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Procurement awarding mechanisms based on average price have been advocated to soften price competition and reduce cost overruns. We show that their theoretical support is shaky. When the bid closest to the average is awarded, firms submit identical bids, making the selection extremely costly and random, without reducing opportunistic behaviors ex-post. When instead the bid closest and below the average is awarded, the equilibrium is very sensitive to firms' production and participation costs. Either it displays tougher competition than in a first price auction, or it induces firms to randomize their bids. [JEL Classification: D44, H57]

1. - Introduction

Bid Average Methods (BAMs) award procurement contracts based on the average price submitted by competing suppliers at the tendering stage. In recent years, different countries have applied these mechanisms, mainly in construction industry, as an alternative to low-bid methods (where the awarding rule assigns a contract to the low-bid firm). The main reason why BAMs are becoming popular seems that, according to their advocates, they soften price competition, thereby reducing the likelihood of cost overrun and consequent costly renegotiation at the contract execution stage.

In this article, we provide a critical assessment of these methods. In Section 2, we describe a number of different forms BAMs have

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taken in practice. Broadly speaking, these can be viewed as (variants of) two main awarding rules: in the first, the bid closest to the average wins; in the second, the winning bid is the one closest and below the average. In Section 3, we compare BAMs with other more established methods, namely beauty contests and negotiations, which may prove more suitable if one needs to soften or suppress all together price competition. In fact, a higher awarding price may help — though at a very high cost — when cost overruns are only due to suppliers' inaccurate estimates of the cost of serving the contract or to the emergence of unforeseen contingencies. However, it need not reduce the incentives for an opportunistic contractor to claim cost overruns, and require a higher compensation, once the contract has been signed.

In Section 4, we analyze in detail the distortions in bidding behavior the various forms of BAMs observed in reality tend to produce. When the bid closest to the average is awarded, firms have incentive to coordinate on a collusive equilibrium: they submit identical bids, making the selection extremely costly and random. When instead the bid closest and below the average is awarded, firms' incentive to coordinate falls. Still, the auction may display collusive behaviors since existing cartels are easier to sustain than under a standard low-bid rule. Moreover, the resulting equilibrium is very sensitive to firms' production costs. If one firm has a large comparative advantage in terms of efficiency, it will be selected, but price competition will be harsher, not softer, than with a low-bid method. Otherwise, the equilibrium will involve randomization. This may make the outcome very hard to predict by the procurement agency.

In Section 5, we analyze the suppliers' decision to submit a bid in case participation is costly. First, we show that BAMs generally increase participation, by giving some chance of winning also to less efficient firms, but equilibrium prices increase with the number of firms submitting an offer. Second, we show that when the bid closest and below the average is awarded, the outcome becomes equivalent to a simpler and more standard low-bid competitive tendering. Section 6 concludes stressing that the popularity of BAMs remains mainly a puzzle for the procurement scholar.

2. - Bid Average Methods in Procurement: Examples and Justifications

2.1 *Examples*

A: Florida Department of Transportation (U.S.A.)

Florida Department of Transportation (FDOT) has adopted the bid average method. This method is considered the best solution when there is ample competition. Concretely, two main scenarios are distinguished. When three or four bidders participate, the bid closest to the average is selected. When five or more contractors bid, the low bid and the high bid are excluded, and the bid closest to the average of the remaining bids is selected. If there are irregularities in the bid, the bid is thrown out, and the next closest to the average is selected.

The method is advocated for *(i)* getting the contractor to bid a true and reasonable cost for a project, and *(ii)* minimizing claims and cost overruns. Until 2001, only four FDOT projects (mainly mowing contracts) had used this technique. According to FDOT the intent of having contractors bid a more realistic cost, thereby minimizing cost overruns, has borne results, as these contracts have only overrun by 4%. FDOT expressed the view that BAM bidding is preferable when a "low bid" is anticipated to be a significant problem. This situation is likely to arise when inexperienced or unsophisticated constructors bid on small maintenance projects.

B: State of New York (U.S.A.)

