with landholders in a regional area of Australia were used to assess the potential use of competitive tenders for the provision of environmental services. The auction mechanism trialed was a discriminatory, first-price, sealed-bid process with multiple bidding rounds. This paper is organized as follows. In the next section, a review of the expected influence of multiple bidding rounds on conservation auctions is presented. The design of the field experiments is outlined in section three, and performance and summary results are presented in section four. Conclusions are drawn in the final section.

2. Conservation auctions and multiple bidding rounds

The application of standard economic theory to conservation auctions suggests that single bidding rounds are appropriate (Stoneham et al., 2003). The 'independent private values model' assumes that the opportunity cost of a contract is the basis of price formulation and as this is a fixed cost and known to participants with perfect information, a single round auction is sufficient (Latacz-Lohmann and Van der Hamsvoort, 1997). In contrast, the provision of multiple rounds would allow participants to potentially engage in strategic behaviour and inflate initial bid levels, as a profit-maximising landholder might be expected to do. The potential for apportionment of economic rent by landholders acting in a strategic manner suggests that multiple bidding rounds will lead to more inefficient use of public funds. In contrast to this standard case for the use of single bidding rounds, there is a range of theoretical arguments and experimental evidence that offers some support to the use of multiple bidding rounds.

The theoretical arguments are focused around the ways that participants form their bid values when problems of risk, uncertainty and asymmetric information are involved. Landholders typically have limited information about the opportunity costs of providing conservation services because they may be unfamiliar with the type of service to be offered, the impact on their operating costs, and the level of transaction and transformation costs that might be involved. The latter costs can also relate to unfamiliarity with the conservation auction process. It is also expected that landholders have limited knowledge about the public benefits of providing conservation actions.

Participants who are unfamiliar with the goods to be provided may have incentives to state higher tradeoffs because of concerns about 'winner's curse', which is where a naïve bid that generates losses becomes successful (Hong and Shum, 2002). The information transfer involved in the open, ascending bid nature of an English auction provides participants with information about the valuations of other bidders (Lusk et al., 2004), and helps to allay concerns about 'winner's curse'. In a closed auction format, such as those employed in conservation tenders, where no information is available about bids (and valuations) from other participants, participants are likely to engage in more conservative bidding (Hong and Shum, 2002). Allowing bidders to learn about others' valuations during the auction can make them more comfortable with their own assessments and less cautious (Klemperer, 2002).

Participants may also adjust their bids for new goods to take account of the information value of learning how the new item relates to their preference set (Shogren et al., 2000). One argument for the use of repeated rounds in trial auction experiments is that subjects learn to

understand the auction process and respond to market information (List and Shogren, 1999). Bid construction is also likely to be influenced by transaction costs (Cheema et al., 2005) and risk aversion (Chakravarti et al., 2002), where these factors tend to be ignored by game theorists. In many auctions, bidding is costly (Colombo, 2003) and bidders can incur costs of learning (McAfee and McMillan, 1987) as well as costs of preparing a bid (Menezes and Monteiro, 2000). Learning effects across multiple rounds may mean that participants reduce their premiums for risk and transaction cost factors, increasing the efficiency of the auction process.

The discriminatory nature of conservation auctions is also a reason why conservative bids may be tendered. In comparison, uniform-price auctions, where successful sellers are paid at the price set by the last rejected seller's offer, provide better incentives to reveal opportunity costs (Cason and Gangharan, 2004). In an English auction system, the winning bidder effectively pays a price just higher than the losing bidder, thus capturing the surplus between their true value and the bid price. The sealed bid equivalent to the English auction is a Vickery second-price auction, where the highest bidder wins the auction but pays the bid level of the second highest bidder (Lusk et al., 2004). This effectively allows the winning bidder to capture some economic surplus, and thus provides better incentives to reveal true opportunity costs. In comparison, a discriminatory, highest bid auction gives participants no opportunity to capture economic surpluses unless they submit bids that are higher than their opportunity costs (Kirwan et al., 2005).

The use of repeated bidding rounds in conservation auctions, where bidders gain information about their potential success levels and market prices at the end of each round, has the potential to affect the surplus levels included in each bid. However, there may be two offsetting influences. Competitive pressures will be expected to reduce the surplus levels, suggesting that increasing numbers of rounds will be associated with efficiency gains. Where the additional information better allows the participants to behave strategically, then increasing the number of bidding rounds may be associated with lower levels of efficiency.

