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Information and Competitive Tendering

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Information and Competitive Tendering*

G. L. Albano, N. Dimitri, R. Pacini and G. Spagnolo

Abstract

This Paper investigates how a buyer's optimal choice between sealed-bid tendering and dynamic auctions is influenced by the degree of uncertainty and the importance of different types of costs suppliers expect to face when undertaking the procurement contract. These costs are typically partly *private*, firm-specific (link to intrinsic efficiency factors), and partly *common* to all sellers (e.g., those linked to demand uncertainty). Dynamic procurement auctions may reduce uncertainty on common supply costs, improving sellers' precision in bidding and the procurement outcome. Dynamic auctions however have drawbacks, including being more exposed to the danger of collusive agreements among bidders, and the optimal choice of the tendering procedure depends on the relative importance of these advantages and disadvantages in each industry. Dynamic auctions may also induce a lengthy bidding process, which may sometimes be problematic. This Paper also discusses the pros and the cons of the different strategies (variants of standard dynamic auctions) available to keep duration under control, when this is a concern for the buyer

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Jel classification: H57, D44, D81.

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1 INTRODUCTION

Procurement contracts attract suppliers for a variety of reasons. New, emerging firms may attempt at establishing a toehold in the market by acquiring a share of a sizeable procurement contract, large incumbents have to defend their privileged position in supplying, say, central public authorities, financially distressed firms may consider a procurement contract their last chance of resurrection. Different goals generate, in general, different criteria for evaluating the expected benefits from participation. However, suppliers find themselves in a more similar position when selecting the relevant information for estimating the cost of undertaking a procurement contract.

It would be optimal for a procurer wishing to buy a sufficiently standardized, and contractually well specifiable, good or service to elicit competition among potential suppliers. There are, however, many mechanisms she could use to elicit such competition. This Paper discusses and provides practical indications on how to choose between a sealed-bid tendering and a dynamic auction to allocate procurement contracts between competing suppliers. It then suggests simple strategies to keep under control the duration of dynamic procurement auctions, when this is a concern for the procurer.

A crucial factor to consider, in the optimal choice of a tendering format, is the degree of uncertainty present and the size of different types of costs the selected supplier will face serving the contract; therefore we begin with an example of such uncertain costs.

Consider a procurement for cleaning services of a large company's or public administration's buildings. The contract may specify a variety of services including the cleaning of offices, corridors, halls, and more demanding tasks such as the sanitation of laboratories. The contract also establishes that the contractor(s) will be paid a fixed amount of money per unit of surface (€/m^2)[1] regardless of the nature of the building. Therefore the unit price coincides across categories of surface, whereas the cost of performing the same task in different environment may vary substantially. The sanitation of a laboratory, for example, is presumably more time consuming and requires more expertise than cleaning an office furnished only with a desk and few bookshelves.

Upon estimating the cost of performing the contract in order to place a bid for it, each supplier has to consider at least two different dimensions. The first dimension concerns the supplier's efficiency in performing each single task specified in the contract. Efficiency results from the interaction of the personnel's experience in similar tasks, managerial skills, and the quality of the cleaning equipment. Thus the supplier's efficiency captures a *private* component in its production cost. It is private in that it is entirely firm specific. The second dimension concerns the supplier's ability to correctly estimate the mix of different tasks in the contract: cleaning few, large buildings with administrative offices requires a different combination of material and human resources than sanitizing a large number of small laboratories. If suppliers are not completely informed about the composition of the demand for cleaning services at time of bidding for the contract, they face a *common* uncertainty.

Uncertainty about the common component of the cost of serving a contract matters since the contractor may find out that the "true" cost of performing the contract differs from his initial estimate. This may happen if the contractor had submitted a bid on the basis of too an optimistic forecast of the common component. More generally, if a supplier does not take this possibility into account at the time of bidding for the contract, he may suffer from the "Winner's Curse", that is he may realize that actual production costs are higher than estimated ones. On the one hand, the danger of running losses ex-post may induce suppliers to bid too cautiously for the contract, which implies potentially high awarding prices for the buyer. On the other hand, the suppliers' inability to recognize the Winner's Curse may generate a too aggressive bidding that results in low awarding prices for the buyer, but may induce the contractor to cut productions costs by lowering the quality of the performance.