The Procurement Services Group of the State of New York Executive Department[1] has formulated an even more convoluted awarding criterion for buying asphalt. The method of award requires a five-step procedure:

[1] Tendering procedure issued on 10th November 2004 for commodity group 31501 - Liquid Bituminous Materials.

1. An "average price" is calculated based on the price of all bids submitted.

2. Any bid that exceeds the "average price" by more than 50% will be made Awarding Pending.

3. A "revised average price" is calculated after removal of those over 50%.

4. Any remaining bids that do not exceed the "revised average price" increased by 10% will receive a contract award.

5. Any contractor given an "Award Pending" may become eligible for award by reducing their price(s) within the parameters of point 4.

C: Italy

The Italian National Agency for Information Technology in the Public Administration (CNIPA) pursues a variety of institutional goals. Among other things, it sets the guidelines for designing, implementing and managing acquisitions of IT solutions for the Italian Public Administration. Among the set of awarding rules suggested in CNIPA (2006)'s guidelines there is one special variant of the bid average method. More specifically, suppose that the tendering process allocates at most N ($0 < N < 100$) points to an economic offer and ($100 - N$) to a technical offer. Consider firm i submitting an offer equal to p_i. Firm i's economic score is determined as follows: If $p_i < a * K$, then firm i gets all economic points (N); otherwise it gets

$$N * [p_{\max} - p_i] / [p_{\max} - a * K],$$

where $p_{\max}$ is the highest among all tenders, a is the average tender, and K is a "correction coefficient" between 0 and 1 (generally around .8 and .9).

Two features of the awarding rule are worth noticing. First, if tenders are not too concentrated and K is high enough, say .9, the CNIPA's variant of the bid award method allocates all economic points to the lowest submitted tender and to all others below the "corrected" average. Thus, it is possible that different firms submitting different offers are awarded the same number of economic points. Second, firms submitting tenders above the "corrected average" get a number of points, which decrease with the distance from the "corrected average."[2]

A second variant used in Italy, reported by Ioannou and Leu (1993), awards the contract to the firm submitting the tender closer to the average *among those below the average.*

D: Peru

Article 4.3.13 of the Peruvian regulations for bidding and contracting for public works states (translation by Henriod and Lantran (2000)):

"An award will be made in accordance with the following procedure:

1) When three or more bids have been received:

a) The average of all bids and the base budget will be calculated.

b) All bids that lie 10 percent above and below this average will be eliminated.

c) The average of the remaining bids and the base budget will then be calculated.

d) The contract will be awarded to the bidder whose bid is immediately below the second average (or, should none of the bids lie below the second average, the award will be made to the bid which more closely approximates the average.)[3]

2) If less than three bids are received, the bidding agency may cancel the process, and award the contract to the lowest bidder or to the only bidder if this were the case.

[2] The variant suggested by Cnipa (2006) is equivalent to a linear scoring rule with an endogenously determined threshold. For more on scoring rules see Chapter 12 in Dimitri N. - Piga G. - Spagnolo G. (eds.) (2006).

[3] We put this in parenthesis because there must have been a mistake in the translation, unless a very novel concept of average has been developed such that the average may be smaller than all its components.

2.2 *Research Discussing their Properties*

While it sounds intuitive that BAMs may soften price competition, little effort has been devoted so far to explore how firms respond to a rule rewarding the bidder with the most accurate guess of the average bid. To the best of our knowledge, a formal model of the bid average method has been studied only by Ioannou and Leu (1993). The authors consider a model in which *N* firms submit sealed bids for a contract. Production costs are assumed to be private information, and each firm's bidding function is equal to its cost plus a mark-up. In "standard" auction theory, it is customary to make certain assumptions on the distribution of private costs. In the Independent Private Value model[4], for instance, private costs are modeled as independent and identically distributed random variables. If a symmetric equilibrium is to be characterized, it is normally assumed that bidders 2 to *N* follow a strictly monotonic (and differentiable) bidding function. Then one looks at the necessary conditions that the bidding function must satisfy in order it to be bidder 1's *best response*. Ioannou and Leu (1993) adopt quite a different approach. They consider firms' bid-to-cost ratios as the relevant random variables and compute the probability that a specific firm bid is the closest to the average. However, this is done by making no assumptions on the shape of other firms' bidding functions. The authors instead perform a Montecarlo simulation and show that firms' expected payoffs are always higher under the bid average method than under the low-bid method.