There is some evidence from laboratory experiments that repeated rounds can be associated with more competitive bid values. Both Kagel et al. (1987) and Kagal and Levin (1993) found a tendency for participants in second-price auctions to overbid, but this tended to reduce across repeated rounds. Shogren et al. (2000) reported that participants in laboratory experiments tended to reduce bids for novel consumer goods over repeated rounds, with the amount of reduction being highest between initial rounds. Lusk et al. (2004) found that bids for different quality steaks tended to increase (became more competitive) across multiple bidding rounds in the closed, second-price auction format, with the largest change occurring between rounds one and two.

There is also evidence from actual conservation auctions that bid levels are not reflecting only opportunity costs, as the 'independent private values model' might suggest. Kirwan et al. (2005) reports that there are substantial premiums being paid to participants in the Conservation Reserve Program, indicating that the bid levels being submitted by farmers are 10-40% above the opportunity costs for their land use. However, it is noted that these premiums may be required before farmers will reveal their opportunity costs and agree to participate in the land conservation scheme.

The optimal design of conservation auctions is likely to depend on the knowledge and experience of participants with the goods or services to be provided, the familiarity of participants with the auction process, and the potential for strategic behaviour to generate payoffs (as when there may be limited numbers of bidders). Where participants are unfamiliar with the services to be provided and the tender process, then repeated rounds of the conservation tender may generate efficiency outcomes. Where participants are very familiar with the actions and processes, then the provision of additional information through repeated rounds may simply increase the potential for strategic behaviour and generate further

inefficiencies. For example, in the Conservation Reserve Program there were three stages or sign-ups in 1986 and both the mean value and distribution of bid levels declined over subsequent sign-ups, implying that bidders had learned an acceptable bid level (Reichelderfer and Boggess, 1988).

This analysis suggests that the decision about whether to hold repeated rounds in conservation auctions may have to be made on a case by case basis. Field experiments may provide an appropriate methodology for performing such tests before actual tenders are rolled out. The following field experiments were designed to test the effect of using multiple bidding rounds in conservation auctions.

3. The design of the field experiments

The field experiments were performed with landholders in the southern Desert Uplands region of central-western Queensland, Australia. The region is approximately the size of Tasmania, the smallest state in Australia. Vegetation in the southern Desert Uplands is becoming more fragmented from clearing and grazing activities. There are very limited areas of public land in the region, with 99% of 'endangered' and 97% of 'of concern' ecosystems occurring on private land. This means that landholders need to be engaged if the conservation of native ecosystems is to be improved. There is potential to contract landholders to manage some areas more conservatively, particularly areas that have high biodiversity values and are under threat from intense cattle grazing.

A series of field experiments were held with landholders in a workshop environment within the region. The use of landholders in the region as workshop participants had potential advantages in terms of identifying:

- the opportunity costs (and heterogeneity in costs) faced by landholders;
- likely participation rates in an auction system, across different auction formats; and
- the transaction costs and potential administration costs associated with a competitive tender mechanism.

The workshops were designed around the use of an experimental 'game'. A series of dummy properties were developed that were realistic for landholders while minimizing the number of variables that could affect participants' bid behaviour. While the dummy properties varied by size and appearance, they were consistent in a number of underlying attributes, such as the proportion of different vegetation types, the amount of infrastructure available (houses, fences and watering points), and the proportion of vegetation cleared and sown to improved pastures.

The workshops each involved up to 12 landholders, and lasted for approximately three hours. Each participant in the game was randomly allocated one of the 12 properties available. While participants were using dummy properties they were asked to develop their bids based on their experience on their own properties.[4] Rather than allow landholders to nominate their management actions, in this experiment a single management action was prescribed to meet certain baseline conditions. The main condition was that landholders would have to ensure a minimum level of grass biomass was maintained throughout the year. Although cattle could still be grazed in these areas, grazing pressure would be reduced. In a region where extensive grazing is the main land use, maintenance of a threshold level of biomass is likely to be associated with:

[4] Further details about the performance of the workshops are available in Rolfe et al. (2004) and Windle et al. (2004).

- improved levels of ground cover;
- reduced runoff and associated movement of sediments and nutrients;
- continued plant diversity;
- protection of habitat for small biota; and
- habitat for larger biota in periods of climatic variation.