In this paper, we explain how the buyer can profit by inducing some "information production" when uncertainty about the common component of the cost of serving a contract is relevant and when suppliers' pieces of private information about the common component are linked. The simple, information-producing device is a dynamic auction format (Section 3). A dynamic auction format, be it increasing in discounts or decreasing in prices, allows each bidder to observe the identities of active competitors at different prices[2] and, more importantly, the prices at which competitors quit the competition. Exiting times provide information about cost estimates of those bidders quitting the auction thus helping remaining bidders revise their own estimates.

When the nature of uncertainty concerns almost exclusively the private component of production costs, suppliers elaborate their bidding strategies on the basis of their private information only. Learning being not an issue, the buyer can then adopt a sealed-bid format that requires lower human and financial resources, is less exposed to the risk that suppliers collude, and whose duration is perfectly determined (Section 2). Auction length may become indeed a crucial issue in a dynamic format when bidders increase discounts (or lower prices) very slowly. In Section 4, we will investigate how the buyer can streamline a dynamic auction without losing the benefits of information production.

2 PRIVATE AND COMMON DIMENSIONS IN THE COST FUNCTION

Several factors affect the cost of performing a procurement contract. Some of them are entirely firm-specific while some others are common to all participating firms. A contract for supplying schools with heating oil involves different distribution costs depending on the distance between any single school and the location where a contractor stocks its oil reserves. Consequently, distribution costs are entirely firm specific. At the same time, when suppliers bid for the contract they are unable to predict the evolution of wholesale price for heating oil throughout the duration of the contract. Such an uncertainty is common in that it affects all suppliers.

One simple way of capturing the private and common dimensions in the suppliers' costs is by using the following general relation

Cost = C(Private, Common),

The relationship makes it clear that, in general, both components affect production costs, although the design of a procurement competitive tendering sometimes requires the buyer to establish which dimension is the more relevant, as we will see in the next two sections.

2.1 The Private Cost Component

We consider again the contract for cleaning services, briefly discussed in the Introduction, and further develop it in order to illustrate how the private component in the suppliers' production costs may affect their bidding for the contract. The contract for cleaning services comprises two main space categories; A) offices and corridors and B) laboratories. Table 1 summarizes the estimated costs per squared meter for PROPER Ltd (PROPER henceforth), one of the competing suppliers. The table also indicates the exact size of surfaces to be cleaned for both category A and B.

Thus we consider the simplest bidding environment where each supplier perfectly knows the composition of the final demand for cleaning services. Hence PROPER's bid for the contract will depend only upon his (private) efficiency component and, arguably, upon its conjectures on other competitors' efficiency levels. The cleaning contract for the two types of surface is awarded through a single-lot tendering process, with a reserve price of *70€/m*^{2}, so that any bid above this level is rejected.

Table 1

	A	**B**
Reserve Price	*70*	
Private Value Component. **Estimated Cleaning Costs: (€/square meter)**	*40*	*80*
Common Value Component with no uncertainty. **Surface to be cleaned: (square meters)**	*30000*	*10000*

PROPER's cost for performing the contract is simply a weighted average of the two unit costs, where the weights reflect the fraction of each type of space in the contract,

$$\textit{Unit Cost} = (40€ \times 30000 + 80€ \times 10000) / 40000 = 50\ €/m^2$$

PROPER can safely submit prices between *50€* and *70€*, without losing money; the exact bid will depend on its conjectures about other competitors' bids. For instance, if PROPER faces a group of rivals with large market shares and with an established reputation of high expertise in the business then it may anticipate intense competition for the contract. This would probably induce PROPER to bid closer to 50€ than to 70€.

2.2 The Common Cost Component and the Winner's Curse

PROPER's bidding strategy becomes more complex when uncertainty affects the common component of production costs. The simplest way of illustrating this point in our example is to introduce some uncertainty about the composition of the final demand. Table 2 illustrates the situation in which both demand for type-A and type-B of surface are unknown to PROPER and to all other firms. Imprecise information about the composition of final demand generally arises when the procurer awards "frame contracts". In this case, a contract may specifies minimal and maximal quantities that public administrations can purchase. However, it is not known at the time of the competitive tendering whether and which particular administrations will make use of the frame contract. Hence, the composition of demand in terms of types of surfaces is not known to suppliers at the bidding stage.

