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Information acquisition versus information manipulation in multi-period procurement markets

Hong Wang

Institute for Social and Economic Research, Nanjing Audit University, Nanjing 211815, Jiangsu, China

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ABSTRACT

In this study, we present a theoretical analysis of the strategic behavior of a bidder's cartel in a multi-period procurement auction market. A buyer employs a Bayesian update mechanism to acquire information from past auction bidding data to formulate his estimation of the expected future price, and thus his procurement decision depends on both his expected future price and the current auction price. The cartel can both increase its profits and mask its presence by manipulating the information transmitted to the buyer. In fact, by employing some informational strategies, the cartel can misinform the buyer and skew the intertemporal procurement decision to its advantage. Finally, we find that imposing a bidding ceiling that exceeds the observed current auction price may be a feasible weapon that allows the buyer to reduce the adverse effects of bidder collusion.

1. Introduction

The managers of procurement projects stress the importance of information acquisition. In multi-period procurement auctions, the buyer can utilize bidding information from previous periods to improve his estimation of the price in the next period, thereby allowing him to make a more careful choice about whether and how to make a procurement decision. However, it is easy to forget that this information acquisition process is vulnerable to manipulation by the strategic behavior of suppliers (bidders). If suppliers are aware of the information acquisition behavior of the buyer, they may have an incentive to form a cartel, and thus they are likely to seriously impede the flow of accurate information through the auction market, although not blocking it entirely. The passing of misinformation by the cartel may eventually inflict harm on the buyer.

Given the importance of information transmission in a repeated procurement auction environment, we develop and analyze a behavioral model of the interaction between information acquisition by a buyer and information manipulation by suppliers (misinformation). Our starting point is the observation that the information acquisition process may involve some distortions because of manipulation by cooperative suppliers. The suppliers privately know their own production cost from the outset, but the buyer is already in a better position to estimate the future auction price based on previous bidding information. Thus, we further investigate the connection between information and collusion by concentrating on the cartel's informational monopoly, and its ability to both increase its profits and mask its presence by passing misinformation to the buyer. In addition, we analyze how the buyer can set a price ceiling to counterbalance this type of cartel manipulation.

Recently, progress has been made in understanding the behavior of rational bidders colluding in auctions. The importance of collusive bidder behavior has been recognized by many researchers (e.g., Porter and Zona, 1993; Baldwin et al., 1997; Klemperer, 2002; Marshall and Marx, 2007; Athey et al., 2011), but its implications for the intertemporal procurement decisions of buyers have not been studied widely. The aim of this study is to address this deficiency. In particular, we consider three main research questions. First, should the buyer reallocate his procurement intertemporally in response to fluctuations in the auction price? Furthermore, how should suppliers misinform the buyer to influence his procurement decision? We aim to model and understand the interplay between the procurement process of the buyer and the strategic behavior of suppliers. Our second research question concerns the impact of the strategic behavior of the cartel. What are the most appropriate strategic behaviors for the cartel in the short run and long run in order to both increase its profits and mask its presence? Finally, we determine the most effective measure for the buyer to counteract the adverse effects of bidder collusion.

E-mail address: hwangsjt@gmail.com

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In our proposed model, a single buyer purchases items over a sequence of first-price (FP) auctions. A continuous inflow of suppliers enters the market. If they are unwilling to supply the product immediately, they may leave the market, or they may wait for more attractive business opportunities in the future. The buyer utilizes previous bids to formulate his estimate of the next period auction price and he adjusts the procurement quantities dynamically to minimize the total procurement cost. During each period, the buyer has an incentive to reallocate his procurement intertemporally and he may choose to buy more or less of the items in the current period depending on whether the current market price is lower or higher than his expectation of the auction price in the next period. Thus, the buyer's procurement decision depends on both the current price and the price expected in the next period. In contrast to our intuition, we find that strategic intertemporal procurement substitution by the buyer may sometimes be beneficial for the suppliers forming a cartel.

Stochastic fluctuations in costs play a key role in our model. These fluctuations are reflected in the winning bids across different periods, and thus the homogenous items awarded in adjacent periods can be substituted for each other. Fluctuating auction prices imply that dynamic procurement is worthwhile because there is an opportunity to reduce the total procurement cost by intertemporal procurement substitution.

The results of this study provide two novel insights. First, we demonstrate that information acquisition by the buyer is a major driver of bidder collusion. After bidders become aware of the informational use of their bids, suppliers will have an incentive to form a cartel, thereby extracting extra revenue by misinforming the buyer and biasing intertemporal procurement substitution to their advantage. Another managerial insight is that the buyer's efforts at information acquisition may eventually benefit the suppliers. This finding counters the common intuition that the buyer who practices intertemporal procurement substitution hurts the suppliers' revenues when he can find lower prices. This is true but we highlight another effect that was usually ignored in previous studies, where in the environment of a multi-period procurement, the suppliers can form a cartel and employ effective informational strategies to counteract information acquisition by the buyer. Therefore, the process of information acquisition by the buyer interacts with information manipulation by the suppliers in a subtle manner, thereby providing a new insight into strategic cartel behavior.

