Auctions for conservation contracts: an empirical examination of Victoria's BushTender Trial

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Abstract

In this paper we provide an analysis of Victoria's BushTender Trial. BushTender is an auction-based approach to allocating conservation contracts that is currently being trialed in two Victorian regions. We analyse the bids provided by landholders. We compare the discriminative price auction to a one-price auction—which is analogous to a fixed-price scheme. We also comment on anecdotal evidence about the likely *indirect* benefits of BushTender.

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1. Introduction

State and Commonwealth governments in Australia collectively allocate significant resources to natural resource and environmental management. Programs such as the Natural Heritage Trust ($1.25 billion over five years), and the National Action Plan for Salinity and Water Quality ($1.4 billion over seven years) demonstrate a substantial and on-going commitment of public organisations to environmental management. These organisations have employed a range of mechanisms, including legislation, planning, market-based approaches, research and development programs and community programs to allocate funds between competing activities.

While many reports have advocated greater use of market-based approaches for environmental management, these have mostly been theoretical rather than practical propositions. This paper reports on the performance of a market-based approach to the problem of allocating funds to biodiversity conservation. The BushTender Trial is an auction-based approach aimed at securing biodiversity conservation contracts on private land.

The following sections of the paper provide a brief overview of the biodiversity conservation problem on private land in Victoria, the rationale for applying auctions to this problem and a summary of key design features for the BushTender Trial. Results from the implementation of the first year of the trial and analysis of the performance of the auction-approach are presented in the final sections.

2. Conservation of biodiversity on private land

There is over one million hectares of native vegetation remaining on private land in Victoria. Much of it is of high conservation significance and it is important for salinity control, water quality, land protection, greenhouse and landscape reasons. Approximately 15 per cent of Victoria's threatened vegetation types are reliant *solely* on private land for their survival while another 35 per cent of threatened vegetation types occur *largely* on private land. Biodiversity conservation is dependent upon these private land areas and conserving and enhancing this vegetation requires a permanent change in the way landholders use and manage the remnants on their land.

Even though an important component of the state's biodiversity assets are on private land, NRE (2000) argues that some of the mechanisms used in the past have not adequately addressed the problem of biodiversity decline:

> *'The current set of mechanisms needs to be strengthened to engage larger more commercially oriented farms. A survey across northern Victoria found that up to 80 per cent of the remnant vegetation in the region occurs on these properties but the landholders tend not to be engaged in existing voluntary programs. A new approach is now needed to encourage effective management of native vegetation on these properties. The key objective in this situation is to encourage long-term changes in the use of management of existing remnants on these properties and to support complementary revegetation. In these circumstances, the mechanism most likely to be effective is the establishment of funded management agreements'*

The auction mechanism is being considered as an additional approach to Government-funded intervention in native vegetation management on private land because it has the potential to:

- encourage NRE to more objectively quantify outcomes, including multiple benefits;
- provide landholders with more flexibility in identifying acceptable cost-sharing arrangements;
- maximise cost-effectiveness through market-based procedures; and
- broaden the spectrum of landholders that participate in these activities.

In common with existing programs, this additional approach must also be mindful of how it can most positively influence other issues, for example:

- long-term attitudinal change to conservation management practices;
- balancing community involvement and individual involvement in decision making; and

- balancing the value of Government intervention against the risk of increasing reliance on this intervention.

3. Auctions for biodiversity conservation contracts

Myerson (1999) argues that many of the important issues facing modern economies can be represented as applications of game theory, or more specifically as problems of sharing information in economic systems. This approach has resulted in the introduction of new policy instruments that promise to extend the policy maker's tool-kit for addressing environmental and natural resource management problems. The key insight that differentiates these new tools—from those that are commonly in use—is the realisation that private and hidden information is often the main constraint on policy making, just as it is a constraint on the free and efficient operation of markets for many environmental goods and services. Joseph Stiglitz, in his 2001 Nobel Prize lecture, explains that information is now understood to be fundamentally different from other "commodities." Asymmetric information creates problems that cannot be treated as just another application of general Chicago school principles, using only traditional concepts such as transaction costs, failure of property rights, and marginal costs and benefits of acquiring information. New tools are now available, augmenting the traditional tool-kit, and they are ready to be used in policy design.

Asymmetric information problems are potentially important in many environmental management problems. For example, landholders make decisions using private information that affect environmental outcomes in different areas such as remnant vegetation, dryland salinity, and waterway quality. Government and departments often have information about the relative priority of these areas. However, landholders may not know government priorities, or may understand them only imperfectly.