Bid average methods are also mentioned by Liu *et* al. (2000) and discussed by Henriod and Lantran (2000) and Engel and Wambach (2004). These last authors argue that the same specification of the bid average method studied by Ioannou ad Leu (1993) pushes all firms to choose the highest possible price even when production costs are private information. Thus, firms coordinate on a focal point, which leads to a random allocation of the contract. To be sure, Ioannou and Leu (1993) also recognize

[4] See KLEMPERER P. (2004).

that the bid average method has a collusive drawback. However, their argument differs from the one made by Engel and Wambach (2004), which is further developed in the current paper. Ioannou and Leu (1993) point out that some firms may have an incentive to create dummy bidders that submit identical offers to their affiliated firms. Thus dummy companies and the affiliated firms pull the average towards their own price. If the dummy variable wins the contract, it simply passes the entire project to the affiliated contractor.

3. - Why Average Price Auctions? Alternative Allocations Mechanisms

The brief survey conducted in the previous section highlights that the practice of BAMs aims mainly at softening price competition in procurement tendering processes. However, it may appear contradictory to use a competitive awarding procedure that hinges on price, coupled with an awarding rule that is meant to limit price competition. If the latter turns out to be the procurer's main concern, one could argue for other allocation mechanisms that, in most cases, do not involve any price competition at all. In what follows, we consider two alternative and established allocation mechanisms that more directly reduce price competition: beauty contest and negotiations.

3.1 *Beauty Contests*

A "beauty contest" (or comparative tender) is an allocation/selection mechanism that specifies a number of criteria according to which firms' projects are evaluated. The contractor is the firm whose project shows the best "mix" of dimensions. At a first sight, a beauty contest is not very different from a procurement tendering process with multiple criteria whereby firms' offers contain both a technical and an economic component that are evaluated according to a scoring rule. However, there are two fundamental differences between a beauty contest and a competitive tendering procedure. In the former: *i)* the rule according to which different offers are evaluated is stated in much more generic terms, leaving more discretion to the buyer in evaluating qualitative aspects that are hard to codify in a formalized way, and in refusing suspicious or unrealistic bids; and *ii)* "prices" are not a crucial aspect, while they are paramount in the latter.

3.2 *Negotiations*

An even more effective alternative, often adopted in private procurement when the good or service procured is not standardized but customized to the buyer specific needs, is that of selecting one (or very few) reputable supplier(s), known to be able to meet the demand, and to negotiate sale conditions only with him (them). In this way, competition is under direct, full control. Negotiations are also used in public procurement, particularly for complex products or services that are hard to specify contractually, and where quality has complete priority over price concerns.[5]

3.3 *Comment*

As average price auctions, these alternative allocation mechanisms soften or suppress price competition, hence leaving a larger margin to the supplier. This reduces (though does not eliminate) the likelihood of cost overrun and renegotiation, to the extent that these are linked either to suppliers' mistakes in the ex-ante estimation of their cost, or to unforeseen contingencies

[5] For example, NASA, and its Italian counterpart ASI, have extremely detailed and effective methodologies to guide first the preliminary supplier selection process, based on direct inspection of potential suppliers production methods and capabilities; and then structured bilateral negotiations on the characteristics of the required good or service and on its price.

occurring after the project has started.[6] In addition, these are generally better than average price auctions, which, as described in the next section, may induce very problematic bidding behaviors.

