European Journal of Political Economy 35 (2014) 122–127

Contents lists available at ScienceDirect

European Journal of Political Economy

journal homepage: www.elsevier.com/locate/ejpe

Corruption in delegated public procurement auctions

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ARTICLE INFO

Article history:
Received 27 January 2014
Received in revised form 26 May 2014
Accepted 26 May 2014
Available online 2 June 2014

JEL Classification:
D44
H57
L13

Keywords:
Public procurement
Corruption
Scoring auction

ABSTRACT

In this paper we theoretically analyse effects of corruption in public procurements within a scoring-auction framework. A corrupt politician, who acts on behalf of the public sector, receives a kickback from the winning bidder. The politician selects the scoring rule. The paper shows that such corruption always leads to lower quality and lower price. Given a level of corruption, a higher bargaining power of the politician in extracting bribes does not affect the quality but leads to higher price.

1. Introduction

In the modern world Government contracts are typically awarded by procurement auctions, which are also often used by firms subcontracting work or buying services and raw materials. In OECD (2011) it is reported that the procurement of public services accounts for approximately 17% of GDP of EU countries. Clearly public procurements constitute a significant part of the economic activities in many countries (see Koning and Meerendonk, 2013).

The theory of auction provides the necessary analytical framework to study such procurements. However, it may be noted that the benchmark model of auctions is really a *price-only* auction where all other characteristics of provision are assumed to be identical for all potential vendors. Thus, in the traditional theory of standard procurement auctions (where the auctioneer is the buyer), the auctioneer cares only about the price of the object, but not the other attributes. However, in many procurement situations, *the buyer cares about attributes other than price* when evaluating the offers submitted by suppliers.[3] Non-monetary attributes that buyers care about include quality — sometimes along several observable/verifiable dimensions and time to completion. For example, in the contract for the construction of a new aircraft, the specification of its airworthiness and other characteristics is probably as important as its price. Under these circumstances, auctions are usually multidimensional. The essential element of such multi-dimensional auctions is a *scoring rule*. In the *scoring auction*, bidders are asked to submit multidimensional bids that include price and some non-price attributes, such as

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[3] "For public funds to be spent efficiently and effectively, value for money is the key principle in public procurement. Low-price auctions have been widely used to allocate contracts as a competitive, transparent, and accountable mechanism. However, costs are not the sole indicator in assessing the best value-for-money contract. More and more procurement buyers, thus, introduce awarding mechanisms with which relevant prices and qualities of proposals in the whole procurement cycle are assessed" (Section 1 in Nakabayashi and Hirose, 2013).

http://dx.doi.org/10.1016/j.ejpoleco.2014.05.003
0176-2680/

quality. The bids are then transformed into a score by an ex ante publicly announced scoring rule, and the bidder whose score is the highest is awarded the contract.

There are many real life examples of such scoring auctions. For example, the Department of Defence in the USA often relies on competitive source selection to procure weapon systems. Each individual component of a bid of the weapon system is evaluated and assigned a score, these scores are summed to yield a total score, and the firm achieving the highest score wins the contract (see Che, 1993). Many state departments of transportation in the US use "A + B bidding" for highway construction work in the United States, where the highway procurement authorities evaluate offers on the basis of their costs as well as time to completion, weighted by a road user cost. A similar mechanism is used in auctions for electricity reserve supply (see Asker and Cantillon, 2008). Ministry of Land, Infrastructure and Transportation in Japan allocates most of the public construction project contracts through scoring auctions based on quality-over-price ratio rules (see Hanazono et al., 2013).

1.1. A brief literature review of scoring auctions

Che (1993) is a pioneer in analysing such scoring auctions. In his model both the quality and the bidder's types are single-dimensional, types are identically and independently distributed and the scoring rule is quasilinear. Branco (1997) analyses the properties of optimal mechanisms when types are single-dimensional but correlated. Asker and Cantillon (2008) analyses the case when both quality and types are multidimensional and the scoring rule is quasilinear. Asker and Cantillon (2010) analyses optimal mechanisms with one-dimensional quality and two-dimensional discrete types. Nishimura (2012) computes optimal mechanisms with multidimensional quality and single-dimensional types that are identically and independently distributed. Very recently scoring auctions with non-quasilinear scoring rules have been analysed by Hanazono et al. (2013) and Dastidar (2014).

None of the papers mentioned above deal with the issue of delegation within a scoring auction framework. We now proceed to say a few words on this aspect.