In addition to the problem of asymmetric information, an environmental agency will often face the problem of imperfect information: the benefits of a policy change will often come in the form of public, or 'non-market' goods. Hence, there are at least three steps that an agency often needs to take in sorting through an environmental issue:

- determine the importance or likely benefits of the policy change using the political process, or some sort of non-market valuation;

- decide on what they can achieve with the different instruments available (the cost-effectiveness of different instruments);

- decide if the cost of the best policy instrument (from step 2) is greater than the implied benefits (from step 1).

Interest in applying auctions to land-use problems has grown because the auction mechanism may help reveal the information needed (by an agency and landholders) to make efficient environmental management choices. Recent applications of economic theory and experimental economics techniques to auction design have improved the performance of auctions, and expanded their application to a broader range of problems. Hence, given the right context, auctions should prove to be a relatively cost-effective option—in step 2 above—if the information problem is critical.

Latacz-Lohmann and Van der Hamsvoot (1998) identified two advantages of employing auctions to environmental management problems involving land-use change. The first is that—as discussed above—auctions reveal information to decision makers. The second advantage of an auction of conservation contracts is that these contracts can be designed to accommodate variable environmental benefits from location to location. Stoneham and Chaudhri (2000) note that each unit of land-use change could deliver different environmental benefits such as unique habitats for plants and animals, carbon sequestration, nutrient interception and individual land management agreements, or contracts, between each landholder and government (society) would be needed to accommodate this diversity.

3.1 BushTender Auction Design

The use of auctions for addressing environmental management problems has been successful where their designs reflect both the nature of the object in question (eg. homogeneous objective or prize, multiple units, heterogeneous parcels of land) and the objectives of the auction (eg. revenue raising, environmental goals, fostering

competition, heterogenous environmental objectives)[1]. Klemperer (2000) notes that "auction design is a matter of horses for courses, not one size fits all".

Formal analysis of auctions in the economic literature is relatively new. Early work on auctions stems from the seminal papers of Friedman (1956) for the case of a single strategic bidder, and Vickrey (1961) for the equilibrium game theoretic approach. The development of appropriate game theoretic tools has made auction theory an increasingly researched topic. The three broad models studied are: the independent private value model of Vickrey (1961), the symmetric common value model of Rothkopf (1969) and Wilson (1969, 1977) and the asymmetric common value model of Wilson (1967).

In auction models, economists use a variety of assumptions. For example, in an auction with many sellers and one buyer, an economist would usually make some assumptions about:

- the set of potential sellers;
- the joint distribution of valuations of these potential sellers;
- the reservation price rule used by the buyer (if relevant);
- bidder uncertainty regarding: the value of the object being auctioned; the strategies likely to be employed by other players; and the characteristics of the other players; and
- the distribution of information across sellers and the buyer.

An understanding of the auction theory (the assumptions of different models and their implications) can assist policy makers design and implement a successful auction. Several important issues that policy makers need to consider include:

- choosing the most relevant model of bidder valuations for use (independent private valuations, symmetric common valuations, or asymmetric common valuations);

[1] We apply this theory to the design of the BushTender Trial below.

- the number; size and distribution of potential bidders, either from a strategic point of view, or from a political point of view;
- the scope for collusion; and
- the scope for secondary markets to change the optimal auction design, reservation price policy, default rules (for penalising false bids), and auction format.

Klemperer argues that we need to take account of an auction's context, so we can counter several potential inefficiencies due to strategic bidder behaviour, collusion, predatory pricing, and other forms of entry-deterrence.

The key elements of auction design adopted for the BushTender Trial are summarised in the Table 3.1. A more detailed discussion of the rationale for these design features can be found in Latacz-Lohmann and Van der Hamsvoort (1997) and Stoneham and Chaudhri (2000).

Table 3.1: Design Features and Economic Theory

Design element	**Rationale**
Competitive bidding	Truthful revelation of on-site costs of land-use change.
Price minimisation objective	Competition between bidders facilitates cost-effective outcomes.
Sealed-bid	Repeated open, ascending and uniform-price auctions are generally more susceptible to collusion than are repeated sealed-bid (see Klemperer 2000). Also reduced admin/running costs associated with single/sealed bid approach. Sealed-bid format reduces overall costs where participants are risk-averse (see Riley and Samuelson 1981).
Price discrimination	Where asymmetric information between bidders is evident (independent private values model), the optimal auction system is one where the item on offer is assigned to the lowest bidder (see Myerson 1981). Where heterogenous items are on offer ranking outputs will improve auction efficiency over a uniform-price approach (see Baneth 1994 and Latacz-Lohmann and Van der Hamsvoort 1997).

