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“Bidding the project” vs. “bidding the envelope” in public sector infrastructure procurements[☆]

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ABSTRACT

We study the relative efficiency of two mechanisms actually employed in large-scale public procurements, often for transportation projects such as roads, bridges and rapid transit systems. In the more common “bidding the project” mechanism, the government specifies the size of the project (a quantity) and firms bid prices (the lowest bid winning). In the “bidding the envelope” mechanism the government specifies what it is willing to spend and firms bid quantities (the highest winning). With uncertainty about project costs and benefits, the much less frequently applied “bidding the envelope” mechanism can lead to higher value for money. Its advantage lies in its ability to allow quantity to adjust to high or low costs.

1. Introduction

Governments around the world are looking at innovative ways to procure large-scale public projects such as roads, bridges, rapid transit lines, hospitals, schools and prisons. The widely-recognized “infrastructure deficit” experienced in many countries, with both developed and developing economies, helps explain this interest. A recent report by the World Economic Forum suggested that an investment of the equivalent of US\$2 trillion would need to be made each year for the next twenty years to bring the world's infrastructure to par levels.¹

There exists an extensive economics and management science literature on the use of auctions to procure public infrastructure, most of which focuses on the design and properties of optimal or near optimal mechanisms. In contrast, the purpose of this paper is to explore the cost and efficiency properties of two very basic mechanisms which are frequently employed in practice even though not optimal in any formal sense.

In the standard representation of a large-scale public procurement the government defines the project it would like delivered. It may leave a lot of discretion to bidders about how that project is to be delivered, but

what we will call the “quantity” of services or “size of the project” to be delivered is precisely defined before bidding begins. Potential private partners will then bid competitively to provide that quantity at the lowest possible price to the government with the winner being the party with the lowest (quality controlled) price. We refer to this kind of procurement as “bidding the project” (or BTP). Competitive bidding will then lead to the provision of the defined quantity/project at a price close to the private sector provider's costs. The optimality of the mechanism then turns on the degree to which the government correctly specified the project before it asked for bids. If the government is uncertain about either the benefits of the project and/or the costs of delivery, it may not specify the optimal project size –determined by balancing the marginal benefits and costs of larger and smaller projects– before asking for bids. The final project, while delivered at close to cost, may not then be of the optimal size, resulting in some deadweight loss through this procurement.

A second method for procuring this project would involve the government determining how much money it was prepared to spend on the project (the “envelope”) and then letting bidders compete through the quantity or size of the project they will provide for that amount of money. We refer to this as “bidding the envelope” (BTE). This approach has been

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¹ World Economic Forum (2010). Deloitte (2008) provides a brief discussion about the deficits in various parts of the world. A McKinsey Global Institute Report in 2013 found that globally, \$57 trillion in investment in infrastructure was needed by 2013. See McKinsey Global Institute (2013) at p. 10.

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used, for example by the Province of British Columbia, Canada in its procurement of large-scale improvements to the Sea-to-Sky Highway linking Vancouver with the mountain resort community of Whistler.²

An important variant of this approach, likely much more common, involves governments specifying a project quantity but then also a maximum amount they will pay (an “affordability ceiling” or “affordability cap”). If their specified project is not feasible given this affordability limit, the bidding becomes essentially a BTE competition to give the government a project as large as possible within that envelope.³

Whether the government was trying to maximize total welfare or “value for money” (defined below), with full information the government can achieve the first best without really needing to choose a mechanism: it can simply offer to buy a project of the optimal size at the known lowest cost of production or the implied envelope. The efficiency of the first-best is lost, however, when there is uncertainty/asymmetric information about costs and/or benefits. In these cases, the government will likely incorrectly (*ex post*) set the quantity or envelope. For example, after setting a project size based on their best estimation of benefits and costs (which will depend on the type of bidding mechanism used), a government finding that firms actually had lower costs than estimated would prefer a larger project. Under the BTE mechanism the firms will indeed bid greater quantities than previously expected; however, under the BTP mechanism the project size will not change.

The purpose of this paper, then, is to explore the conditions under which each of these mechanisms will be superior to the other in terms of minimizing the inefficiencies associated with second-best project sizes *ex post*. We will see that the relative advantages of the mechanisms will depend on a number of factors including the general level of benefits derived from the project and the expected size and distribution function of the marginal cost. It should also be clear that when we talk about the project “size” or “quantity” we could alternatively be talking about “quality” as long as, in this case, the quantity is fixed and quality is a measurable and contractible output.

The next section reviews the related literature including that on the regulation of prices versus quantities and scoring auctions. Section 3 then presents an overview of the model with the key results presented in Section 4. Section 5 offers our conclusions.

2. Related literature

As indicated, there is now a large literature on public procurement investigating the properties of various procurement methods for infrastructure and other goods and services. Previous research has explored many topics such as the design of optimal procurement auctions, scoring rules for multidimensional projects, second-sourcing, contract design for complex projects, collusion in bidding and transparency issues.⁴ Our goal here, again, is to contribute to this literature by focusing on the efficiency properties of these two simple yet practical mechanisms.