While a procurement agency may try to insure against post-contractual problems by limiting price competition, it is important to consider the serious drawbacks induced by this strategy. First, and most obviously, all these methods may be extremely costly in terms prices to be paid to the winning firm. For example, as seen in the next section, in the standard average price auction the agency might end up paying its reservation price. Second, there exist alternative methods to directly purchase insurance that are generally more effective and less costly. For example, the agency can pay a specialized surety company to bear the risk of a non-performing winning firm. This is done by issuing a bond, specifying the amount to be paid to the agency in case the contractor defaults and the surety company does not resume the contract (see Ch. 13 in Dimitri, Piga and Spagnolo (eds., 2006). Third, it is not even clear that, higher prices help reducing cost overruns and hold-up problems. Indeed, standard economic theory identifies moral hazard as a major source of these issues, and in this respect the awarding prize, being sunk, is simply irrelevant. In other words, absent reputation or fairness concerns, high awarding price does not reduce a firm ability to behave opportunistically once the contract has been signed.

Hence, the last problem is contractual, and not linked to the awarding method. It should then be resolved by choosing the appropriate contracting strategy. In particular, if lock-in and unforeseen contingencies are important, then fix-price contracts are generally not advisable. In construction industry, for instance, the most common sources of changes in building construction are defective plans and specifications, and differing conditions than expected at the construction site. Thus, the initial contract

[6] In the construction of a new tunnel, for instance, excavation may be delayed, and even stopped, by the discovery of a particularly resistant rock that needs specific drilling machine.

suffers from some form of incompleteness which often leads to contentious adversarial negotiations. These are likely to arise whenever the initial contract is awarded by using a fixed-price competitive tendering, while if the contract has a cost-plus (or cost-reimbursement) nature, changes to the original specifications can be almost automatically included. In fact, by adopting a cost-plus contract (CPC) the buyer agrees to reimburse all (documented) production costs related to the project. Moreover, as argued in Bajari and Tadelis (2006), the buyer should not use a competitive tendering procedure to award such a contract, since this procedure may fail to choose the most efficient supplier. Whenever possible, the agency should instead search among the most reputable firms and choose one to negotiate with and agree on the terms of the CPC.

4. - The Drawbacks of Bid Average Methods

4.1 *Pro-Collusive Aspects of the Florida Type*

Three firms compete for procuring a service. Each firm $i = 1, 2, 3$ bears a cost c_i for procuring the service. For illustration, assume that competitors know each other's efficiency levels, since for example they have been interacting in the market for quite a while.[7] However, the procurement agency cannot distinguish low-cost from high-cost suppliers. Without loss of generality, we assume that

$$c_3 > c_2 > c_1,$$

that is, firm 1 is the most efficient firm whereas firm 3 is the least efficient. The procurement agency publicly announces a reserve price $r > c_3$ which represents the highest price at which it is willing to buy the service. Firms submit sealed-bid offers (p_1, p_2, p_3). The

[7] Moreover, each of them knows that all others know his efficiency and so on. Formally, we are assuming that production costs are "common knowledge" among the competing firms.

winner is the firm whose bid is closest to the average of all admissible bids. Thus firm i's payoff writes

$$\Pi_i(p_i, a) = \begin{cases} p_i - c_i \ \text{ if} \left|p_i - a\right| < \left|p_j - a\right|, \forall j \neq i, \\ \qquad 0, \text{otherwise} \end{cases}$$

where a is the average of all tenders, that is, $(p_1 + p_2 + p_3)/3$. Moreover, we also assume that ties are broken by using a random device that assigns equal probability to each winning offer. Notice that ties can only arise when all firms submit the same price.

The bid average method provide firms with an incentive to submit exactly the same tenders. This can be easily seen by using the following line of reasoning. Suppose that firm 1 were to believe that firms 2 and 3 are willing to submit $c_3 < p_2 = p_3 = p < r$. Does firm 1 have an incentive to submit any p_1 different than p? Notice first that if $p_1 = p$, the average $a = p$ and firm 1's payoff is $(p - c_1)/3 > 0$. Suppose, instead, that firm 1 deviates by submitting $p_1 < p$.[8] The new average is $a_1 = (1/3)\ p_1 + (2/3)\ p$. Clearly, the value p has a higher weight in the average than p_1. Thus, p is closer to the new average than p_1, which implies that firm 1 gets a payoff equal to zero.