Design element	Rationale
Individual Management Agreements	Where there are non-standard benefits (ie, benefits that vary from site to stie), individual management agreements, or contracts, developed with landholders will improve auction efficiency (Latacz Lohmann and Van der Hamsvoort 1997).
Progress payments	Normally payments are assumed to be a function of bids only. However, conditional payments will improve auction performance where contracts extend over time (see McAfee and McMillan 1987). Progress auction payments could be perceived by landholders as a more reliable form of income than commodities, and this could conceivably increase participation (also see *Price Discrimination,* above*)*
Single round of bidding	When landholders are assumed to have 'independent private value' then each bidder knows precisely the cost of implementing his conservation contract. Each individual bidder is unaware of the value placed on the item by competing bidders but assumes those valuations will be drawn from the same probability function. A landholder who learns about other landholders' valuations would not, *generally*, change his bid. In this situation, multiple rounds of bidding would not alter individual bids markedly. BushTender is a single round auction.

Design element	Rationale
Sequential or multiple round auction	If the assumption of independent private value is incorrect, then the auction could be improved through sequential or multiple rounds. Stoneham and Chaudhri (2000) have argued that repeated, sequential auctions should be considered for the context under which BushTender operates. However, this additional design feature was not pursued for the pilot, where simplicity for the landholders was considered paramount. If a more expansive version of BushTender were used in the future, then NRE may consider additional auction design features such as sequential or multiple rounds.
Reserve price	A reserve price strategy is less important where there is a budget constraint (see Myerson 1981, Riley and Samuelson 1981). BushTender has a severe budget constraint and (hence) NRE did not use a reserve price.
Limited Information Revelation	Cason *et al.* (2002) use experimental economics methods to test the impact of full, verses partial, disclosure of information by the environmental agency. They find that partial disclosure generally improves cost-effectiveness of the auction. These findings were incorporated into the BushTender design.

3.2 Implementation of the pilot auction of biodiversity conservation contracts

The Victorian Government allocated a total of $600,000 to BushTender in June 2001. $400,000 of this was earmarked for landholder payments. The rest was used to fund, *inter alia*, project development and management, regional officer visits to properties, communication, and evaluation.

In addition NRE accessed fencing money, that was available via a fencing scheme operating in the trial area, where landholders proposed activities that were consistent with the scheme. This raised the total *potential* budget for BushTender, but the magnitude of additional funding was dependent upon the number of successful bids that contained fencing as part of their management strategy[2].

[2] The constraint on NRE funds is: total payments < $400,000. Hence, the actual budget paid is less than $400,000 due to the 'lumpiness' of total bid amounts, see Section 4.

NRE conducted BushTender in two trial regions, namely parts of the North East and North Central Catchment Management areas (Figures 3.1 and 3.2).

Figure 3.1: North Central Trial Area

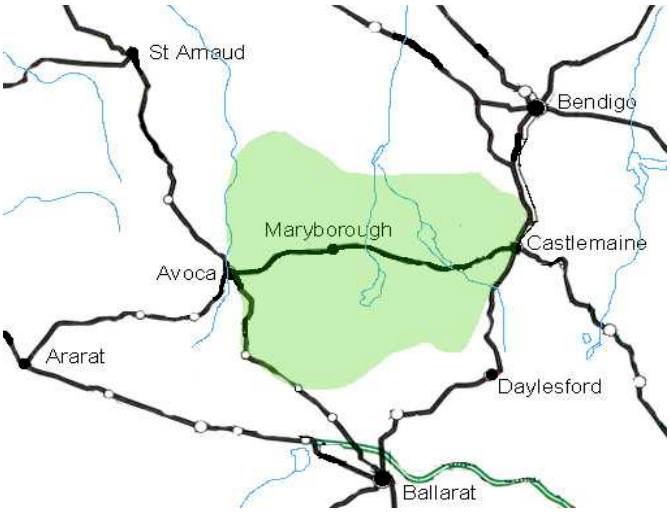
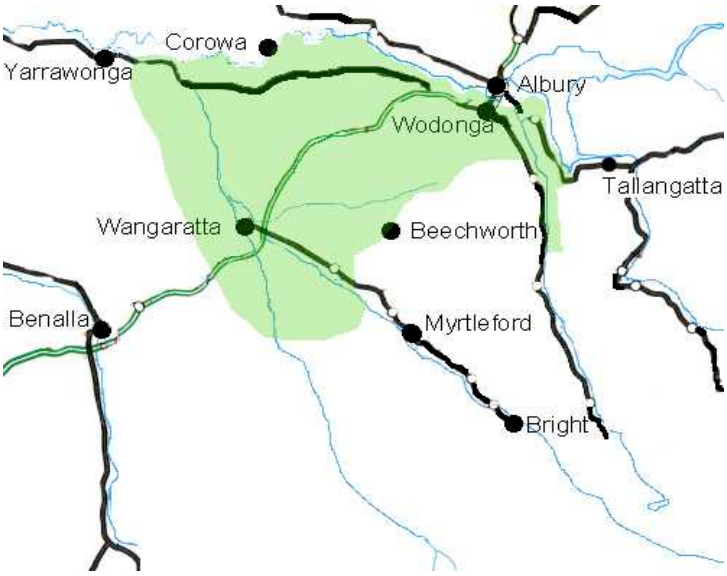