Specifying the management action required meant that all participants were bidding to provide the same service, although they were free to design the area and shape of nominated vegetation on their dummy property. This made bid assessment more manageable in the workshop and allowed the heterogeneity in opportunity costs between landholders to be explored. Contract details were also specified, with landholders advised that any agreements would:

- be for a five year period with annual payments;
- be in the form of a contract; and
- include a monitoring process based on an annual visit, with two weeks notice.

Each dummy property had four different vegetation types (Brigalow, Box Ironbark and Yellowjacket), reflecting broad soil types of different productive capacity. There was also a category to show areas that were cleared and sown to improved pasture. Participants were required to nominate the area of each vegetation type on their dummy property that they were prepared to manage in this way. While each vegetation type had a different biodiversity score for the metric, participants were only informed of the relative ranking and not the assigned score.

To make a bid to be paid for conserving areas of vegetation, participants had to mark a proposed conservation area on a property map, and then nominate an annual payment level that they would require. They also had to identify the area of each vegetation type involved in their bid. The bids were only to relate to the opportunity costs associated with the conservation action, as participants were informed that necessary changes to water points and fencing involving one-off capital costs would be funded separately.

In order to be able to make a rapid assessment of bids in the experimental workshop, a simple metric was used. There were two principal components of the metric; the biodiversity score and the endowment score. In the biodiversity score, weights were assigned to each vegetation type, based on relative scarcity in the region. A weighting of 0.5 was adopted for cleared areas to identify that while they have some value for conservation purposes (perhaps to allow regrowth in connecting strips) they had a much lower biodiversity benefit than the vegetated areas. The biodiversity score was assessed by adding the relative contribution of each vegetation type:

$$\textit{Biodiversity Score (BS)} = \textit{Brigalow area} * 10 + \textit{Box area} * 5 + \textit{Ironbark area} * 2.5 + \textit{Yellowjacket area} * 1.5 + \textit{cleared area} * 0.5$$

In order to reflect ‘real’ variations and to make the landscape maps appear more realistic, there was substantial variation between properties in terms of size. Because participants in the workshops were competing for rewards, bids were weighted according to property size so that participants with smaller ‘dummy’ properties were not disadvantaged. The relative values of the bids were assessed in the following stages:

1. Assess the biodiversity score (BS);
2. Assess relative bid value ($ bid offer/BS); and
3. Adjust for the endowment effect.

A spreadsheet had been created in ©Microsoft Excel and bids were rapidly assessed. The most cost-effective bids from a workshop round were announced and small financial prizes were given to the first, second and third best bids. No further details of the bids were

revealed. This provided bidders with a competitive incentive to try and improve their bids in subsequent rounds.

Participants were asked to make their bids as realistic as possible, given their knowledge of the area and their own production enterprises. The potential for strategic bias in bid formation was addressed by pointing out that government funding for any subsequent program might be informed by the workshop results, so any under-bidding by participants (to win an incentive prize) might flow through to reduced government funding.

4. Conduct and summary results

Two workshops were held in the southern Desert Uplands in April 2004. A preliminary trial was used to test the workshop format, and then two subsequent workshops were held in the small rural towns of Barcaldine and Jericho. The socio-economic characteristics of landholders attending the workshops are reported in Table 1.

Table 1. Socio-economic and attitudinal characteristics of workshop participants

Participant characteristics	Barcaldine	Jericho
Gender – Males	42%	57%
Average age	45 years	52 years
Experience in the area	20	27
Cattle enterprise - less than 1000 head	83%	43%
Ownership – Leasehold	83%	86%
Off farm income – have some	58%	57%
Off farm income – average % of total income	18%	15%
Average % of property cleared or developed	9%	24%
Focus equally on production and environment	92%	57%
Interested in being paid by government	58%	71%

Landholders were being asked in the workshops to manage their land more conservatively, and while grazing was still permitted, it was likely that some destocking would be required. It was expected that the cost involved in these management changes would be based on the costs of lost production and any other costs incurred, minus the reduced operating cost and other associated benefits. The bid price was formulated by the landholders based on an assessment of these costs and reflected their opportunity cost of management change. While the participants had dummy properties to work with, they were asked to assess the cost of these management changes based on experience with their own property.

To help participants make these calculations and formulate their bids the following assistance was provided:

- a practice worksheet;
- examples of stocking rates that might apply for the different vegetation types in the area;

- a property map with gridlines to help calculate the size of a particular area; and
- workshop facilitators were on hand to assist if required. (Advice was only given on the calculation process and not on the specific values to include).

