



An experimental examination of target based conservation auctions



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ABSTRACT

Conservation auctions are increasingly employed to increase the provision of Ecological Goods and Services (EG&S) for achieving environmental goals. Most applications of conservation auctions concern the efficient allocation of a fixed conservation budget. However an important and under-explored application of conservation auctions is in meeting environmental targets, either as part of regulatory compliance by industry or by governments in meeting specified policy objectives. This paper examines the ability of a conservation auction to meet an environmental target. We use experimental economics methods benchmarked to a wetlands restoration case study to examine bidder behavior and efficiency in both budget constrained and target constrained auctions when landowners with increasing marginal costs can offer increasing sized bundles of wetland acres. The target constrained auction is characterized by an all or nothing rule, where there is no payout if the target is not met. We find that rent seeking and average cost in the target constrained auction is less than in a budget constrained auction, but that efficiency eroded in repeated rounds suggesting learning effects as participants realize there is no budget cap. Even with learning effects the target based auction out-performs the budget based auction. Adding a reserve price to the target based auction significantly reduced rent seeking but also increased the probability that the target was not met. The results have important implications for auction design in real world settings.

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Introduction

The use of conservation auctions in agri-environmental policy and natural resource management is increasingly common. Direct auctions have long been used to reveal the preferences and willingness to pay of buyers for goods and services in order to provide efficient allocations as well as maximize revenues to sellers. Conservation auctions are a form of reverse auction, where landowners (sellers) submit offers to a single agency (buyer) to provide projects that enhance ecosystem services. The appeal of conservation auctions for policy makers arises from their potential to use competition to improve cost effectiveness and economic efficiency relative to a fixed price or cost share scheme. Specific examples of conservation auctions include the USDA Conservation Reserve Program; Eco-tender in Victoria, Australia; and the UK

Challenge fund scheme. Each of these programs provides payments to landowners to enhance ecosystem services.

Estimates of cost effectiveness gains for conservation auctions relative to fixed price programs range from 16% to 29% in experimental and computational studies (Latacz-Lohmann and Van der Hamsvoort, 1997) to 700% for Bush Tender (Stoneham et al., 2003). Even though auctions can be more cost effective, there can still be considerable rent seeking depending on the design. For example Kirwan et al. (2005) find that landowners signing up for the Conservation Reserve Program are on average overpaid 20% relative to their opportunity costs.

Before designing an auction, governments must determine what kind of allocation problem they are trying to solve. In particular is the allocation of a fixed budget to the most cost effective suite of projects available the problem, or is it finding the most cost effective way to meet a fixed conservation objective? The first case involves a budget based auction format where the budget is fixed, but the number of projects is endogenous. A body of experimental and empirical literature has examined the efficiency of different auction rules and formats in the budget based context. Alternatively when the government needs to achieve specific environmental targets either by law or policy, a target based auction is appropriate. Examples of target based programs include water license buy-backs to meet instream flow objectives (Janmaat, 2011; Cummings

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et al., 2004); buy-back of quota in fisheries (DePiper et al., 2013; Freeman and Woodward, 2004); and environmental offsetting with specific equivalence requirements (Bardsley and Burford, 2013; Nemes et al., 2008). It is likely that interest in target based auctions will increase over time due to shrinking budgets and increased public pressure to see expenditures matched to measurable environmental outcomes. Indeed, governments may formulate initial program objectives based on the relative performance of budget based versus target based approaches. The purpose of this paper is to explore the performance of target based auctions in achieving conservation goals.

Auction design

There are a number of design elements that influence the performance of conservation auctions including: choice between discriminatory versus uniform payment rules (Cason and Gangadharan, 2005); one-shot versus repeated bidding rounds (Reichelderfer and Boggess, 1988; Cummings et al., 2004; Hailu and Schilizzi, 2004; Hailu et al., 2005); use of an environmental benefits index, bid caps and reserve prices (e.g. Cason et al., 2003; Hellerstein and Higgins, 2010); and provision of information to participants (Cummings et al., 2004). Except under relatively restrictive assumptions there are few theoretical results to inform optimal design of conservation auctions (Hailu and Thoyer, 2010).

One of the most important issues relates to choice between the discriminatory and uniform payment format. In the former, winners are paid what they bid, while in the latter bidders are paid the market clearing price, equal to the cost of the highest accepted or lowest rejected offer. In discriminatory price auctions, bidders shade their bid above costs in order to obtain information rents, and bid shading is higher for low cost bidders that are less likely to lose a contract (Hailu and Thoyer, 2010). In the context of conservation auctions, discriminatory pricing is the norm, possibly because of perceived difficulties in explaining how a uniform price auction works, particularly when landowners can bid multiple units (Cummings et al., 2004; Hailu and Thoyer, 2010). Alternatively there may be opportunities for government to manipulate the price after receiving bids with a uniform price auction (Schilizzi and Latacz-Lohmann, 2007).