Table 2

	A	**B**
Reserve Price	**70**	
Private Value Component. **<u>Estimated Cleaning Costs: (€/square meter)</u>**	*40*	*80*
True Demand for cleaning services. **<u>Surface to be cleaned: (square meters)</u>**	*30000*	*10000*
Estimated Common Value Component		

Surface to be cleaned: (square meters)	*32000*	*2000*

Suppliers may gather information about both types of surfaces by inspecting a sample of buildings. In fact, PROPER has inspected a sample of five buildings and recorded the surface occupied by offices, corridors and laboratories in each site. Table 2a reports the results of the inspection.

Table 2a
Sample Observations

First Building	Second Building	Third Building	Fourth Building	Fifth Building	Sample Average SA	Estimated Number of Buildings to Clean NB	Estimated Surface SA*NB
1000	*2200*	*1600*	*500*	*2700*	*1600*	*20*	*32000*
80	*120*	*100*	*140*	*60*	*100*	*20*	*2000*

Table 2a says that PROPER observed *1000*, *2200*, *1600*, *500*, *2700* squared meters of type A of surface, so the resulting sample average is $1600m^2$; it also observed *80*, *120*, *100*, *140*, *60* squared meters of type B of surface with a resulting sample average of $100m^2$. Moreover, data concerning a previously awarded contract and other similar contracts induce PROPER to believe that the contract will cover *20* buildings. Multiplying the sample average by the estimated number of buildings to be cleaned, PROPER estimates a surface of *32000* squared meters for type A and *2000* squared meters for type B. If PROPER were to predict the unit cost by using *only* the sample observations it would derive a unit cost equal to

$$(40 \times 32000 + 80 \times 2000) / 34000 = 43.52 \text{ €/(squared meter)}$$

Sample observations induce PROPER to overestimate the task requiring the lower unit cost, but to underestimate the task with the higher unit cost. As a result, submitting unit prices between *43.52* and *50* will make PROPER to lose money. The sample observation is to be interpreted as favourable information on the contract which can induce aggressive bidding, namely submitting offers below the price level at which PROPER's *actual* costs are equal to revenues.

In general, different suppliers may have different pieces of information concerning the composition of the demand which is easily explained by different samples of inspected buildings, but also by past experience concerning similar contracts. PROPER, for instance, belongs to the set of suppliers with almost no experience in similar contracts, while, say, CLEANFAST Ltd (CLEANFAST henceforth) has a long history of participation in procurement contracts for cleaning services and is able to reasonably predict the range of type-A and type-B surfaces to be cleaned.

If suppliers are similar in terms of intrinsic efficiency[3], the winner is likely to be the one with the most favourable information on the contract, that is, the firm that most likely underestimates the impact of the high-cost task and overestimates the impact of the low-cost one. Why? Let us reconstruct the possible thought process adopted by PROPER. Suppose the latter were firmly convinced that all competitors, including himself, follow a very simple bidding strategy: the submitted bid is equal to the estimated cost, based on all available information ex-ante, plus a constant mark-up, identical across all suppliers. This is only a heuristic bidding strategy, plausible in some respect, but without any ambition to illustrate an “optimal” criterion. In general, some estimates of the “true” cost for cleaning the different types of surfaces will be higher while some others will be lower than the “true” cost. Given the heuristic bidding strategy just described, the contractor will be precisely the supplier who held the most optimistic estimate of the “true” cost. Hence, it is possible that the contractor's winning bid (that is, his initial cost estimate plus a fixed mark-up) does not cover the “true” cost of performing the contract.

To sum up, if a supplier ignores the possibility of holding a too optimistic piece of information about the composition of demand, he may end up suffering from the Winner's Curse as being awarded the contract eventually generates losses. This phenomenon was originally noticed in tendering competitions for the sales of oil drilling rights[4] where winners paid sums that turned out to be higher than their revenues from oil sales. How could a supplier avoid falling victim of the Winner's Curse? The intuitive answer is to bid cautiously! More precisely, it should modify the size of the mark-up to cover the additional cost that arises when he learns that he has been awarded the contract and, thus, that the “true” cost is somewhat higher than his initial estimate. More succinctly, an accurate bidding strategy requires each supplier to anticipate the news of “winning” and to adjust his bid upwardly.