Considerable time was taken to ensure all participants were comfortable with the way in which they formulated their bids. Once they had made the initial bid, the formulation of bids for subsequent bidding rounds proceeded more rapidly. To make a bid, participants were provided with a bidding sheet which had the property map on the reverse side. They were required to:

- indicate the location of the conservation block on the map provided;
- provide details of the area of each vegetation type included; and
- indicate the amount of the bid (an annual payment for five years).

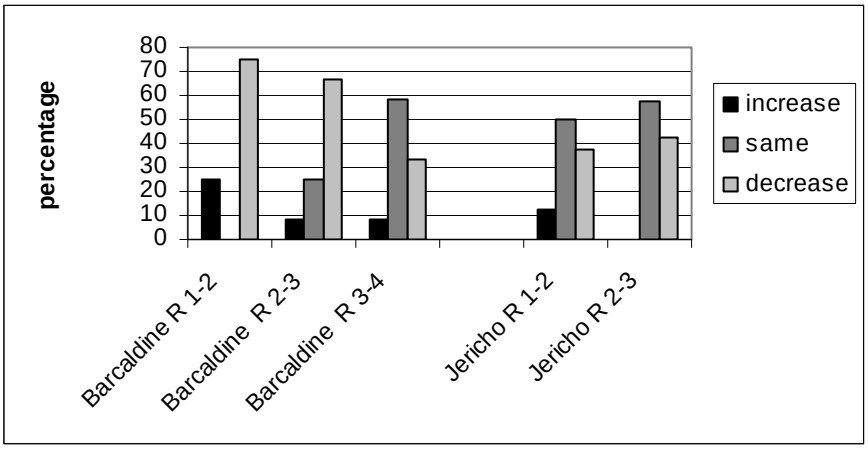
After the bids from the first round were submitted, bids were evaluated in the Excel spreadsheet. All bids were ranked, and the three participants lodging the most cost-effective bids were rewarded with small cash prizes. Participants were then invited to repeat the exercise in separate bidding rounds, where they could compete by (a) reducing their bid amount, (b) changing their bid area or (c) increasing their bid area for the same bid price. Four individual bidding rounds were held in one workshop (Barcaldine), while three rounds were held in the other (Jericho).

The purpose of the multiple round workshops was to test if relative bid prices fell across rounds, creating potential efficiency gains. Competition is a key element of conservation auctions, which should drive efficiency outcomes. The conduct of the multiple round auctions was designed to test if repeated rounds generated more cost-efficient bids, with other factors controlled to minimize confounding effects. The results of the multiple round bids can be described generally, as well as evaluated for statistical significance. Here, those results are outlined.

4.1 Preliminary analysis

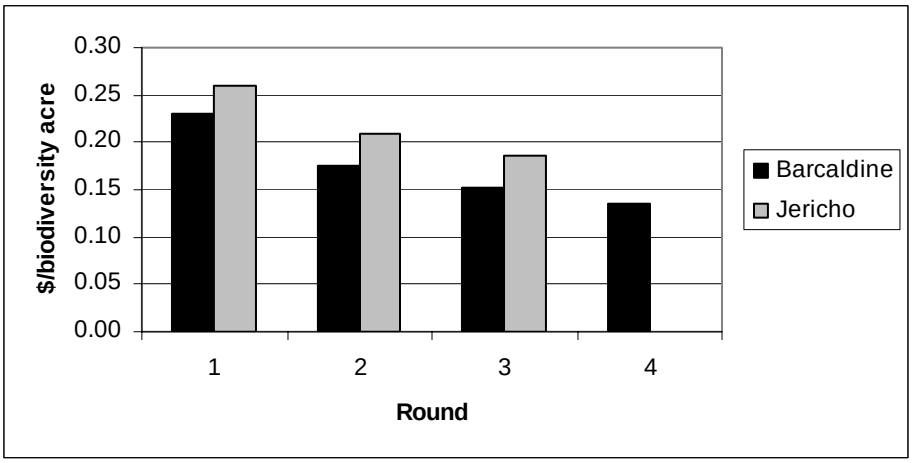
Results from the two workshops show that relative bid values tend to decrease between rounds, while the proportion of lodged bids not changing between rounds tended to increase (Figure 1). The results also demonstrate some variation in bidding behaviour between the workshops.