To sum up, if any of the three firms believes that the other two competitors are willing to submit the same tender (higher than the reserve price), the remaining firm finds it profitable to submit exactly the same tender as well.[9] The resulting outcome is that the three firms will end up submitting the same tenders and the winner will selected by a random device. Our analysis suggests two main conclusions:

— The first variant of Bid-Average Method provides a clear incentive to firms to find a "focal point". This is arguably collusive, since the higher the focal point the higher firms' profit.

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[8] This is without loss of generality. The same line of reasoning would hold with $p_1 > p$.

[9] More formally, any profile of tenders $p_1 = p_2 = p_3 = p < r$ constitutes a Nash equilibrium (in pure strategies) of the Bid-Average tendering game.

— The allocation of the contract may be inefficient since the probability that the low-cost firm is awarded the contract is 1/3.

It can also be proven that firms do not have an incentive to submit different tenders provided that they are all lower than the reserve price, but higher than the highest production cost (c_3).

4.2 *Additional Pro-Collusive Aspects of the NYS Type (Coalition Proofness)*

When firms manage to coordinate on the same bid, the variant used by the State of New York described in Section 2.1 induces the same outcome as the one generated by the BAM in Florida. To see this, suppose that the three competing firms submit the same $p \leq r$. Since the average will be exactly p, no firm will be ever given an Award Pending. Thus, there is no need to compute a "corrected average." Being all identical, bids will not exceed the average by 10%, so all firms will receive a contract award.[10]

A closer look reveals two subtler aspects of the variant used by the State of New York. First, it makes coordination feasible even when some firms accidentally do not submit the "right" bid. To see this, consider a very simple numerical example. Suppose that 10 firms try to coordinate on a price for the contract of USD 90k. Upon submitting their offers, one firm, say firm 1, "accidentally" bids USD 150k. The resulting average is then 96k, and firm 1 is given an Award Pending. The corrected average is 90k and firms 2 to 10 are given a contract award. However, firm 1 can still correct its mistake and submit the "right" bid (90k) thus obtaining a contract award as well.

The second aspect of the variant used by the State of New York concerns a pro-collusive mechanism, which is built in the awarding rule. Suppose that all potential competitors, say 10 firms, form a cartel and coordinate to submit the highest possible price, that is, the reserve price. Under the variant used by FDOT it is possible that some of the firms in the cartel, say five out of

[10] That is, if the State of NY is buying USD 10M of asphalt, each contractor gets 1/3 of the contract. This is equivalent ex ante to getting the whole contract with probability 1/3 according to the variant used by FDOT.

ten firms, agree to make a joint deviation by submitting a lower price. Such a deviation would consist in submitting an offer that makes the five defecting firms the sole winners. Thus, the variant of FDOT may induce coordination; it cannot prevent "joint deviations" or deviations made by sub-coalitions. Under the variant used by the State of New York, instead, if the joint deviation is such that the non-deviating firms are left above 50% of the average, they are still given an Award Pending and have still a chance of modifying their bids to react to deviating firms' offer. Thus, deviations by sub-coalitions are less profitable than under the FDOT variant.

4.3 *Instability and Collusion in the BAMs Used in Italy*

The two variants of the BAM used in Italy destroy firms' incentive to coordinate on the same price. In the variant suggested by CNIPA, this is immediately seen since all firms get a number of economic points equal to zero if they submit exactly the same price. In the second variant, whereby the winning firm is the one submitting the tender closest to the average *among those below the average*, we can also show that it is not in the firms' interest to submit the same offer.

To see this last point, assume first that when firms submit the same offers — so no bid is below the average — each firm is awarded the contract with equal probability. Consider the same three-firm environment studied in Section 4.1. Suppose again that firms 2 and 3 submit the same tender $p > r$. If $p_1 = p$ then firm 1's payoff is $(p - c_1)/3$. However, firm 1 can raise its payoff by submitting an offer just below p, say p_1'. The resulting new average would lie in the interval (p_1', p), and firm 1's offer would be the unique offer below the average. If p_1' is lower than, but sufficiently close to p (say p – 1cent), firm 1's deviation yields a payoff $(p_1' - c_1) > (p - c_1)/3$.