From the buyer’s point of view the Winner’s Curse may then generate two kinds of problems.

i) *Underbidding:* If participants are aware of the Winner’s Curse and afraid of ending up suffering losses, they may adopt a too cautious bidding strategy which, in turn, generates high awarding prices.

ii) *Overbidding:* If participants are unaware of the Winner’s Curse, they elaborate their bidding strategy on the basis of their cost estimate only. Hence they may end up bidding too aggressively, thus submitting too low prices. Although this may benefit the buyer in terms of low awarding prices, it may also deteriorate the contractor’s financial stability and induce the latter to adopt opportunistic cost-reducing actions that would result in a bad quality service. Even worse, the contractor may go bankrupt and disrupt the service altogether.

Both underbidding and overbidding are explored in more depth in the next section.

2.3 Underbidding and Overbidding

Underbidding.

Suppliers may have access to an imprecise source of information about the common component of the cost function. If they anticipate the possibility of experiencing losses ex-post, suppliers may adopt an extremely cautious approach to bidding for the contract. Caution protects firms from losses, but implies potentially high awarding prices.

Underbidding can be illustrated with the aid of Table 2b below

Table 2b

Sample Observations

First Building	Second Building	Third Building	Fourth Building	Fifth Building	Sample Average SA	Estimated Number of Buildings to Clean NB	Estimated Surface SA*NB
160	*240*	*200*	*280*	*120*	*200*	*20*	*4000*

Data in, the above table, represent the observations from 5 sampled buildings, still concerning type-B surface, collected by CHIEF, a third company providing cleaning services. The available sample, however, which would lead to an estimate of 4000m^2 squared meters of type-B surface, is not the only information that CHIEF has on the demand for service. Indeed CHIEF built up some experience, though less than CLEANFAST, in the sector which turned out to be useful for two major reasons. Thanks to that CHIEF became aware of the possibility of overbidding, and so of incurring in the Winner's Curse, and then experience was also used to construct an interval estimate for the actual demand for type-B surface, thinking that it will lie somewhere between 8.000 m^2 and 38.000 m^2 (the true demand being 10.000). Therefore, the sample observations and the information coming from past experience are inconsistent; what could CHIEF do in this case? Both the observations from buildings inspection and the limited past experience do not entail CHIEF's full confidence in the available information. However, since CHIEF is aware of the Winner's Curse, it may prefer to be cautious and privilege information coming from previous experience, which provides a higher estimate of the more expensive surface B, in so doing disregarding sample observations, This way CHIEF would feel better insured against the risk that actual demand of type-B surface, the more expensive, could be quite high. Within the interval it would choose the mid-point, 23.000m^2, as an estimate for type-B surface. Assuming CHIEF estimated type-A surface to be 32.000 m^2, it would not be willing to submit an offer below

$$(40 \text{ x } 32000 + 80 \text{ x } 23000)/55000 = 56.7 \text{ €}/ m^2.$$

This value might represent a safe harbour, but since the "optimal" bid normally includes a mark-up component[5], the minimum price CHIEF might be induced to offer is *60€/m²*. Caution may then be caused by moderately reliable information, both private and public, about the common component of production costs. Indeed, once aware of the Winner's Curse by experience, the less reliable the information, the more cautious the bidding (i.e. underbidding).

As we said CLEANFAST is also experienced, indeed more than CHIEF, and then fully aware of the Winner's Curse; would the behaviour of the two differ? Would CLEANFAST be also very cautious and meaningfully underbid? Because of its large experience, and recent sample observations too, CLEANFAST feels confident on its demand prediction, which is also more accurate than the one by CHIEF. As a result, the minimum price CLEANFAST would be likely to bid is just above *50€/m²* (i.e. slightly underbid), the lowest price that could offer in case it knew the true demand for service.

Therefore CLEANFAST bidding behaviour would be much less conservative than CHIEF and, thanks to its presence, the buyer less likely to suffer for underbidding.

Overbidding.

This behaviour is caused by suppliers' inability to take into proper account the information of "winning the contract" while they formulate their bids. The cleaning contract will provide again a useful framework to illustrate this point. Consider four competing firms whose demand estimates for Lot B are illustrated in Table 2c. Each bidder has inspected a different sample of five buildings, and predicts a different number of buildings to be cleaned.

