



Collusion and information revelation in auctions



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ABSTRACT

The theoretical literature on collusion in auctions suggests that the first-price mechanism can deter the formation of bidding rings. However, such analyses neglect to consider the effects of failed collusion attempts, wherein information revealed in the negotiation process may affect bidding behaviour. We experimentally test a setup in which theory predicts no collusion and no information revelation in first-price auctions. The results reveal a hitherto overlooked failing of the first-price mechanism: failed collusion attempts distort bidding behaviour, resulting in a loss of seller revenue and efficiency. Moreover, the first-price mechanism does not result in less collusion than the second-price mechanism. We conclude that, while the features of the first-price mechanism may have the potential to deter bidder collusion, the role of beliefs in guiding bidding behaviour make it highly susceptible to distortions arising from the informational properties of collusive negotiation. Auction designers should take this phenomenon into account when choosing the auction mechanism.

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1. Introduction

Bidder collusion poses a major impediment for auctions. By colluding, members of the colluding cartel—also known in the literature as a *bidding ring*—can improve their respective outcomes and substantially reduce the auctioneer's revenues. Recent studies have documented the prevalence of bidder collusion across sundry domains (Asker, 2010; Hendricks and Porter, 1989; Pesendorfer, 2000; Porter and Zona, 1999)¹ and it is now acknowledged as a major challenge for optimal auction design (Klemperer, 2002; Marshall et al., 2014).

Collusive negotiations reveal private information and affect the bidders' beliefs regarding private values of other bidders. If negotiations break down and bidders bid competitively, the effect on beliefs may extend to altering bidding strategies. The auction designer can take this into account, creating incentives for cartel members to misrepresent their private information, thus inhibiting successful collusive negotiations.² Specifically, theory predicts that the first-price mechanism deters collusion due to the opportunities to manipulate the other party's beliefs that arise in the bargaining process, as compared to the second-price mechanism, where optimal bidding does not depend on beliefs. On the other hand, if information is revealed but negotiations break down (which in many theoretical models never happens in equilibrium), the effect on the

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¹ A large proportion of court cases pursued under U.S. antitrust laws deal with auction markets (Agranov and Yariv, 2014; Froeb and Shor, 2005).

² Deterrence can also be achieved by way of sanctions levied on cartel members. We abstract from such considerations to isolate the effects of the incentives created by the auction mechanism on top of existing legal mechanisms.

bidders' beliefs may drastically distort bidding in first-price auctions, whereas the second-price mechanism is immune to such distortions.

In this paper, we study the implications of information revelation in collusive bargaining in first-price and second-price auctions. We test the theoretical prediction that the first-price mechanism deters collusion, and provide the first systematic study of the effects of failed collusive bargaining on subsequent bidding. We study experimentally first-price and second-price private-values auctions with two bidders. The baseline treatments follow the tradition of the seminal papers that study first-price and second-price sealed-bid auctions (Cox et al., 1982; Kagel and Levin, 1993). In these treatments, subjects bid for an object without previous interaction with the other bidder. In the collusion treatments, one bidder can 'bribe' the other bidder to stay out of the auction, leaving the remaining bidder free to win the auction at the seller's reserve price.³

In the experiment, the collusive agreement is reached through a simple ultimatum bargaining protocol, in which one bidder (the *proposer*) can make a take-it-or-leave-it offer to the other bidder (the *responder*). The responder can choose whether to accept the offer and consequently refrain from bidding in the auction or to reject the offer and participate in the auction.

This particular type of bargaining protocol is well suited for our experimental examination for several reasons. First, it is highly structured and simple to understand, thus serving as an ideal environment in which to study the implications of information revelation in collusive bargaining. Second, it has been analyzed in the theoretical literature for second-price auctions (Esó and Schummer, 2004) and first-price auctions (Rachmilevitch, 2013). These papers illuminate the deterrence properties of the first-price mechanism. Whereas Esó and Schummer (2004) proved the existence (and, under a mild refinement, uniqueness) of a collusive equilibrium in second-price auctions, Rachmilevitch (2013) proved that, assuming undominated bidding and a pure, continuous, and monotonic bribing function, no bribes are offered in the unique equilibrium of the first-price auction. This result illustrates how the effects of information revelation on bidding in first-price—but not second-price—auctions lead to the breakdown of collusion, as proposers have incentives to misrepresent their private information.

Finally, the simple bargaining protocol is well suited for the study of failed collusive bargaining, as it generates such failures as a natural part of the mechanism. The theoretical model we build on thus provides a useful benchmark to guide this first experimental study of failed collusive bargaining. As such, it should be viewed as a workhorse designed to capture the essential features of collusive bargaining that we aim to study rather than a realistic model of real-world collusion.

Our results can be organized into two main findings. First, the experimental data reject the theoretical prediction that there are substantial differences in bribing behaviour between first-price and second-price auctions. Second, the bargaining process has dramatic effects on bidding behaviour in first-price (but not second-price) auctions, leading to a substantial drop in seller revenue and efficiency. Our empirical analysis is able to attribute this loss of efficiency to a selection effect arising from failed bargaining. Bribe offers are likely to be accepted when proposers have a relatively high value and responders a relatively low value. This leads to a positive bias in the distribution of responder values in the auction and a negative bias for the proposer values. Proposers in the resulting asymmetric auction bid higher than responders who have the same private value (but face a lower distribution of opponents' values). Consequently, proposers often win the auction even if the responder's value is higher. A best-response analysis confirms that rational bidders should bid asymmetrically in the auction and that actual bids follow, on average, the optimal pattern.

Thus, our paper brings to light an hitherto overlooked principle: while the features of the first-price mechanism may have the potential to deter bidder collusion, the role of beliefs in guiding bidding behaviour make it highly susceptible to distortions arising from the informational properties of collusive negotiation. In this, our paper contributes to two distinct literatures. First, the literature informing auction design, specifically on how to use the auction mechanism to counter collusion attempts. The consensus in the theoretical literature is that the first-price mechanism has the power to deter bidder collusion (Marshall and Marx, 2012). We bring to the discussion a new consideration, which auction designers should take this phenomenon into account when choosing the auction mechanism. Second, our paper contributes to the literature on bargaining. Most theoretical and empirical analyses of bargaining assume that failure to reach an agreement results in a known disagreement allocation. Recent treatments in cooperative game theory have explored the implications of endogenizing the disagreement point as a function of the strategic environment (Bozbay et al., 2012; Vartiainen, 2007). In contrast, we explore an environment in which the disagreement point depends on private information and on the players' actions in the bargaining stage.

2. Related literature

Although we are the first to test the informational effects of collusion on bidding behaviour, several experiments have studied the more general question of how the auction mechanism affects collusion. These mostly look at situations where collusion is not directly enforceable, where the first price mechanism can deter collusion by providing opportunities for

³ In order to focus on the effects of information revelation, we assume that bribes are committing. This is possible when the cartel can prevent members from bidding (McAfee and McMillan, 1992), or can submit bids in the name of the members (Marshall and Marx, 2007). A large body of literature analyzes the commitment problem, showing that, under general assumptions, first-price auctions have the potential to deter collusion. As the bidder assigned by the cartel to win the auction must place a low bid, other cartel members can enter and win the auction contrary to the terms of the collusive agreement (e.g., Robinson, 1985; Marshall and Marx, 2007).

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