1.2. Delegation in scoring auction

Delegation, or empowering one to act on behalf of another, is pervasive in the modern firm. Shareholders delegate strategic decisions to managers; delegation is efficient when managers allocate resources, including their own efforts, in ways that do not divert from owners' objectives. However, that separation in decision making also gives rise to conflicts among the actors involved. A rather impressive body of work has developed on related topics, including agency theory (Dalton et al., 2007; Gibbons, 2005; Prendergast, 1999), organizational controls systems (Goold and Quinn, 1990), organizational structure (Keats and O'Neill, 2001), strategic leadership (Finkelstein et al., 2008), strategic commitment theory (Ghemawat, 1991; Schelling, 1960), and the role of irreversibility in competitive interaction (Chen and MacMillan, 1992; Chen et al., 2002). For a recent excellent survey, see Sengul et al. (2012).

Apart from the abovementioned papers two recent contributions deserve mention. In an experimental study Vetter (2013) examines some aspects of delegating decision rights for future rewards as an alternative to corruption. The study finds that even the pure anticipation of future rewards from a lobbying party suffices to bias a decision-maker in favour of this party, even though it creates negative externalities to others. In a rent-seeking model Hessami (2014) examines the relationship between political corruption and the composition of public spending.

It may be noted that the impact of corruption on procurement auctions may be huge in terms of efficacy of the project and thus merits discussion. Surprisingly, none of the papers in the literature on scoring auction has touched upon this aspect. As such, we endeavour to fill up this gap in the literature.

The literature so far has not dealt with the case where a corrupt, politically appointed government representative acts on behalf of the government agency and chooses the rules of the scoring auction. This situation is quite common in many countries. For example, in emerging economies like India, large infrastructure projects (roads, airports) are often commissioned by public sector organisations. The contracts for such projects are typically awarded through an auction and often some form of scoring auction is used (for example the construction of the new international airport in Delhi).[4] The public sector is typically controlled by politicians, who act as public representatives and thus often have substantial say in this procurement process. Consequently, they have significant influence on the design of the scoring rules also. Problem arises when a public sector is saddled with a politician who is not honest.[5] A typical corrupt politician receives a bribe from the winning bidder.[6]

In short, the politician has the power to act on behalf of the public sector and he decides on the rules of the auction. In particular, he has a say in the selection of the scoring rule to be used, which need not reflect the true utility of the public sector or representative voter of the region. The scoring rule so selected is geared towards increasing the utility of the corrupt politician.

[4] In the mechanism for award of contract for the New Delhi Airport each firm was asked to submit a document called a technical bid that included the firm's design of the airport as well as the firms' characteristics. It also had to simultaneously submit a financial bid which represented the percentage of revenue that the supplier was willing to share with the Government.

[5] A few years back in the 2G spectrum auction in India, a minister allegedly changed the rules of the game to benefit some particular bidders. The Supreme Court of India later cancelled all licences allocated in this auction. Subsequently, the government was forced to conduct a new set of 2G spectrum auctions.

[6] In India, for example, it's often the case that if the winning bidder does not pay the bribe, he will not be awarded the contract. The politician may create technical hassles to block the award of contract and consequently, winners are forced to pay the bribe.

1.3. Contribution of this paper

In this paper we theoretically analyse effects of corruption in public procurements within a scoring-auction framework. A corrupt politician, who acts on behalf of the public sector, receives a kickback from the winning bidder. Keeping this in mind, the politician selects the scoring rule. The paper shows that such corruption always leads to lower quality and lower price. Given a level of corruption, a higher bargaining power of the politician in extracting bribes does not affect the quality but leads to higher price.

In Section 2, we proceed to provide the theoretical model of our exercise. Section 3 collects the main results. Finally concluding remarks are made in Section 4.

2. The model

A public sector is planning to build up an infrastructure within a region. This public sector is effectively controlled by a politician. In an emerging economy like India this is possible in the following two scenarios: (i) in the parliament (or state assembly) this region is represented by the politician who has been elected and (ii) this infrastructure project falls under the purview of a department ministered by this elected politician.

The public sector solicits bids from n firms. Each bid, (p, q), specifies an offer of promised quality, q and price, p, at which a fixed quantity of products with the offered level of quality q is delivered. The quantity is normalized to one. As a first attempt, for the sake of simplicity, quality is modelled as a one-dimensional attribute.

A representative voter of this region values the good (p, q) at $v(p, q) = u(q) - p$, where $u'(.) > 0$ and $u''(.) < 0$. This means that the representative voter's utility is strictly increasing in the quality of the public infrastructure project (like roads or power facilities) and strictly decreasing in its price. Since the quality of the infrastructure directly affects the wellbeing of the voter in this region, his utility is increasing in quality. The project is financed by taxpayer's money and since the representative voter is a taxpayer, he cares for the price of the project.