Table 2c

Bidders' estimates for Lot C

Buildings→ Suppliers↓	**First**	**Second**	**Third**	**Fourth**	**Fifth**	**Sample Average SA**	**Estimated Number of Buildings to Clean NB**	**Estimated Surface SA*NB**
1	*500*	*1000*	*800*	*500*	*600*	*680*	*20*	*13600*

2	*450*	*900*	*850*	*450*	*650*	*660*	*10*	*6600*
3	*400*	*950*	*750*	*550*	*750*	*680*	*10*	*6800*
4	*550*	*1100*	*700*	*500*	*650*	*700*	*20*	*14000*
Average Estimate								*11075*

The row corresponding to each bidder contains five observations, their sample average, the same bidder's estimated number of buildings to clean, and the overall estimated surface. The average of the individual estimates is $11075m^2$. So, if the four estimates were available to each bidder, they could all take the average to forecast the demand. The resulting estimation error would be lower, $11075\text{-}10000=1.075m^2$, than if they relied only on their individual estimate. However, if bidders compete independently from each other they have access only to their sample observations. Hence, by relying only on the information available *ex-ante*, each bidder would make a bigger estimation error (between $-3400m^2$ and $+4000m^2$).

If a bidder relies upon his piece of information only, and fails to take into account that the winner is the one who is most likely to have underestimated the surface of Lot B (higher unit cost) then he may submit too a low bid. Hence the bidder with the most optimistic information *ex-ante* may experience losses *ex-post*.[6]

Lack of experience[7] is sometimes considered a plausible explanation for bidders' inability to anticipate the information coming from "winning the auction" Consider, for instance, how PROPER's bidding strategy may differ from the one adopted by CLEANFAST. The latter has a long experience in similar contracts, whereas PROPER is little less than a novice in the procurement market. Even if the two firms had access to very similar information about the current contract and were not to differ much in terms of intrinsic efficiency, CLEANFAST would be able to integrate its current information with past experience. More precisely, CLEANFAST, having been in the same market for, say, ten consecutive years, has been able to construct an informative time series that contains the realized demands for type-A and type-B surfaces.[8] Hence, any piece of *current* information can be evaluated by integrating it with past observations. PROPER, instead, has to rely on its current information only, and to reduce or avoid overbidding it would be better off by knowing something about CLEANFAST's time series in order to fine-tune its bidding strategy. In the next section, we will investigate more in detail what auction format may facilitate PROPER's learning process.

The inability to anticipate the effects of the winner’s curse due to lack of experience may produce an even more dangerous outcome for the buyer. Suppose that more efficient suppliers are more likely to be experienced bidders because, say, they have participated and have been selected as contractors in previous procurement contracts. Hence, they are more likely to anticipate the effects of the Winner’s Curse and bid more cautiously. If, for symmetric reasons, less efficient suppliers are more likely to be inexperienced and, thus, more prone to suffer from the Winner’s Curse, they may end up bidding more aggressively than experienced suppliers. As a result, the competitive process may not allow the buyer to select the most efficient contractor. As we will see in the next Section, the buyer can minimize the occurrence of a “bad selection” by designing a competitive process allowing less experienced suppliers to learn from more experienced suppliers’ bidding behavior, that is, to enrich their poor initial information about the common component with more experienced competitors’ information revealed through the bidding process.

We conclude this section by observing that overbidding, that is, submitting too a low bid, can also be due to a strategic choice. Suppliers in financial distress, while struggling to remain in the market, may be tempted to offer particularly low prices to win the contract. They may aim at renegotiating better conditions once they have started performing the contract. This phenomenon has obviously nothing to do with aggressive bidding originated by lack of awareness of the Winner’s Curse.

3 COSTS AND BENEFITS OF INFORMATION CIRCULATION: CHOOSING THE COMPETITIVE TENDERING FORMAT

The previous section has drawn a competitive environment in which two competitors, PROPER and CLEANFAST, rely on considerably different experiences. Moreover, the simple fact that PROPER considers CLEANFAST an “expert” in the market may induce the former to believe that any positive information about the current contract (low estimated unit cost) makes it more likely that CLEANFAST has received positive information as well.[9] This situation captures a broad set of circumstances in which the buyer would benefit from adopting a dynamic, rather than a sealed-bid tendering format. The latter would certainly leave inexperienced and poorly informed bidders such as PROPER fully exposed to the risk of overbidding Why? The simple, almost obvious, reason is that such a bidder would have to rely on its very limited information and experience to make a fairly complicated inference on the "true" demand for the cleaning service.