Figure 3.2: North East Trial Area



The process involved landholders from within the trial areas registering an expression interest in response to NRE's information campaign. NRE responded to expressions of interest by mailing out further information on the scheme and subsequently contacting registered landholders to arrange a property visit. During each visit, field officers assessed the quality and significance of the native vegetation on the site and discussed management options with the landholder.

Landholders then identified the actions they proposed to undertake on the site and with the field officer, prepared an agreed management plan as the basis of their bid.

Following the site visit, landholders received a printed draft management plan, a summary of the relative conservation value of their site and their Habitat Service Score as determined by the quality and size of their site and their proposed management commitments.

Each landholder had 14 days from the date they received their draft plan in which to submit their bid. All bids were assessed on the basis of the:

- current conservation value of the site (measured through the 'biodiversity significance score', or BSS);
- amount of service offered by the landholder (measured through the 'habitat services score' or HSS); and
- cost as provided in the landholder bid.

This information was used to calculate a Biodiversity Benefits Index (BBI) for each site according to the following formula:

$$BBI = \frac{BSS \times HSS}{bid} \qquad (1)$$

Table 3.2 provides some summary statistics about participation in each of the two trial regions. In total there were 126 expressions of interest from within the trial regions. Field officers assessed 116 properties containing 223 sites. Landholders with more than one site on their property were given the option of submitting individual bids for each site or a single bid for all the sites in combination. In total 98 landholders submitted bids.

Table 3.2: Summary Statistics of Participation in the Two Trial Regions

	North Central	**North East**
Expressions of interest:	63 (in trial area)	63 (in trial area)
Properties assessed:	62	54
Number of sites assessed	104	119
Average sites per property:	1.7	2.2
Total hectares offered:	1,834 ha.	2,011 ha
Number of vegetation types identified/assessed:	20 (out of a possible 25)	18 (out of a possible 25)
Vegetation quality range (score out of 100):	17 - 73	13 - 79
Largest site:	294 hectares	218 hectares
Number of remnant vegetation management proposals:	100	108
Number of revegetation proposals:	4	11

