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Improving the estimation of probability of bidder participation in procurement auctions

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Abstract

Anticipating the number and identity of bidders has significant influence in many theoretical results of the auction itself and bidders' bidding behaviour. This is because when a bidder knows in advance which specific bidders are likely competitors, this knowledge gives a company a head start when setting the bid price. However, despite these competitive implications, most previous studies have focused almost entirely on forecasting the number of bidders and only a few authors have dealt with the identity dimension qualitatively. Using a case study with immediate real-life applications, this paper develops a method for estimating every potential bidder's probability of participating in a future auction as a function of the tender economic size removing the bias caused by the contract size opportunities distribution. This way, a bidder or auctioner will be able to estimate the likelihood of a specific group of key, previously identified bidders in a future tender.

Keywords: Bidding; Bidder identity; Auction; Tendering; Construction; Competitiveness

1. Introduction

Studies of construction companies in the U.S. (Ahmad and Minkarah, 1988) and the UK (Shash, 1993) have shown one of the three most important factors that influence bidding decisions to be the likely number of bidders involved. This way, previous experience of the bidders' involvement in a series of past tenders for the same type of work and for the same Contracting Authority[4] provides qualitative knowledge about which firms regularly take part in those contracts, as well as the degree of competitiveness each regular bidder has demonstrated historically (Fu, 2004). Consequently, quantifying who and how many bidders are likely submit a future tender for a specific contract provides valuable information for a contractor when making the decision-to-bid (d2b); this is also a key factor in strategically setting a bid price to optimise the likelihood of winning the contract. There is also an economic impact at a business level, because being awarded more contracts decreases the overhead of

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[4] The terms Contracting Authority, client and owner are taken here to be synonymous.

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the company in the short term, and increases its production and turnover in the long run, as well.

Likewise, there are several contributions that evidence interesting connections between the number of bidders N and tender outcomes. For instance, the degree of correlation between the average bid and the highest and lowest bids in collective bid tender forecasting models is higher on average when N is higher (Ballesteros-Pérez et al., 2012a,2012b; Skitmore, 1981a). Similarly, the amplitude of the bid standard deviation was recently demonstrated to be also proportional to N (Ballesteros-Pérez et al., 2015a).

Most of the vast literature on the economic theory auctions also assumes the value of N to be known in symmetrical models, and at least the identity of all the bidders known in asymmetric models (e.g., Maskin and Riley, 2000). This is especially crucial for the theory of common value auctions, where the value of N is a major determinant of the extent of the *winner's curse* (e.g., Capen et al., 1971).

Finally, another approach to this issue (Fu, 2004) tries to foresee the number and identities of bidders in practice through personal experience of the past appearance rate of bidders, mostly as a function of project features (client, type, size, location, etc.).

Nonetheless, forecasting the number and identity of bidders is challenging, since no conclusive solution has yet been found for its accurate prediction, nor exists a suitable quantitative model to forecast the identities of a single or a group of specific key competitors likely to submit a future tender (Ballesteros-Pérez et al., 2015c). This is the gap of knowledge identified and, therefore, the point of departure of this research. Hence, the goal of this paper is to propose a useful quantitative model for forecasting, first, the identities of likely competing bidders in procurement auctions by means of calculating their respective probabilities of participation; and, second, the number of total contributing bidders involved. It builds on the previous work of Skitmore (1986), who introduced a simple model that assimilated probabilities of the bidders assuming them constant from tender to tender. However, the model proposed in this paper will take into consideration the contract economic size, removing the bias caused by uneven number of contract opportunities. The use of the model is explained and demonstrated by a case study with an actual construction tender dataset.

The paper is structured as follows. In the next section a brief *Literature review* is provided first, which is followed by a *Model outline* in the next section. A *Case study* is then described in the fourth section, introducing an example tender dataset contained in the construction bidding literature, together with the calculations required to implement the model. Next, a *Results* section provides the case study bidders' probabilities of participating; and a validation subsection shows how closely the proposed approach depicts reality. Finally, *Discussion* and *Conclusions* sections comment on these results, highlighting where improvements are possible, posing unsolved research questions and presenting options for future work. For the sake of clarity, the American term "procurement (or reverse) auction" and the European "tender" are used here synonymously.

2. Literature review

As far back as 1956, Lawrence Friedman proposed several methods for estimating the average number of bidders in a future tender observing that, on many occasions, there is little information available to a firm about their competitors' intentions, but that it should still be possible to obtain a good estimation of the identity and number of future participating bidders if this firm is shrewd enough to combine such scarce information with its managers' experience (Friedman, 1956). This approach was restated by Rubey and Milner (1966) in a more broad tendering scenario with a specific emphasis on contract type.

Afterwards, another step taken by Friedman concerning the number of bidders was to suggest the existence of a relationship between the contract size (the complete budget to carry out the project) and the number of bidders N (Runeson and Skitmore, 1999). This was followed through by Gates (1967) and Wade and Harris (1976) but the results were weak. Other researchers had a similar experience, with Sugrue (1977), for example, failing to find a noteworthy relationship between the contract size and both the number of bidders and the number of suppliers and subcontractors involved. Also of interest at this point, is that Park (1966) had suggested ten years earlier the possibility of a non-linear relationship between the contract size and the number of bidders, but without any empirical support at the time.

Later, Skitmore (1981b) performed several tests with some international tender datasets from different time periods that helped identify a correlation between market conditions and the number of bidders but did not develop a mathematical model. Skitmore (1986) analysed this phenomenon again with different data, confirming that the correlation between the market conditions and the number of bidders really existed. This relationship was weak or moderate in most cases; however, the correlation was significantly better when contract size was considered. More recently, Ballesteros-Pérez et al. (2015c) backed up this statement, underlining the importance of including the variable contract size in modelling N instead of simply treating N as a purely random variable.

In this regard, there have been many statistical distributions used so far to model the number of bidders N. Friedman (1956) suggested that N might follow a Poisson distribution, reasoning that if related individuals independently choose whether or not to bid for a particular object, this would be equivalent to the number of bids following a binomial distribution—which is known to be well approximated by the Poisson when the average of the number of bids is a small fraction of the total possible.

Several researchers have tried to test Friedman's conjecture. For example, Keller and Bor's (1978) analysis of the bidding configurations of a significant number of analogous construction contracts and their outcomes concurred with the Poisson assumption. However, others making use of U.S. Outer Continental Shelf Statistical summary data from 1976 to 1978, indicate that N might follow not only a distribution different to the Poisson, but may even be bimodal.