A scoring rule is a function $S : \mathbb{R}^2_{+\,+} \to \mathbb{R} : (p, q) \to S(p, q)$ that associates a score to any potential contract and represents a continuous preference relation over contract characteristics (p, q). *This scoring rule is influenced by the politician as he effectively controls the management of the public sector.*

The contract is awarded to a firm whose offer achieves the highest score. This is similar to a standard auction. We consider on first-score auction where the winning firm's offer is finalised as the contract. This auction rule is a multi-dimensional analogue of the first price auction.[7]

A firm i upon winning, earns from a contract (q, p) profits:

$$\pi_i(q,p) = p - c(q,\theta_i)$$

where firm i's cost $c(q, \theta_i)$ is increasing in both quality q and cost parameter θ_i. It is assumed that $c_{qq} \geq 0$, $c_{q\theta} > 0$, $c_{q\theta\theta} \geq 0$ and $c_{qq\theta} \geq 0$. It is also assumed that the buyer never wishes to split the contract to more than one firm (i.e. the cost is not too convex in q). These assumptions are satisfied by $c(q, \theta) = q\theta$. Losing firms earn zero.

Prior to bidding each firm i learns its cost parameter θ_i as private information. The buyer and *other* firms (i.e. other than firm i) do not observe θ_i but only know the distribution function of the cost parameter. It is assumed that θ_i is identically and independently distributed over $[\underline{\theta}, \overline{\theta}]$ where $0 < \underline{\theta} < \overline{\theta}$. The distribution function of θ_i is given by $F(.)$ and the density function by $f(.)$. We assume that the reverse hazard rate, $\frac{f(\theta)}{F(\theta)}$, is decreasing in θ.

The politician is corrupt and he demands bribe from the firm winning the contract, which is a share, α (where $0 < \alpha < 1$) of the payment, p, paid to the firm. This α depends on the bargaining power and other cultural factors and is exogenously given in this model.[8] Thus the bribe received by the politician is αp. However, the politician also cares for the representative voter of this region because of re-election considerations. The politician's utility is given by a weighted average of what he receives as a bribe and the representative voter's utility. His utility function is the following:

$$U(q,p,\beta,\alpha) = \beta(\alpha p) + (1-\beta)(u(q)-p), \quad \text{where} \quad 0 \leq \beta < \frac{1}{1+\alpha}.$$

Where β represents the degree of dishonesty of the politician. $\beta = 0$ means that he is completely honest and cares only about the representative voter's utility. Higher β means that he is more dishonest. Since $\beta < \frac{1}{1+\alpha}$ we are assuming that it's never the case that he is completely dishonest. Note that if he is completely dishonest (where $\beta = 1$), then he cares only about the bribe that he receives. We rule this case out as apart from some genuine concerns for the representative voter, the politician also keeps in mind possibilities of his re-election from the same constituency. Note that since $0 \leq \beta < \frac{1}{1+\alpha}$ the politician's utility, $U(.)$, is strictly decreasing in p and strictly increasing in q. This means that the politician's utility resonates with the representative voter's unity.[9] Also note that since the

[7] In the literature there is also a second-score auction. Here the winning firm is required to match the highest rejected score. In meeting this score, the firm is free to choose any quality-price combination. This auction rule is a multi-dimensional analogue of the second-price auction.

[8] In India newspapers often report about the 10% (or 15%) rule, which is the fraction usually paid to the politician (or bureaucrat) to enable the winning bidder to get the contract finally awarded without any technical hassles. A few years back in a much publicised sting operation, a politician was dubbed as Mr. 15%!!

[9] Typically, the politician comes from the same region as the representative voter and has similar preferences.

politician receives αp as bribe the net payment to the winning bidder is $(1-\alpha)p$. This implies that the winner's payoff is $(1-\alpha)p - c(q,\theta)$.

We noted before that the scoring rule, $S(.)$ is chosen by the politician as he effectively controls the management of the public sector. The politician will choose an optimal mechanism whereby he maximises his expected utility. We now proceed to discuss the main results of our paper.