4. Results

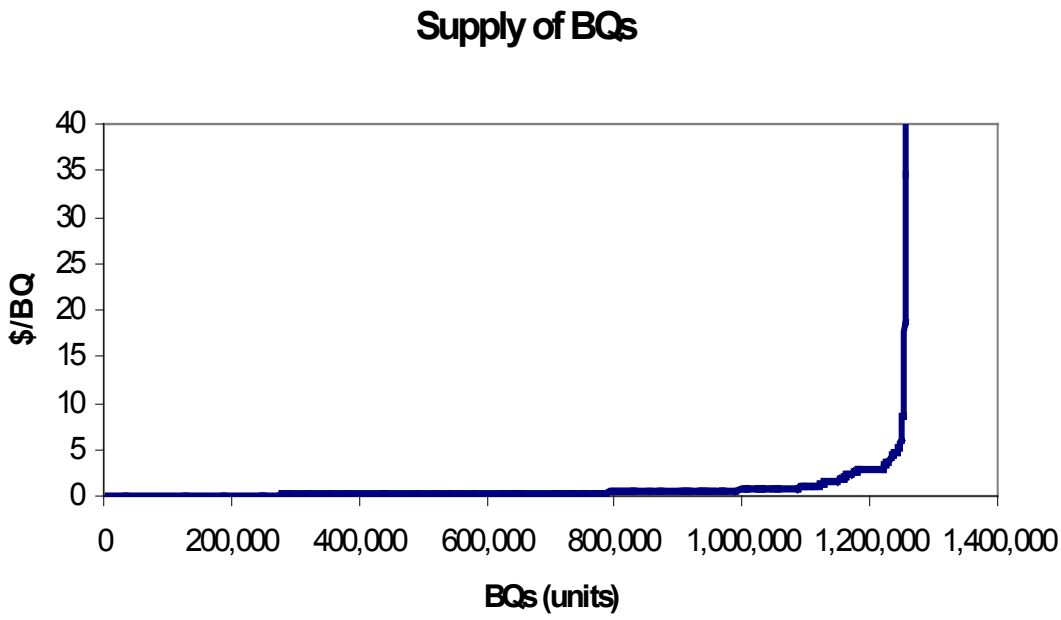


Figure 4.1: Marginal Cost Curve

Figure 4.1 shows the marginal cost or supply curve for biodiversity from the BushTender Trial[3]. On the horizontal axis is the total quantity of biodiversity in terms of what we have labelled biodiversity quality adjusted (BQ) units. These are the numerator of the BBI as given in (1): the conservation value score times the habitat services score.

If an agency were to use a more expansive (spatial and temporal) auction approach then the information in the marginal cost curve could be very valuable: it would enable the agency to efficiently allocate its funds across auction rounds. An agency would perceive those bids on the steep-rising segment of the marginal cost curve as relatively lower 'value for money'. From this, an agency could more clearly identify the cut-off point from each auction round, presumably by using the equi-marginal principle.

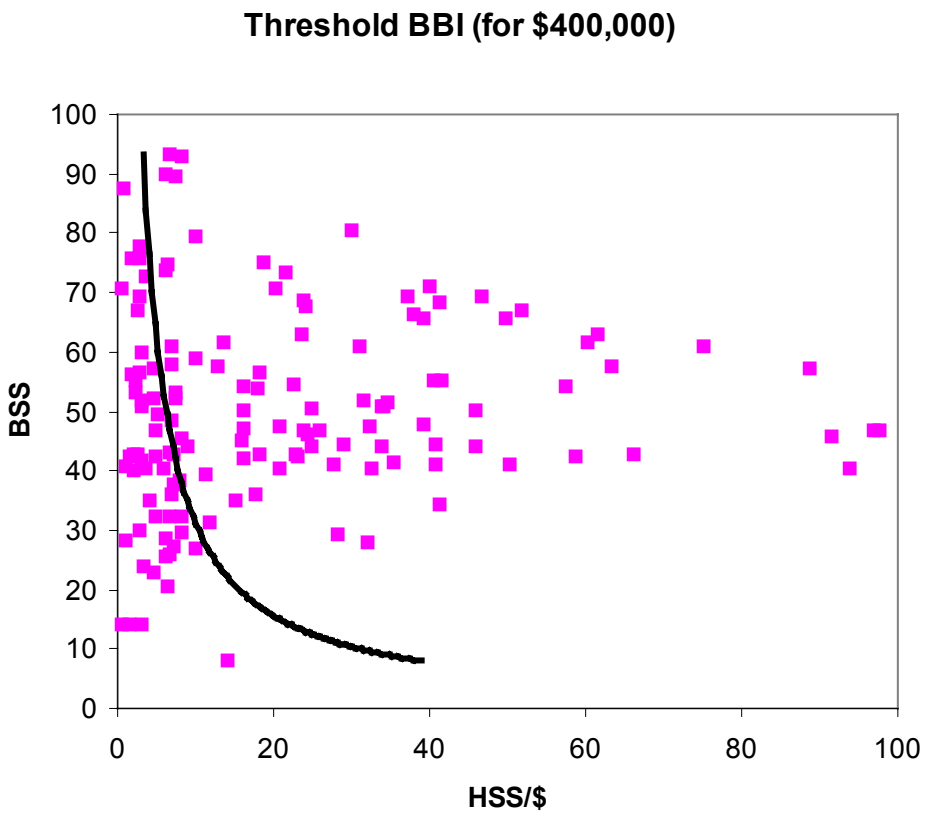


Figure 4.2: Threshold-BBI and Bid Data

[3] For reasons of confidentiality, we have altered all graphs in this section by doing two things: removing all outliers; and re-scaling the axes.

Figure 4.2 shows a scatter of bids, with the threshold-BBI curve (the solid curve). The threshold BBI is the value of the marginal bidder's BBI. The threshold BBI curve shows combinations of HSS/bid and BSS which—when multiplied by each other—equal the threshold-BBI. Bids at the top-right of the figure are high value and low price; they are preferred bids. All those bid points to the right of the threshold-BBI curve are 'successful' bids. The horizontal distance between each bid point, and the threshold-BBI curve, represents NRE's surplus from the contract.