While not providing an incentive to coordinate on a focal point, this variant still makes deviations from an existing collusive agreement more costly than, say, the low-bid awarding method.

Consider a procurement contract for supplying a number of identical laptops, with a reserve price of €1,000 each. Suppose, for the sake of simplicity, that competition takes place on the price of the laptop only, so there are no technical points related to the various quality dimensions. $N > 2$ firms participate in the competitive procurement and adopt a simple collusive mechanism: firm "1" wins the contract by submitting an offer of €999/laptop while all other (N–1) firms bid the reserve price.[11] Surplus is then shared. If the low-bid awarding rule is adopted, non-winning bidders can break the cartel by just offering €998. The cost of breaking the cartel is the same for all: by reducing the price by €1/laptop, any bidder is effectively able to break the agreement and win the contract.

Consider now the variant of the BAM whereby that awards the contract to the supplier whose bid is closest to the average, *but* below the average. Again, the cartel selects bidder 1 to win by submitting €999. The remaining N–1 bidders bid the reserve price. What is the amount a deviating bidder should submit in order to win the contract? How much does the deviation cost to him? Notice first that bidder 1 is indeed the winner since €999 is the only bid below the average, where the latter is equal to (1/N)€999 +[(N–1)/N]€1000. To win the competitive procurement a defecting bidder, say bidder 2, needs to place a bid such that all other bids remain above the average. It is easy to see that €998 is not low enough as under linear and lowest-bid scoring. To see this more clearly, consider the situation where N=5. Should bidder 2 submit €998 the average would be (998+999+3(1000))/5= 999.4. With such an average, bidder 1 is still the winner. As a result, €998 is not sufficient for bidder 2 to win the competitive procurement. In order to be the winner, bidder 2 needs to bring the average below €999. Then he needs to bid a price b_{def} such that (b_{def}+999+3(1000))/5 ≤ 999, which implies b_{def} ≤ €996. More generally, when the number of colluding firms is N, then b_{def} ≤ (N–1)€999 – (N–2)€1000.

[11] We assume in this example that prices have to be formulated as multiples of 1€.

The most interesting remark, though, is that the equilibrium outcome, i.e. the winning firm and offer, becomes very sensitive to the distribution of costs among the bidders. This is of course problematic since costs are typically unknown to the procurement agency, which will then face high uncertainty and instability. In fact, two competitive scenarios with slightly different distributions of costs may lead to extremely different outcomes. In particular, if the most efficient firm can supply at much lower costs than its competitors, it will win by offering an even *lower* bid than in the case of low-bid competitive tendering. If it cannot afford such a low bid, firms are induced to bid in a "strange" (and sometimes unpredictable) way. More precisely, in this case firms' optimal strategy would involve some randomization. Rather than a single offer, each firm would submit a probability distribution over a number of offers, i.e. firms will submit the offer p_i^1 with probability $q_i^1 < 1$, the offer p_i^2 with probability $q_i^2 < 1$, and so on.

We can see this argument in more details, considering again the environment described in Section 4.1. First, suppose that firm 1 has strong efficiency advantages with respect to the competitors. That is, let for now

$$c_1 < 2c_2 - c_3$$

In this case, an equilibrium requires firm 1 to win by submitting an offer $p_1 = 2c_2 - c_3$. In fact, suppose $p_2 = c_2$ and $p_3 = c_3$. The average bid is c_2 and firm 1 wins, while firm 2 and 3 cannot lower their bids any further.[12] In this case, the method is able to award the most efficient firm, but it is exacerbating, rather than limiting, price competition. In fact, firm 1 is bidding below the price needed to win a low-bid competitive tendering ($2c_2 - c_3 < c_2$).