3. The main results

First note that the politician's utility can be written as follows:

$$U(.) = (1-\beta)u(q) - (1-(1+\alpha)\beta)p. \tag{1}$$

Since by assumption $u'(.) > 0$, $u''(.) < 0$ and $\beta < \frac{1}{1+\alpha}$ we get that $U_q(.) > 0$, $U_p(.) < 0$ and $U_{qq} < 0$.
We now define the following:

$$q_0(\theta) = \arg\max_q (1-\beta)u(q) - c(q,\theta) - \frac{F(\theta)}{f(\theta)} c_\theta(q,\theta). \tag{2}$$

The first order condition and the second order condition for the above maximisation are as follows:

$$\text{FOC}: \quad (1-\beta)u'(q) - c_q(q,\theta) - \frac{F(\theta)}{f(\theta)} c_{\theta q}(q,\theta) = 0 \tag{3a}$$

$$\text{SOC}: \quad (1-\beta)u''(q) - c_{qq}(q,\theta) - \frac{F(\theta)}{f(\theta)} c_{\theta qq}(q,\theta) < 0. \tag{3b}$$

Note that given our assumptions, the second order condition will always be satisfied.

3.1. Comment

$q_0(\theta)$ will play an important part in our analysis. We earlier noted that the politician will choose an optimal mechanism whereby he maximises his expected utility. It may be noted that in an optimal revelation mechanism the firm with the lowest θ is selected as the winner and the winning firm is induced to choose quality $q_0(.)$. In the optimal mechanism quality is distorted downwards to limit the information rents accruing to relatively efficient firms.[10]

We now provide the first set of results.

Lemma 1. **(i)** $q_0(.)$ is strictly decreasing in θ.
(ii) $q_0(.)$ is strictly decreasing in β.

Proof. Straightforward and follows from our assumptions.■

Since $q_0(.)$ is strictly decreasing in θ (Lemma 1(i)), for any $x \in [q_0(\overline{\theta}), q_0(\underline{\theta})]$ we have a well defined $q_0^{-1}(x)$. The next lemma follows directly from Lemma 1(ii).

Lemma 2. $q_0^{-1}(.)$ is strictly decreasing in β.

Now define

$$\Delta q = \int_0^q \frac{F\left(q_0^{-1}(x)\right)}{f\left(q_0^{-1}(x)\right)} c_{q\theta}\left(x, q_0^{-1}(x)\right) dx \text{ for } q \in [q_0(\overline{\theta}), q_0(\underline{\theta})]. \tag{4}$$

Remark. Note that we have assumed that $\frac{f(\theta)}{F(\theta)}$ is decreasing in θ and $c_{qq\theta} \geq 0$. Using these assumptions and Lemma 2 we get that Δq is decreasing in β.

In the previous section we noted that the politician will choose an optimal mechanism whereby he maximises his expected utility which is $U(.) = (1-\beta)u(q) - (1-(1+\alpha)\beta)p$. From Proposition 4 of Che (1993) we know that under a suitably modified scoring rule (which is different from the true utility function) the first-score auction implements the optimal mechanism. Using Proposition 4 of Che (1993) we come to our next result.

[10] A Pareto efficient level of quality maximises $(1-\beta)u(q) - c(q,\theta)$. The definition of q_0 ensures that it is strictly less than the Pareto efficient level of quality. See Che (1993) for details.

Proposition 1. The politician will implement the optimal mechanism by choosing the scoring rule,

$$S(q,p) = (1-\beta)u(q) - (1-(1+\alpha)\beta)p - \Delta q$$

and conducting a first-score auction.

3.2. Comment

We know that an optimal mechanism induces a downward distortion of quality from the first best level to internalize the information costs of the buyer. This optimal downward distortion can be implemented by a scoring rule that penalizes quality relative to the buyer's actual valuation of quality. From (1) and Proposition 1 above we get that this scoring rule differs from the true utility function by the term Δq.

Note that in the traditional direct, rather than the delegated, procurement auction the trade-off between the utility, $u(q)$, and distortion, Δq, is relatively more in favour of quality than here. The trade-off here works out to be $(1-\beta)u(q)$ vs Δq, attaching a lower relative weightage on $u(q)$.

