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Analysis

Wildlife corridor market design: An experimental analysis of the impact of project selection criteria and bidding flexibility

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ABSTRACT

In this work we used controlled laboratory experiments to investigate the impact of project selection criteria and bidding flexibility on the economic performance of wildlife corridor auctions. Bidders coordinated their bids to form valid corridors and compete with other valid corridors to be successful. We tested the impact of bidding flexibility in terms of (a) bidders differentiating their offers for different eligible corridors and (b) bidders submitting a single offer that would automatically be considered for all eligible corridors. Within the bidding options, we compared the performance of the auctions under a net benefit and a benefit cost ratio selection criteria. We found that participants conditioned their offers in terms of corridor benefit information. As a consequence, allowing multiple offers significantly increased payment and rent extraction. On the other hand, a single offer restriction facilitated a higher proportion of valid agreements and reduced rent extraction and, as a result, the agency's payment. We could not find any significant difference between project selection criteria in terms of payment and rent extraction. These results provide important insights for policy makers engaged in conservation market design throughout the world.

1. Introduction

The ecological benefits of establishing wildlife corridors in fragmented landscapes are well documented (Niemela, 2001; Parks et al., 2013). Wildlife corridors can provide a route for daily and seasonal migrations and connectivity for species dispersal; which in turn can improve long term persistence of species in the face of climate change (Conrad et al., 2012; Sutcliffe et al., 2003). Wildlife corridors can also provide additional and complementary services such as carbon storage, provision of amenity benefits and amelioration of other environmental problems (Parris et al., 2011).

Early models of reserve and corridor selections were motivated by ecological objectives, such as minimizing the number of sites required to ensure that a set of species are preserved or minimizing the amount of unsuitable habitat in the corridor (Parks et al., 2013). Only in the last few decades have planners and policy makers started to incorporate opportunity costs and spatially heterogeneous parcel costs in the design of corridors (Sessions, 1992; Williams, 1998). Since then, many studies have incorporated opportunity costs in the form of budget constraints (Naidoo et al., 2006). For example, Conrad et al. (2012) designed corridors for grizzly bears in the US which cover maximum amount of suitable habitats subject to a budget constraint. While these studies provide valuable information on the tradeoffs involved in environmental and ecological objectives (Ando et al., 1998; Naidoo and Adamowicz, 2005; Polasky et al., 2001), in most cases these studies did not consider landholders' strategic response to the design of a corridor program.

It is necessary to design appropriate incentive mechanisms for private landholders to engage them in wildlife corridor programs (Morse et al., 2009; Rolfe et al., 2008; Windle et al., 2009). This is particularly important in fragmented landscapes, where most of the ecologically important areas are under private ownership or control (Windle et al., 2009). Parkhurst et al. (2002), Shogren et al. (2001, 2003) and Wätzold and Drechsler (2005) conducted some of the early studies of the impact of spatial incentives in the form of agglomeration bonuses. Under such schemes, landholders received financial bonuses if they retired lands adjacent to other retired lands. In many cases, agglomeration bonus was successful in securing spatially arranged environmental services. Later, Rolfe et al. (2009) and Windle et al. (2009), in a series of field experiments on multi-round auctions to improve landscape connectivity, observed that most of the cost-effectiveness benefits were captured very early in the auction. Reeson et al. (2011) tested the impact of a 'lock in' rule. Under this rule during intermediate rounds, provisional winning bidders were not allowed to increase their offers above their original offers. They observed that the 'lock in' rule improved coordination and reduced rent seeking.

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It has also been found that bidders respond to the environmental quality information of the land. For example, Cason et al. (2003), in a series of laboratory experiments exploring drivers leading to non-point source of pollution reduction, observed that bidders conditioned their offers on their projects' environmental quality when such information was available. Later, based on actual offer data submitted under the Conservation Reserve Program (CRP), Kirwan et al. (2005) observed that landholders asked for higher rental rates if the parcel has a higher environmental benefit score. Similarly, landholders with low environmental benefit scores offered higher discounts (or reduced offers) to improve their chances of selection. For example, in one particular round they observed that landholders with low quality land offered a discount more than twice as large as those in the highest quality lands (Kirwan et al., 2005). Later, Glebe (2013) provided a theoretical foundation for the Cason et al. (2003) study. They theoretically proved that bidders have an incentive to raise their offers for higher quality projects. They also observed that concealing information about conservation benefits may be the optimal strategy when entry decisions are not relevant. However, revealing quality information might be beneficial to entice reluctant or marginal landholders.

While these studies provide valuable information, they are only concentrated on individual bidder settings, where aggregate outcomes would arise from individual responses. Our paper follows on from this set of literature and studies rent seeking and strategic behavior in the context of coordinated bidding and competition in a corridor auction. We have used economic experiments to provide information on rent seeking behavior in the context of coordinated bidding when landholders could potentially be part of multiple corridors, all relevant landholders have to coordinate their bids to form valid corridors and compete with other valid corridors.[3]

Another important dimension of a wildlife corridor auction is the bid selection criteria. Traditionally, conservation auction programs have a budget constraint. As a result, the most ecologically beneficial corridor (or parcel of lands) is selected given the available budget. In order to achieve this, conservation auctions implemented in Australia and elsewhere, commonly apply a cost effectiveness approach as the project selection criteria. Benefit is measured as the expected environmental or ecological improvements (Hajkowicz et al., 2009). While cost effectiveness analysis is convenient, it suffers from several problems. It does not, for example, provide a definitive criterion for selecting a given project. Rather, it provides a measure for ranking projects. It also has a tendency of not including all the relevant benefits and costs of a project (Commonwealth of Australia, 2006).