The ideas here are clearly related to the pioneering work on the uses of prices versus quantity controls as regulatory mechanisms. In

² This was a public-private partnership – an increasingly important procurement mode for large-scale infrastructure projects in many countries. On this project see: www.partnershipsbcc.ca/files-4/project-seatosky.php. To be precise, the original call did specify baseline requirements that bidders must satisfy, but then let them offer up further improvements beyond that. The winning bidder provided many additional benefits beyond the baseline and within the envelope provided (e.g. more kilometers of passing lanes, better lighting and signage, and improved highway maintenance etc).

³ British Columbia has used this approach as well (e.g. for a hospital: http://www.partnershipsbcc.ca/files/documents/FSJH-RFP_Volume_1-Revision1.pdf). See also the description of the implementation of affordability caps in Ireland in OECD (2008 at p. 169). The concept is described in the Certified PPP Professional (CP³P) certification program materials (created with support from the World Bank and other development banks): <https://ppp-certification.com/ppp-certification-guide/164-tender-and-award>.

⁴ See, for example, the collection of essays in Piga and Thai (2007) and Dimitri et al. (2006). Important papers in the procurement auction literature also include Porter and Zona (1993), Compte et al. (2005), Compte and Jehiel (2002), Bajari and Tadelis (2001) and Anton and Yao (1987).

Weitzman's (1974) classic contribution, he asked whether it was better to control the behavior of a regulated private firm by setting the price it receives for its output and letting it choose profit-maximizing quantities, or by directly setting the quantity to be produced by the firm. As is true here, these mechanisms will trivially produce identical results when the regulator has full information. However, when there is uncertainty about the benefits and/or the costs of output, introduced much as we have here, the mechanisms are not equivalent and the superiority of one over the other will depend on the shapes of the benefit and cost functions.

Laffont (1977) clarified and extended Weitzman's results, distinguishing between “genuine randomness” – random elements of costs and benefit functions unknown to all players (regulator/planner, producers and consumers) – and random elements that, while unknown to the regulator/planner, are known to the consumer (in the case of benefits) and producer (in the case of costs). This second type of randomness contributes to the information gap that drives the differences between mechanisms. In a similar way, we show below that genuine randomness in project benefits will not affect the relative merits of the two procurement mechanisms we study.⁵

Despite these similarities, there are significant differences between the present paper and this prior literature. First, in Weitzman (1974) the regulator sets a quantity after balancing expected marginal benefits and costs, but Weitzman never discusses how the firm is compensated (problematic given that costs are uncertain). Our BTP mechanism, which also establishes a quantity, clarifies this: bidding will determine how much the winning firm is paid. Second, our BTE mechanism is quite different from the price mechanism in Weitzman (1974). This becomes most apparent when unit (“marginal”) costs are constant: a firm responding to a fixed price per unit would either supply zero output (if the price was below its unit costs) or an infinite quantity (if the price was above), hence the Weitzman price mechanism cannot work here.

The most important difference here, however, derives from the fact that we are exploring a procurement model in which bidding modifies firms' behavior in an important way. In fact, it is largely the bidding that regulates firms in our model and, without it, neither of our mechanisms would produce satisfactory results.

Our focus here on two very simple mechanisms – both in current use and each one-dimensional – also sets this paper apart from the literature on scoring auctions. That literature, for example Che (1993), and Asker and Cantillon (2008, 2010), considers procurements in which the government invites prospective suppliers to quote on multiple dimensions of a project including price and possibly numerous aspects of project quality. In contrast, we consider simple mechanisms in which prospective suppliers quote just one number – either a price or a quantity.⁶ And, importantly, one of these mechanisms – unlike virtually all of those discussed in the scoring literature – requires the government to specify an envelope and does not ask the bidders to quote a price as part of their bids. In other words, while in either a scoring auction or under the BTP mechanism the government will not know at the bidding stage what the final cost of the project will be, in a BTE mechanism it will know, something that governments may find desirable.⁷

In its focus on the efficiency properties of practical procurement

⁵ Laffont (1977, p. 180) does recognize that if the different parties have different expectations about genuine randomness, the mechanisms will not be equivalent. This would be true in our model as well.

⁶ As a result we do not need to score multiple attributes of a bid. Of course, it may be the case in the BTE mechanism that there are multiple dimensions of “quantity” that the government cares about, in which case it will have to create some scoring mechanism to determine which of a set of different bids provides the greatest aggregate quantity for the purposes of winning the competition.

⁷ Cost overruns in the provision of public infrastructure would appear to be an important problem. This has been most comprehensively documented with respect to transportation infrastructure; see for example Cantarelli et al. (2010) and the studies cited therein. For example, these authors (at p.6) cite one study that found that 77% of highway projects in the United States experienced cost escalation, and another that found that the average cost overrun of infrastructure projects was over 50%.

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