Figure 1. Changes in relative bid values



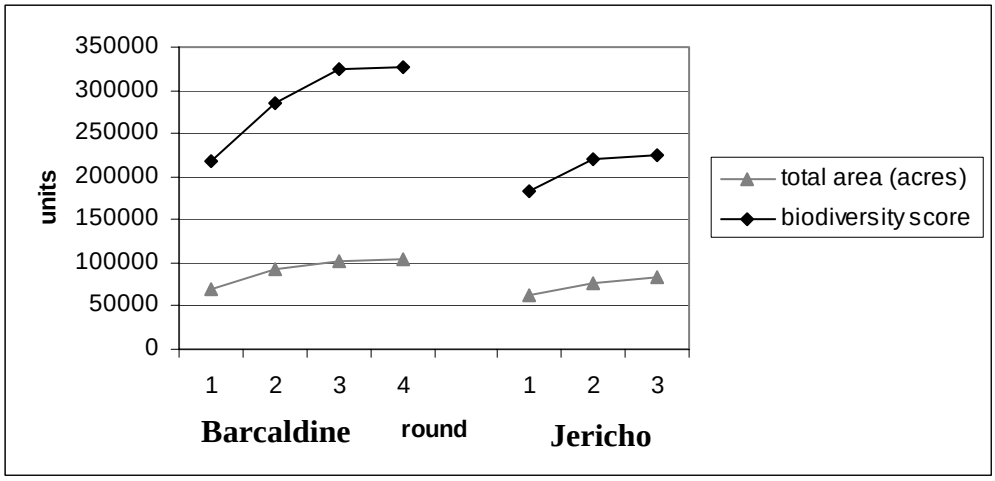
Average relative bid values in the different rounds are strongly influenced by individual bid behaviour. In Barcaldine, most participants put in lower bids in later rounds. However, two players increased their bids from round one to two, which affects the average bid value for these rounds. In a real auction, it is unlikely that the two who increased their bid values would have been successful as there would be a budgetary limit on the amount funds allocated for conservation contracts and only the most cost-effective bids would be accepted until that limit is reached. If, for analytical purposes, a hypothetical budgetary restriction of $50,000 is imposed, it limits the number of successful bidders in each round. For example, such a limit would mean that in Barcaldine, 58% of the bids in round one would have been successful, increasing to 75% in the fourth round. In the workshops, participants were only given information about the first three winning bids and the budgetary limit of $50,000 has only been introduced here to effectively isolate the influence of outlier bids. Given this limitation, the average relative bid values of the successful bidders clearly decline over the bidding rounds at both workshops (Figure 2).

Figure 2. Average relative bid values for successful bidders



While there were some competitive gains to be made in relative bid values, there were also relative gains in biodiversity score and bid area; both of which increased over the rounds. Figure 3 shows how the use of multiple rounds for a hypothetical purchase cap of $50,000 would have generated increasing supplies of biodiversity credits and land area in both workshops. For example, in Barcaldine 69,151 acres with a score of 217,391 biodiversity units could have been bought in round one compared with 104,322 acres and 326,910 biodiversity units in round four. This indicates strong competition existed between participants across multiple rounds, although most gains were captured in the first three rounds.

Figure 3. What could be purchased from landholders for $50,000



4.2 Statistical tests

Three types of statistical tests were conducted to assess whether there was a significant reduction in bid prices between successive rounds. T-tests were used to assess potential differences between individual rounds, two-way ANOVAs were used to test the significance of rounds within a workshop, and multiple regression was used to test for the significance of rounds across workshops.

The simplest tests available were independent sample t-tests, which could be used to compare results between rounds. In this case the relative bid values of the successful bidders in each round were compared. In Barcaldine, there was a statistical difference between rounds one and four (T statistic: 2.487; DF = 14), but most of the gains appear to have been made between the first and second rounds as there was no statistical difference between rounds two and four. There was no difference between rounds at Jericho. However, the lack of significance in the t-tests may be partly a consequence of small sample sizes available.

An analysis of variance (ANOVA) test for relative values allowed the data for the different rounds to be combined for each workshop. This provided a stronger test given the limited data sample and all bids were included in the analysis. Two-way ANOVAs were conducted to avoid potential confounding effects between individual bidders and bidding round. The results for the Barcaldine workshop indicates that there was a significant interaction between round and individual bidders (ID), and that relative bid values did change significantly between rounds (Table 2). However, the ANOVA test for the Jericho workshop indicated that the bidding round was not a significant driver of bid prices.