Suppose instead $c_1 > 2c_2 - c_3$. The previous strategies are no

[12] Since firms 2 and 3 are getting zero profit, they could deviate at no cost; hence, the equilibrium is not robust. Suppose for example firm 3 submits $p_3 = r$. Now our condition becomes stricter: firm 1 will have to bid $2c_2 - r$ in order to win. Firm 3 bid is part of the equilibrium if its offer will always be above the average, even if it bids its production cost.

longer feasible, since firm 1 will not bid below its marginal cost. Instead, we argue that a strategy profile in which all firms submit a single offer with probability one cannot be part of an equilibrium. We can easily show this by contradiction. Suppose that firms submit (p_1, p_2, p_3) with probability one. Without loss of generality, consider the following strategy profile

$$c_1 < p_1 < p_2 < p_3 < r.$$

Two relevant scenarios may arise. If $p_2 < a$, firm 2 is the winner, so firm 1 has an incentive to profitably deviate by bidding marginally higher than p_2. Firms will start increasing their bids, but we know that $p_1 = p_2 = p_3 = r$ cannot be an equilibrium since all firm will then have an incentive to undercut their competitors. If instead $p_2 > a$, firm 1 is the winner, so firm 2 has an incentive to profitably deviate by reducing its bid to a level marginally higher than p_1. Firms will decrease their bids up to their marginal costs, where, given that $c_1 > 2c_2 - c_3$, the average bid exceeds $p_2 = c_2$, and we are back to the previous scenario.[13] Hence, there exists no equilibrium such that the three firms submit a single offer with certainty.

We can draw two main conclusions. First, this particular variant destroys firms' incentive to coordinate on a focal point generated by other BAMs, so the tendering procedure may have a pro-competitive effect. Nonetheless, it cannot be considered fully competitive, since collusive agreements are easier to sustain than in the case of a low-bid rule. Second, the equilibrium behaviour either requires the most efficient firm to submit a very low bid (hence intensifying rather than softening price competition) or it involves randomization (hence producing an unpredictable outcome from the procurement agency's viewpoint as well). In essence, similar competitive scenarios may generate very different awarding prices.

[13] Note that the same argument applies to the cases where either $p_1 = p_2 < p_3$ or $p_1 < p_2 = p_3$.

5. - In Further Research of a Rationale: BAMs and Costly Participation

The discussion so far has assumed that each firm, even when expecting to make zero profit, was submitting a bid. Moreover, all offers were important for the description of the equilibrium, since in BAMs the winning bid depends on all other submitted bids. We can now relax this assumption, leaving each firm the possibility to decide whether or not to participate in the competitive tendering. To make the discussion interesting, we consider the case where participation is costly. When submitting a bid, each firm has to pay some $\varepsilon>0$, which can be thought as an entry fee or, more generally, as the cost to be spent in order to acquire information about the auction and to decide the bidding strategy in a sensible way. Given this ε, it is clear that no firm will participate if it expects zero profit in equilibrium, i.e. if it will have to bid at its marginal cost or if it has zero probability of getting the prize. This simple observation changes somewhat the results in the previous sections, as we now describe in more details.

Consider first the method where the winner is simply the bidder closest to the average. As discussed in Section 4.1 firms will submit the same offer, somewhere between the highest production cost and the reserve price. These are still equilibria in a game with costly participation, if ε is low enough, but we now have an even larger set of possible outcomes. In fact, suppose there are n potential competitors, ordered in term of efficiency:

$$r > c_n > c_{n-1} > \dots > c_2 > c_1$$

One can show that there exists an equilibrium where only the first k most efficient firms enter and bid c_{k+1}. For example, one can have that firm 1, 2 and 3 enter and bid c_4. Given this, no other firm is willing to enter, since in order to win, it will have to bid c_4, which never exceeds its production cost. The average bid will then be c_4 and, for the same reason explained in Section 4.1, no participating firm has incentive to deviate. Whether this more efficient equilibrium or some other will actually take place is something one cannot say a priori. This depends on how firms manage to coordinate, which incentives they have to do so, hence in particular on the distribution of production costs and reservation price.[14]

Notice however that in any equilibrium at least three firms will submit a bid.[15] Hence, BAMs generally increase participation, by giving some chance of winning also to the less efficient firms. Moreover, having a large number of competing firms now is not good news for the procurement agency: the higher the participation the higher will be equilibrium prices, i.e. the further we will move from the most efficient outcome.

