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# Outside options: Another reason to choose the first-price auction

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ABSTRACT

In this paper we study equilibrium and experimental bidding behaviour in first-price and second-price auctions with outside options.

We find that bidders do respond to outside options and to variations of common knowledge about competitors' outside options. However, overbidding in first-price auctions is significantly higher with outside options than without. First-price auctions yield more revenue than second-price auctions. This revenue-premium is significantly higher with outside options. In second-price auctions the introduction of outside options has only a small effect.



## 1. Introduction

During the last decade, auctions have increasingly attracted attention from academia and the wider public. A major part of this increased interest is due to growing popularity of auctions as market institutions for consumer-to-consumer and business-to-consumer transactions, allocating public resources and procurement contracts. Cases in point are worldwide spectrum auctions, online auction platforms such as eBay and Ricardo and virtual business-to-business market places, e.g. Covisint for the automotive industry or Consip's AiR for Italian public procurement offers.

Typically outside options are available to bidders in addition to the object offered in the particular auction. For example, consider the fierce bidding war of the software giants Oracle and SAP in 2005 to acquire Retek, a developer of specialised software for retailing firms. The "object" in this takeover auction, Retek, offered both firms the opportunity to acquire specialised software and an established customer base. Clearly, both bidders faced the outside option to develop software and build up a customer base independent of the takeover. In fact, the unsuccessful bidder SAP announced in a press release on 22 March 2005 that it precisely plans to follow that outside option after revealing its unwillingness to continue bidding.

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Sequential sales of similar products constitute another example for outside options. Bidders in the first sale know that they have the option to bid for the product also in the second sale.

In this paper we augment the standard symmetric independent private value (SIPV) model to allow for public and private outside options. We derive equilibrium bidding functions and implement the auction in the laboratory.

To our knowledge, there is no literature systematically inquiring the effects of outside options in auctions other than Cherry et al. (2004).[1] We show that a model with jointly distributed private values and outside options can be reduced to a standard SIPV model.[2] One special case is analysed by Holt (1980) who assumes that valuations are constant and the same for all bidders. A related case is examined by Weber (1983), Gale and Hausch (1994), and Reiß and Schöndube (2007) who study sequential auction models: A subsequent auction in such a sequential auction process can be interpreted as a specific outside option whose value is endogenously determined. Brosig and Reiß (2007) demonstrate that bidders' behaviour in a prior auction is affected by a subsequent first-price procurement auction. In their complex outside option model, the expected option value depends on beliefs about other bidders' entry behaviour, their bidding behaviour in future auctions and the cognitive abilities to assess the outside option value given beliefs. In contrast, in our paper we isolate the effects of exogenous outside option values from other factors and systematically investigate their impact on allocative efficiency, seller's revenue, and bidders' behaviour in first-price and second-price auctions.

In particular, in our experiments we want to find out the following for the first-price and the second-price auction:

- Do exogenous outside options affect bids at all?
- Do bids in the laboratory deviate from equilibrium bids in the same way as they deviate in standard auctions without outside options?
- How are revenue and efficiency affected if outside options are present?

The plan of the paper is as follows: In Section 2 we introduce outside options into the SIPV auction model and derive equilibrium bidding strategies for the first-price and second-price auctions, Section 3 describes our experimental design, Section 4 provides experimental results and Section 5 concludes.

## 2. The SIPVs auction model with outside options

There are $n$ risk neutral individuals with single-object-demand. Each individual $i$ has a valuation $v_i$ for an object that is for sale in an auction. In addition to the auction offer each individual has access to an outside option that can be substituted for the object offered in the auction. The value that an individual derives from exerting the outside option and not receiving the auctioned object is denoted by $w_i$.[3] We assume here that receiving the auctioned object eliminates the value of the outside option entirely. Individuals may exert their outside options before, during or after the auction.

We distinguish between public and private outside options. In the case of public outside options, each individual derives the same benefit from the outside option. This is common knowledge. In contrast, private outside options are individual-specific and private information.

We briefly report equilibrium bidding functions for first-price and second-price auction in the SIPV model in Section 2.1. In Section 2.2 we introduce public outside options. In Section 2.3 we extend the SIPV model to allow for private outside options.

### 2.1. Bidding without outside options

Consider first the case of an object which has individual valuation $v_i$ for each bidder $i$. This valuation is private information and independently and identically distributed according to a cumulative distribution function $F(v_i)$ where $v_i \in [\underline{v}, \bar{v}]$. Without outside options, the symmetric risk neutral Bayes–Nash equilibrium bidding functions for the first- and second-price auctions are well known (cf. Riley and Samuelson, 1981; Vickrey, 1961): For the first-price auction we have $b^{\mathrm{fp}}(v) = v - \int_{\underline{v}}^{v} F^{n-1}(x)\,\mathrm{d}x / F^{n-1}(v)$ and for the second-price auction $b^{\mathrm{sp}}(v) = v$.

### 2.2. Public outside options

As in Section 2.1 individual $i$ has a valuation $v_i$ for the auctioned object. Now, however, individual $i$ can also exert the public outside option and obtain a value $w$ which is, in the case of a public outside option, the same across all individuals. We assume $w \leqslant \underline{v}$. This ensures that every individual voluntarily participates in a standard auction.

[1] Cherry et al. (2004) inquire into the value of laboratory testbed markets regarding field applications. They note that one difference between laboratory and field is the possibility of substitutes in the latter. To test the robustness of the testbed hypothesis, they conduct a second-price auction with the possibility to buy an object identical to that offered in the auction at some price $p$. They find that bidding behaviour is affected by the presence of outside options.

[2] In particular, our theoretical analysis will include the case of correlated values and outside options. See Section 2.3.

[3] Valuations of transaction alternatives are net of transaction costs. If, for instance, an alternative object is offered at a posted price, then $w_i$ represents the value of the outside option net of its price. If there are many alternatives, then $w_i$ corresponds to the best alternative net of prices.