As a result, there are potential benefits and flexibility to be gained from using a range of economic decision making tools when the environmental benefits and costs can be objectively evaluated (Boardman et al., 2011). In this article, we have studied the performance of two standard project selection criteria: net benefit (NB) and benefit cost ratio (BCR) in our experimental setting. While there is a large body of literature on the relative merits of these criteria, we are not aware of any study which has used experimental economic techniques to compare these two approaches.

In our experiment, subjects were asked to make offers for incorporating a parcel of land that they manage into a wildlife corridor. In each experiment session there were six subjects that represent agricultural landholders. Each landholder was assigned an opportunity cost for their unique parcel if it is selected to become a part of the corridor (as presumably it cannot then be used for agricultural production). The first treatment variable explored the effect of allowing participants to submit multiple offers per round (conditional on which corridor they would be a part of) or restricting them to making only one offer. The second treatment variable varied whether the "winning" corridor is selected based on the highest net benefits or the highest benefit to cost ratio. We posed two research questions: (1) Does flexibility in offer submission influence aggregate outcomes of a corridor auction? and (2) Does the project selection criteria influence bidding behavior and aggregate outcomes?

We describe the auction model in the following section. Then, we discuss the details of our experiments followed by results and discussion.

2. Auction Model

We have implemented a repeated open bidding auction design.[4] There are several reasons behind selecting such a design. It has been observed in previous experimental studies on landscape auctions with individual bidding that a repeated design was necessary to achieve coordinated outcomes, as it provides an opportunity for the landholders to identify potential ecological and economic synergies (Parkhurst and Shogren, 2007; Reeson et al., 2011). Rolfe et al. (2009) and Windle et al. (2009) in their field experiments found that multiple bidding round auctions can improve auction performances. They observed that the auction efficiency improved by 66% between the first and the final rounds (Rolfe et al., 2009; Windle et al., 2009). Similar results have been observed in a number of laboratory experimental studies (Davis and Reilly, 1998; Gneezy and Smorodinsky, 2006; Kagel and Levin, 1993; Kagel et al., 1987; Shogren et al., 2000). Studying multiple bidding rounds is important as (a) any new market based instrument takes time to evolve and understanding the relative time it takes to achieve optimal outcomes is important, (b) while there would not be annual renegotiations of existing contracts, there are often a series of tenders involved in the implementation of a conservation strategy, and (c) finally, in some cases there might be requirement for annual re-negotiations. For example, if the corridor project involves maintaining certain land use for a particular season of the year (e.g., maintaining fallow land for seasonal migration of birds and animals) then instead of a multi-year contract the agency might want to re-negotiate the contracts frequently through repeated auction.

In our corridor auction setting, bidders share their offers with other potential bidders to form viable corridors. This necessitated the open auction format as individual bidders could see their potential partners and competitors' bids. This format might occur informally in the field as landholders live in local well-connected communities and be useful in situations where landholders are relatively inexperienced in these types of landscape scale auctions. It might be beneficial to them to gain some experience in this market before making a final offer[5] (Cummings et al., 2004).

In our experiment, the notion behind open repeated bidding is that once the round starts individual bidders enter offers for their eligible corridors. They can see what other bidders are doing in terms of offers and corridor choices. They also see the current status (such as validity of the corridor and net worth of the proposed offer) of all corridors. Bidders can respond to the information by revising their offers (prices and/or corridor choices). Groups become valid when all bidders

[3] A potential extension would be to test the market when it is regulated by the competition of multiple corridors in different locations within the landscape.

[4] In traditional iterative bidding, allocations are made at the end of series of iterations. In our experiments, earnings for successful participants are calculated after every round and they were paid their aggregated earnings at the end of the session. This was done to comply with the fairness principle that participants earn income based on their overall performance in the session. In our experiments, participants were assigned properties randomly before the start of a session and only a sub-set of properties were in the optimal allocation. Therefore, if we conditioned participants' earning based on their winning condition in the final round and the auction efficiently allocates the contracts, only participants assigned to the optimal corridor would receive payments and the rest of the participants would earn no income for their effort.

[5] We recognize that conservation tenders focusing on individual projects often work by offering limited opportunities for individual bidders to learn. However, in the case of a corridor auction, bidders need to know about the relative standing of their neighbors' bids and projects to form a viable corridor. While allowing for this flexibility, in our experiments, coordination happened only through bid revision and learning from previous outcomes. We did not allow any informal or direct communication (such as chat) before or during the auction. In the future experiments, it would be useful to test the impact of learning and direct interactions on corridor auction outcomes.