Despite affecting participation and the set of possible outcomes, costly entry does not change the essential feature described above: simple average method pushes towards homogeneity of bids, thereby strongly limiting (or destroying) the ability to screen and opening up to the possibility to extremely costly collusive behaviours.

Now consider the variants of BAMs used in Italy. In this case, a small entry cost makes a great difference, revealing once again the instability of this method. In fact, the "strange" outcomes described in Section 4.3 disappear: irrespective of the strength of its efficiency advantage, firm 1 will win the auction by bidding (slightly below) c_2. Given firms' incentives to bid slightly below the average, bids will keep decreasing and the most inefficient firms will then prefer not to participate (and not waste the ε). In equilibrium, only firm 1 will bid and will make an offer exactly sufficient to keep all the other firms, and in particular firm 2, out of the competition. Hence, we get the very same outcome of a low-bid competitive tendering. At this point, it is not clear why one should use a method producing the same outcome as the most standard tendering format. After all, awarding rules should aim

[14] These determine for example whether firms 1,2,3 prefer getting 1/3 of a smaller prize (c_4) rather than increasing the prize (up to r) but then having to share it with a larger pool of participants.

[15] If only firm 1 and 2 are participating, they both have the incentive to increase their bid. This would not change their chance of winning (1/2) but it would increase the size of the prize. By bidding higher than c_3, however, they will attract firm 3 into the competition.

at simplicity, which is a way to improve transparency and reduce costly litigations; hence, this variant of BAMs cannot be defended because of equivalence with low-bids methods.

6. - Conclusion

We have reviewed the increasingly popular Bid Average Methods and their strategic implications, which have proven often in contradiction with what claimed by their advocates. The major reason behind the adoption of BAMs is that they are supposed to soften price competition, push competing firms to coordinate on a "true and reasonable" bidding price, and hence reduce *ex-post* transaction costs linked to delay and wasteful renegotiations following cost overrun. We have argued that there are no theoretical arguments to support these claims. If anything, standard economic analysis would instead predict that firms will coordinate to bid on the highest admissible price. We have also shown that a variant of BAMs, where the winner is the one closest and below the average, may be very sensitive to the specific features of the strategic environment (distribution of production costs, participation costs...) hence generally quite unpredictable from the procurement agency viewpoint. At best, its outcome can be replicated by a simple low-bid tendering format.

More generally, the awarding price affects ex-post cost overrun and renegotiation problems only if they are linked to innocent mistakes and exogenous shocks, and not at all when these originate from opportunistic behaviour of suppliers. In any case, these are better handled through cost-plus-contracts, surety bonds, or alternative awarding methods described in Section 3.

A possible line of defence of BAMs may still be that there are situations where none of the proposed alternatives is viable. For example, given public procurement regulation to enhance accountability and prevent corruption, one may need to insure against "excessive" price competition while not being able to: identify the most suitable contractor and privately negotiate with it; rely on any surety firm; evaluate discretionally the qualitative aspects of the offer... Hence, in a sense, despite giving up most of the benefits of competition (and in particular failing to select the most efficient firm and pay the lowest price) BAMs would represent a "compromise" between a number of conflicting requirements and constraints. It is clear however that, even accepting this line of reasoning, one cannot advocate any general role for these methods, being they dependent on a particular situation, where many conditions need to be satisfied simultaneously.

In conclusion, our analysis has not revealed any convincing and general way to rationalize the fundamental tension inherent to BAMs, which soften price competition while at the same time using a competitive awarding rule. For these reasons, BMAs remain largely a puzzle, which calls for further attention by scholars and scrutiny by practitioners.

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