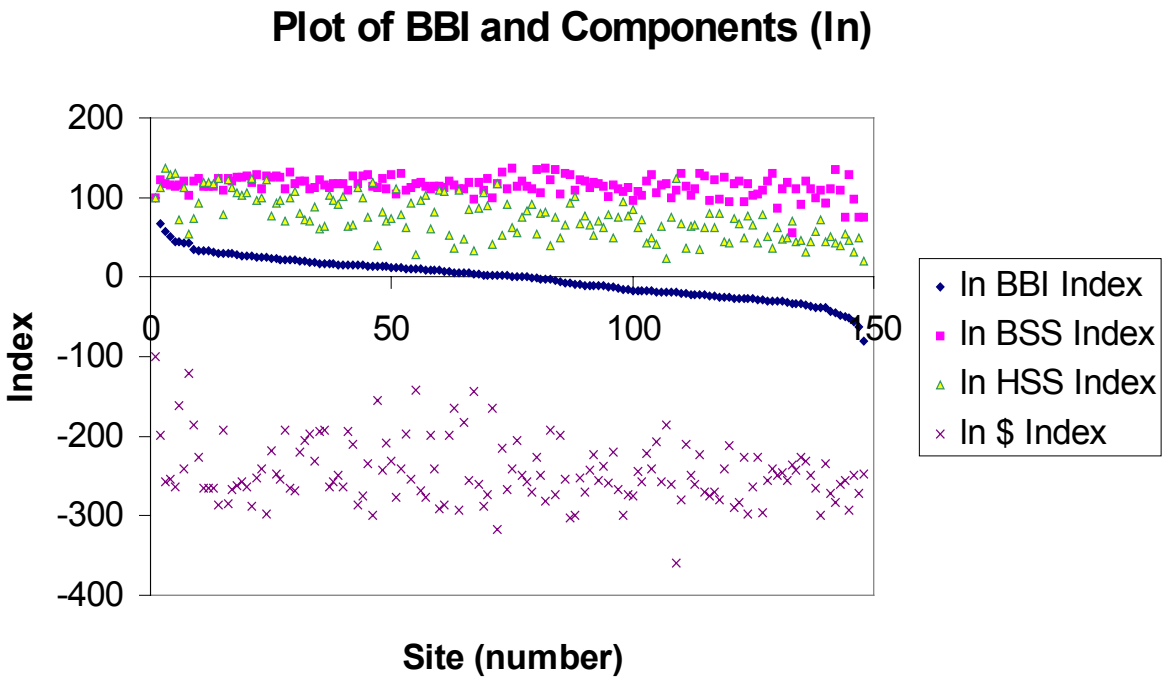


Figure 4.3: Scatter Plot of BBI, BSS, HSS, and Bids (all in Natural Logs)

Figure 4.3 shows the natural log of BBI, versus the natural log of its components: HSS, BSS and bid. Since the formula for the BBI—given in (1)—is multiplicative, the log transformation turns the formula into an additive one: the log BBI can be interpreted as log BSS plus log HSS less log bid.

Figure 4.3 illustrates that there is relatively little variability in the BSS, and relatively more variability in HSS and the bids. Hence the BBI is strongly influenced by a landholder's HSS, and his bid: landholders have control over those aspects of the index that highly influence their success in the auction, or otherwise.