The remainder of this paper is organized as follows. Section 1.1 provides a literature review. Section 2 presents the multi-period procurement auction model with a Bayesian update mechanism, which allows the buyer to utilize previous bidding information to improve his estimation of future auction prices. In fact, as our argument proceeds, it becomes obvious that an uninformed buyer's attempt to generate market information through the auction mechanism actually encourages the formation of a cartel. Thus, we then characterize the short-run and long-run informational strategies employed by the cartel to misinform the buyer in Section 3. In Section 4, we show that the buyer can use a price ceiling as a weapon to reduce the adverse effects of bidder collusion. We give our conclusions in Section 5. Many of the proofs can be found in the appendix.

1.1. Related literature

Many previous studies of auctions characterize FP auctions as less susceptible to collusion than other auction formats such as second-price and ascending-bid auctions (e.g., see Robinson, 1985; Marshall and Meurer, 2004, and Marshall and Marx, 2007). However, in some environments, we show that FP sealed bid auctions are not immune to certain types of bidder collusion. Our results show that the cartel can exert its informational advantage to misinform the buyer and force him to make decisions about intertemporal procurement that ultimately benefit the cartel.

Indeed, bidders collude in many FP auctions, such as by submitting identical bids (McAfee and McMillan, 1992). There is extensive evidence of collusion in FP auctions, including highway construction (Feinstein et al., 1985; Porter and Zona, 1993) and the distribution of school milk (Porter and Zona, 1999; Pesendorfer, 2000). In each of these cases, the colluding bidders meet prior to the auction to discuss their bids and to determine the transfer payments among the cartel members. Some researchers have proposed several approaches for assessing whether auction data are consistent with competitive or collusive bidding (Porter and Zona, 1993; 1999; Baldwin et al., 1997; Bajari, 1997; Pesendorfer, 2000; Bajari and Ye, 2003; Asker, 2010). However, these approaches either required prior knowledge about the existence and structure of a cartel, or they derived in-sample specification tests of the competitive model and treated collusion as the alternative.

Both theory and practice suggest that collusion is a particularly critical issue and it may be more stable when FP auctions are repeated frequently (Blume and Heidhues, 2008; Abdulkadiroglu and Chung, 2003; Aoyagi, 2003; 2007; Skrzypacz and Hopenhayn, 2004). In a dynamic setting, bidders may learn to coordinate their strategies, thereby competing less aggressively with each other in order to increase profits compared with those obtained in a static setting. Skrzypacz and Hopenhayn (2004) and Blume and Heidhues (2008) both studied tacit collusion in repeated auctions, where bidders do not communicate prior to each auction stage. They showed that a degree of improvement is possible compared with a one-shot Nash equilibrium as well as simple bid rotation in independent private values models. Motivated by these examples, we focus on the hardest possible case for the buyer in a repeated procurement setting, where the suppliers in the cartel do not fear defection from within the cartel and where side payments are possible between cartel members (a "strong cartel" in McAfee and McMillan's, 1992 terminology, and a "bid submission mechanism" according to Marshall and Marx, 2007). Our decision to focus on cartel formation in a repeated auction environment is also supported by experimental evidence. Thus, Phillips et al. (2003) showed that even groups of six bidders who interact repeatedly can form stable coalitions when communication is allowed. In their treatment of communication, Hamaguchi et al. (2007) found that in procurement auctions, subjects do not cheat on the agreement reached in the communication phase.

Bidder collusion can decrease the revenue obtained by the auctioneer and distort the efficiency of the final allocation. As a result, competition authorities have focused on prosecuting bidder collusion. Understanding the mechanisms that allows bidders to support collusive agreements can be valuable for informing the choice of auction format, as well as for detecting and prosecuting cartels. Fighting collusion is a primary concern for auctioneers because bidders who manage to form a cartel can seriously damage the seller's revenue. Klemperer (2002) argued that collusion and other competition policy-related issues such as predation and entry deterrence are more relevant for practical auction design than risk aversion, affiliation, and budget constraints, which play prominent roles in mainstream auction theory.

Previous studies have provided several methods that allow auctioneers to implement auction rules to discourage bidders from collusion. It is well known that an auctioneer may impose a reserve price as a deterrent (Graham and Marshall, 1987). Some studies have shown that collusion-proof mechanisms exist under fairly general circumstances and these mechanisms raise as much revenue as a revenue-maximizing mechanism in the absence of collusion (Laffont and Martimort, 1997; 2000; Jeon and Menicucci, 2005; Che and Kim, 2009). Cramton (2007) studied the design of