One justification for conservation auctions is cost discovery. Vickrey (1962) proved that a uniform price auction, in which winners are paid the highest rejected bid, is incentive compatible for the sale of a single contract, resulting in truthful revelation of underlying costs. Revenue equivalence was also established between the discriminatory and uniform pricing formats. In a generalized multi-unit context both uniform and discriminatory payment formats lead to bid-shading (Hailu et al., 2005; Hailu and Thoyer, 2010). Bid shading is highest for low cost bidders who are not likely to be penalized through loss of contract, and is also higher for steeper cost functions. Bid shading also increases as the number of contracts required approaches the number of participants in the auction (or as rationing decreases). In budget based auctions there is no equilibrium bidding strategy because bidders do not know the number of winners in advance, resulting in multiple Nash equilibria (Muller and Weikard, 2002; Schilizzi and Latacz-Lohmann, 2013).

Relatively little effort has been devoted to understanding the performance of target based auctions in multi-unit settings. Schilizzi and Latacz-Lohmann (2007) compare the performance of budget based and target based tenders for the adoption of farm technologies to reduce non-point source pollution using experimental methods with the number of conservation contracts (or the number of successful bidders) as a target. Each experiment involved three bidding rounds to investigate the performance of the auction with repetition. In terms of economic efficiency, target

based consistently outperformed the budget based format in a one-shot auction. However, with repetition the budget based auction performed slightly better than the target based auction and there was no significant difference between the two auction formats by the end.

Hailu et al. (2005) compare budget based and target based auctions when there is learning. Each seller was given a non-decreasing supply function as well as a maximum supply capacity. The simulated bidding behavior indicated that bidding is almost truthful with regards to entry price for all auction formats when the ratio of demand to aggregate capacity is less than 50%. As expected, entry prices progressively increased as the demand to capacity ratio rose and competition weakened. Over time under the discriminatory format there was an incentive for bidders to bid at the market clearing price except when competition is tight.

Cummings et al. (2004) examined the design of an auction to buy back irrigation licenses for Georgia's Flint River Drought Protection Act. In the auction the state is a single buyer with a fixed budget as well as a target, with many sellers that have multiple heterogeneous units. The items offered were water licenses with fixed acreages attached. Farmers could sell more than one license. Participants were told that there was a target number of acres to be taken out of irrigation, but were not told the target. Offers were accepted either until the target was reached or the budget was expended. In one field experiment subjects participated in an auction with no fixed budget constraint. Instead, the lowest 15 offers were accepted without consideration of the money required. They found that after the first round the average accepted price fell between rounds.

In this paper we use experimental economic methods to compare the target based with the budget based format where the agency has a particular conservation objective, in this case, the amount of wetland acres restored. We explore a number of design issues within the context of the target based auction including the impact of reserve prices and the effect of repeated auction rounds. Targets can be determined in a variety of ways for a variety of different environmental assets, usually according to urgency and importance (Carwardine et al., 2009). The important point is that targets are often defined in terms of conservation assets and outcomes, rather than inputs (e.g. Possingham et al., 2006). This is important since much previous analyses of the target based approach focuses on fixed number of inputs, or contracts, rather than outputs. In this case the required budget to pay successful bidders is unknown prior to the auction taking place.

The applied policy setting

The conservation action examined in this paper involves the restoration of wetlands in a prairie watershed in southern Manitoba, Canada. Wetland conservation is an important issue in Canada, with approximately 20 million hectares drained or lost since 1800 (Environment Canada, 2009). Drainage is of particular importance in the prairie pothole region, which is a landscape containing many small wetland basins embedded in lands suitable for agricultural production. This overlap results in high levels of wetland conversion to agriculture. Due to the topography, agriculture in the area does not suffer from seasonal drought as in other regions in the Prairie Provinces, but rather must deal with flooding and excess water. Scientists estimate that up to 70% of wetlands that existed in some areas of Manitoba prior to human settlement have been drained (DUC, 2008).

Awareness of wetland loss has led to a number of policy initiatives, the most successful being the North American Waterfowl Management Plan (NAWMP). Manitoba lies in the Prairie Habitat Joint Venture (PHJV) which has the stated objective to "restore waterfowl to levels enjoyed in the 1970s" (MIP, 2008). Specific

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