We have noted earlier that since the politician receives αp as bribe the net payment to the winning bidder is $(1-\alpha)p$. This implies that the winner's payoff is $(1-\alpha)p - c(q,\theta)$. Now from Che (1993) it is straightforward to show that in a Bayesian-Nash equilibrium of the first-score auction chosen by the politician (see Proposition 1), a firm with type θ will choose $(q_s(\theta), p_s(\theta))$ where

$$q_s(\theta) = \arg\max_q [(1-\beta)u(q) - (1-(1+\alpha)\beta)p - \Delta q - c(q,\theta)] \tag{5a}$$

$$p_s(\theta) = \frac{1}{1-\alpha}\left[c(q_s(\theta),\theta) + \int_\theta^{\bar\theta} c_\theta(q_s(t),t)\left(\frac{1-F(t)}{1-F(\theta)}\right)^{n-1} dt\right]. \tag{5b}$$

For any given type, θ, we obtain such $q_s(\theta)$ by using the following first order condition:

$$(1-\beta)u'(q) - \frac{F\left(q_0^{-1}(q)\right)}{f\left(q_0^{-1}(q)\right)} c_{q\theta}\left(q, q_0^{-1}(q)\right) - c_q(q,\theta) = 0. \tag{6}$$

Given our assumptions and Lemmas 1 and 2, the second order condition will always be satisfied. Using (6) we get that $q_s(\theta)$ is strictly decreasing in β. Since $c_q > 0$ and $c_{\theta q} > 0$ from (5b) we get that for any given α, $p_s(\theta)$ is also strictly decreasing in β. This means that higher is β, lower will be both the expected quality and price.

Since β is an index of corruption in our model (higher β indicates higher levels of corruption) we come to the next result.

Proposition 2. For any public sector procurement which is controlled by a corrupt politician, quality and price offered in equilibrium are strictly decreasing in the levels of corruption.

3.3. Comment

The intuition proposed regarding the findings of Proposition 1 carries over very simply to this proposition. It is clearly outlined that corruption reduces quality. What is interesting is that the offer price also gets reduced in the process, as we are considering honest vendors. The payoff to the politician in this case will be $\alpha p_s(\theta)$, which increases in the order of $\frac{\alpha}{1-\alpha}$, which is a superlinear function of α. So the payoff for the politician becomes quite attractive.

It has been mentioned before that α depends on the bargaining power of the politician and other cultural factors. It may be noted that α is given in this model. Also, note that from (5a), (5b) and (6) we get that for any given β, changes in α do not affect the equilibrium quality but affect the price quoted by firms. We state this in our next proposition.

Proposition 3. For any given level of corruption (β), increases in the politician's bargaining power (α) increase the price quoted by firms but do not affect the quality offered by them.

3.4. Comment

Proposition 3 identifies the real source of inflated prices in face of corruption in procurement. The final offer price gets inflated solely due to the side payment payable to the politician but the payoff accruing to the vendor is reduced as stated in Proposition 2.

Corruption often has two dimensions, one systematic (which is modelled through β here) and one idiosyncratic (represented by the individual bargaining power, α). Our results clearly delineate the contribution of each dimension to the resulting loss in efficiency, both in terms of quality deterioration (Proposition 2) and price inflation (Proposition 3). The relative contribution can be easily computed for specific examples in our setup.

4. Concluding remarks

In emerging economies, often key inputs in the major infrastructure sectors are not indigenously produced. These are imported from the industrialized, more developed economies; often through a procurement auction. Large public sector units (roads, power, ports etc.) typically commission such auctions. Even though the public sector units are chaired by technocrats/bureaucrats, the effective control is often in the hands of the elected political representative. In the face of the magnitude of such orders, corruption often follows. It is a moot question whether we should allow some extent of corruption while ensuring that opportunity for private benefits will expedite such procurement processes. Proposition 2 provides a partial answer to this question by presenting theoretical rationale behind the fact that such license leads to poor quality in the infrastructure thus procured. Proposition 3 shows that if the politician's bargaining power is very high (which may be due to sociopolitical factors) then it will invariably result in higher prices of infrastructure. Anecdotal evidences from India also suggest that in states where politicians are more corrupt (higher β) or are more adept in extorting money (higher α), the infrastructure (roads, railway stations) are of poorer quality and relatively higher expenses are incurred to finance them.

When quality is of paramount importance, particularly in terms of the safety and security of the citizens, due care must be taken to safeguard their interest. Moreover, since in emerging economies resources are scarce, effort must be made to bring down the cost of infrastructure. Our results provide a first step towards the formulation of such safety nets.

The way forward would be to explore appropriate adjustments to the procurement mechanism so that such distortion gets reduced. On a more technical front, it would also be interesting to explore the situation when quality is a multidimensional attribute.

Acknowledgements

An anonymous referee of this journal provided extremely helpful comments and this led to a significant improvement in the exposition. Comments from Prof. Arye L. Hillman, Editor-in Chief of this journal were very helpful when we were preparing the final version. A major part of the research was done when Krishnendu Ghosh Dastidar was a “Visiting Research Scholar” at ISER, Osaka University during 2013–2014. He is deeply indebted to ISER for the excellent support to his research.

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