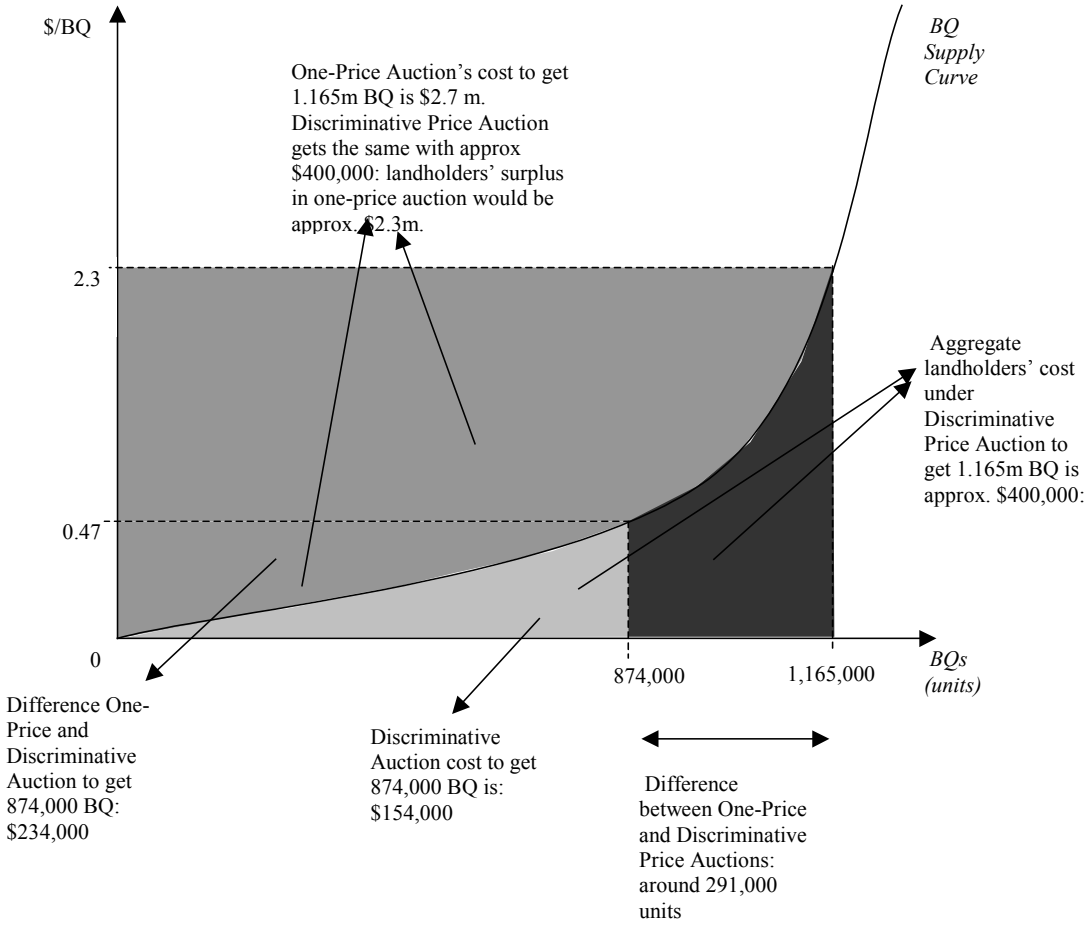


Figure 4.4: Comparison on One-Price versus Discriminative Price Auction

Figure 4.4 is a comparison of the discriminative price auction with a hypothetical one-price auction[4]. In a one-price auction, an agency would pay each successful landholder the same price: the price of the marginal offer[5]. The one-price auction is analogous to a fixed-price scheme.

Figure 4.4 shows that—for the same budget of around $400,000—a one-price auction would give an agency approximately 25 per cent less biodiversity (from 1,165,000 to 874,000 BQ units) than a discriminative price auction. Looked at another way, a one-price auction would require a budget of approximately $2.7 million (almost seven times more than the actual budget) to get the same quantity of BQ units as the discriminative price auction.

[4] This comparison is not strictly correct because bidder behaviour would probably be affected by auction design.
[5] 'Price' here is dollars per BQ.

5. Discussion

The BushTender Trial has been useful because it has enabled analysis of both the design and implementation of an auction-based approach to biodiversity conservation. The advantages of an auction-based approach such as BushTender to biodiversity conservation arise from both direct and indirect sources.

5.1 Direct benefits of BushTender approach

Direct benefits refer to the static economic efficiency gains that arise from more efficient and effective mechanism design (see Table 3.1). We *expect* economic efficiency gains in three areas: information revelation, cost minimisation and contract specification.

Information revelation – The main advantage of the auction is that information is revealed from the relevant parties involved in biodiversity conservation. This approach contrasts with fixed-price offers, where, potentially the wrong information is solicited from the wrong parties: these require the landholder to reveal the actions that they believe will improve the environment (when this information is perhaps held by environmental agencies); and agencies reveal the price that will be paid for these actions (when this information is often held by landholders). The BushTender auction, on the other hand, allows an environmental agency to use information it has to determine the relative biodiversity outcomes of actions proposed by a landholder on any particular site; and it allows landholders to reveal the on-site costs of these actions. This change in the information revelation processes should allow an agency to make better resource allocation decisions, thereby improving economic efficiency and targeting of highest priorities.