A multiple regression analysis allowed data to be pooled across the main Barcaldine and Jericho workshops. A number of independent variables, including areas of vegetation and participant characteristics, were used to predict the bid price that was lodged. As well, the bidding round was included in the data set as an independent variable. The results of a linear regression model from the combined Barcaldine and Jericho data sets are shown in Table 3. They show that the bid round was a highly significant variable across the workshops. The negative coefficient on this variable means that bid values decreased between rounds by $2,815 per round.

Table 2. General linear model for Barcaldine: relative bid value vs round and ID

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Round	3	0.213	0.259	0.086	34.580	0.028
ID	11	16.019	16.011	1.456	583.050	0.002
Round*ID	33	4.201	4.201	0.127	51.000	0.019
Error	2	0.005	0.005	0.002		
Total	49	20.438				
S = 0.050		R^2 = 99.98%		Adj. R^2 = 99.40%		

Note: The number of observations is n = 50.

Table 3. Predictors of bid value in individual rounds at main workshops

Coefficients	**Coefficient**	**Std. Error**	**Significance**
Constant	-17793.26	3657.38	0.000
Brigalow (acres)	11.62	2.21	0.000
Box (acres)	2.77	0.86	0.005
Broadleaf Ironbark (acres)	-0.06	0.67	0.931
Yellowjacket (acres)	-0.11	0.31	0.727
Cleared (acres)	5.31	0.52	0.000
Enterprise size (dummy)	3549.27	1091.21	0.004
% of property developed	-331.48	116.88	0.011
Interested in being paid by govt (dummy)	8355.42	1684.95	0.000
BID ROUND	-2814.92	427.07	0.000

Notes: The dependent variable is bid amount. The number of observations is n = 70. The adjusted R^2 is 0.973.

The model has high explanatory power (Adjusted R^2 = 0.973). Apart from the bid round, the areas of the three most productive land types (cleared, Brigalow and Box) were very important, but areas of lower production (Ironbark and Yellowjacket) were not. The coefficients for vegetation type show that respondents wanted on average: $11.62 for each acre of Brigalow, $2.77 for each acre of Box, and $5.31 for each acre of cleared land that was involved.

The results of both the interpretative and statistical analyses are consistent, and indicate that there is a significant relationship between successive bid rounds and reduced bid prices. Results from the experimental workshops confirm that increasing competitive pressure by holding successive bidding rounds can generate efficiency outcomes in the form of reduced bid prices.

5. Conclusion

The field experiments described in this paper offer insights into the issues associated with using auction mechanisms to provide conservation outcomes. Not only did the use of landholders as participants provide more practical information than a laboratory experiment with students, but they provide a valuable learning experience for both natural resource managers and landholders.

A number of analyses, both interpretive and statistical, have provided evidence that the use of multiple bidding round auctions does generate efficiency gains in terms of reducing the potential bid values of participants. This is consistent with other experimental results (e.g. Shogren et al., 2000) which indicate that bid values in sealed auctions will change with repeated rounds. Similar to the experimental work reported by Lusk et al. (2004), most of the gains occurred in the first two rounds where participants were still in a learning phase. While the possibility exists that the results are an outcome of the experimental process, it appears likely that they reflect the improved learning and risk assessment of participants, with some stimulus from competitive pressures. Where participants are familiar with the auction process and there are reduced opportunities for extra information and reappraisals of risk, the potential efficiency gains from multiple rounds may be lower.

However, the decision to use multiple bidding versus single bidding rounds must also take into account the transaction and administrative costs involved. These may be high in many areas, and suggest there are real limitations to the application of multiple bidding rounds. As well, the conduct of multiple bidding rounds may increase the potential for strategic behaviour to create inefficient outcomes.

The results suggest that mechanism designers face a real paradox in the application of multiple round auctions for conservation outcomes. Major efficiency gains are available from auctions where participants are unused to the process, and uncertainty and ignorance drive up initial bid prices. However, higher transaction and administration costs are likely to be involved for this group. While auctions involving more experienced participants are likely to have much lower transaction and administration costs, the potential efficiency gains may also be lower. These outcomes mean that, while there is substantial potential for limited multiple round auctions to be designed, their potential net benefits should be assessed on a case by case basis.

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