During the BushTender Trial, the conservation value of a site (and hence the chance of a bid succeeding) was improved by the presence of any rare/threatened species recorded for the area. Landholders were invited to sign species disclosure agreements if any such records were verified by the field officer. As such, there was an incentive for landholders to disclose the presence of rare species inhabiting their land. In the past landholders may have been reluctant to reveal this information because they feared that this might precipitate future restrictions on the use of this land. Under BushTender, landholders are rewarded (and not penalised) for disclosing information

about rare and threatened species and such populations become assets rather than liabilities. Site assessments during the trial revealed a number newly discovered rare plant species populations that, with the landholder's permission, have been entered on the public record. This has provided better information to NRE about biodiversity assets on private land in the two trial areas.

Cost minimisation – BushTender specifically incorporates cost minimisation as the basis of ranking bids. The bid curve presented above is in effect a supply curve for biodiversity on private land. Like supply curves for commodities, the biodiversity supply curve has been derived within a competitive environment, with attention paid to minimising collusive and gaming behaviour of landholders, and maximising the advantage of variation in landholders' opportunity costs.

Contract specification – Recognising that biodiversity services provided by different landholders have non-standard benefits and that landholders have different opportunity costs, individual management plans were completed for potential bidders. NRE has included periodic landholder reporting, random monitoring of sites and sanctions (cessation of payment) in these contracts to ensure landholder compliance.

Auctioning conservation contracts reveals information needed for efficient allocation of resources and facilitates deals between landholders and government. With resources allocated on the basis of better information, and within a competitive environment, an agency should be able to improve the cost-effectiveness of its environmental expenditure.

5.2 Indirect benefits of BushTender approach

The following observations during the trial indicate that—in addition to the direct benefits listed above—indirect benefits could also be an important spin-off from the BushTender approach.

Public decision making – One important observation from the pilot thus far has been the prospect of using information revealed from the auction. Public sector decision-makers anticipate that information about the marginal cost of biodiversity conservation for private land will be able to be compared with the marginal cost of

alternative supplies of biodiversity, eg. public land. This will assist public management and resource allocation decisions. Good quality information is being introduced into the economy.

In addition, BushTender has identified the need for Government to determine its conservation preferences 'up front' and to identify and quantify the outcomes of any proposed changed land use according to an objective and repeatable assessment process. This in turn has ensured that agency funding of landholder contracts is relatively visible, defensible and auditable[6].

Trading and off-sets – In limited instances, it may be possible to introduce more flexibility into the economy by allowing degradation of one area of habitat to be offset by purchased habitat improvement through the auction system. Urban development, mines infrastructure projects such as roads and transmission systems could all benefit from increased flexibility. These behaviours imply value creation because this segment of the economy is now part of the economy that is "marketed".

Education– The amount and type of information provided to landholders during the trial was quite sophisticated. Each participating landholder in the trial was provided with a plan of their proposed site identifying the different vegetation types and management zones, a summary of the site conservation values and a three-year management plan. All landholders also had the opportunity to discuss the quality and management of their site with the field officer during the site assessment. Rarely, has such specific and targeted information been provided through other incentive or extension programs and it is possible that even 'unsuccessful' bidders initiate some of the actions as proposed in their management plan as a result of having learned more about the conservation values of their site.

6. Concluding Comments

The following observation can be made about the pilot auction of biodiversity conservation contracts:

Improvements in economic theory—particularly the economics of information and game theory—have developed, and will continue to develop, new policy mechanisms. These mechanisms should allow an environmental agency to shift more environmental problems from the non-marketed to marketed zones of the economy .

The BushTender trial allows NRE to examine the use of one particular mechanism—an auction approach—to the problem of biodiversity on private land. This application adds to the increasing experience of environmental agencies, around the world, who are using mechanisms that take account of the information context of a policy problem. We expect direct efficiency gains from an auction mechanism in this context because it allows an environmental agency and landholders to exchange information that is vital to efficient decision making (by both parties).

In our context, a key aspect of realising such potential efficiency gains is auction design. In this paper we have related auction theory to practical design of the BushTender trial. Taking account of auction theory can help policy makers achieve their aims: auction design theory allows policy makers to tailor an auction to their circumstances. The discriminative-price auction system used in BushTender would seem far superior to a similar scheme that used fixed-price offers.

The BushTender trial potentially provides *indirect* efficiency gains to NRE for several reasons: it allows more flexibility in other policy decisions (such as offsets for infrastructure development); it provides education to landholders that may affect their general attitudes towards conservation; and it alters landholders' perceptions about whether rare species on their land are an asset, or a liability.

[6] Notwithstanding the selective revelation of information by NRE to ensure the auction's cost-effectiveness.

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