How would PROPER's bidding behaviour be affected by a dynamic format[10]? From the discussion in paragraph 2.2.we observe that the minimum price PROPER would be willing to bid, including a mark-up, is 45€; above that price the bidder would expect nonnegative profits, if it were to win the contract. Let us imagine the following scenario. Prices start at *70€* (reserve price) and are gradually lowered. Suddenly, and unexpectedly, NODIRT Ltd, another expert in the market,quits the auction. This event becomes a very useful source of information to PROPER that *has* to revise upwards the expected cost for undertaking the contract. It is now likely that PROPER will not be willing to remain active if the price goes below, say, *55€.*

Information production during the auction helps bidders revise their estimates of the common component. In doing so, they may avoid to become victims of underbidding when adjusting for the Winner's Curse (i.e. the case of CHIEF) or overbidding when relying only on their estimates of the common component (i.e. the case of PROPER). More confident bidders bid more aggressively than in sealed-bid formats, thus benefiting the buyer through a lower awarding price. Moreover, the winner discovers more frequently ex-post that the cost of serving the contract is no higher than its ex-ante estimate. Hence, it is less likely that the contractor will look for opportunistic, cost-reducing actions that would undermine the quality of the service.

But what about the possible drawbacks of a dynamic format? There exist indeed two sources of concern for a buyer when opting for a dynamic auction.

1. Information circulation may increase the risk of collusion, especially in auction for multiple contracts (objects). Indeed, bidders can exploit the openness of the auction format to send signals (through prices) to each other in order to coordinate. Moreover, dynamic auctions allow members of a bidding ring to detect deviation from a collusive scheme and punish deviating bidders.
2. The transparency and the openness of a dynamic format may induce some bidders to adopt bidding strategies (i) to conceal their information to rivals or, to the other extreme, (ii) to bluff, that is, to deceive rivals. The kind of strategies in (i), sometimes described as a "snake in the grass", are more likely to take place in those dynamic formats in which the pace at which prices evolve over time

depends entirely upon bidders' activity. A slow-moving bidding process may produce little valuable information and may result in an excessively long auction. Strategies in (ii) may take the form of "jump bidding".[11] This is the situation whereby a bidder submits a very low price early in the contest which is meant to "persuade" competitors that he is in a position to get the contract at a very low price, thus deterring further competition.

The discussion developed so far leads us to the following

Practical Conclusion 1

The buyer should prefer a sealed-bid tendering over a dynamic auction when

- **the common component in the production costs is believed to be small or not very uncertain;**
- **bidders are likely to have relatively similar information about the common cost component.**

The buyer should prefer a dynamic auction when the common component in the production costs is believed be substantial and uncertain *and* it is reasonable to expect that bidders possess different, though linked, pieces of information and/or experience on the common cost component.

Adopting a dynamic format does not automatically solve the problems of underbidding and overbidding. The openness of the auction format is a necessary condition for some learning to take place. However, other aspects of information circulation during the auction are likely to affect bidders' learning process and, consequently, the extent to which underbidding or overbidding arise. In order to illustrate this last point suppose that a dynamic auction is used with a fixed-end rule. That is, the bidding process cannot last more than, say, two hours. In this environment, if bidders are allowed to raise discounts (or lower prices) by small amounts (ticks), they may opt for a snake-in-the-grass strategy. Experienced bidders may have a special interest in doing so in order not to disclose their information to less experienced or poorly informed bidders. Hence, bidding activity may become more "lively" only in the last handful of minutes, thus leaving little time to inexperienced bidders for learning about the common component. However, if the auction end were extensible, the outcome might change substantially. Suppose that the auction has an initial duration of two hours, but ends only if during the last ten minutes no price offer is received. Otherwise, it is extended by another ten minutes and so on until no bid is eventually submitted. Such a simple modification of the design might considerably affect the evolution of the bidding process and, consequently, the amount of information circulation during the auction.

Whenever the buyer is concerned with "information production", she can take other actions that may be at least as effective as the appropriate choice of rules for a dynamic format. The buyer could actively gather and publicly release as much information as possible on the common value component before the auction starts. The reserve price, for instance, may provide a useful benchmark cost to the bidders. If the procurement contract is split in several lots, uncertainty could be reduced by setting a separate reserve price for each individual lot.[12] More in general, in the effort of mitigating uncertainty, the procurer should include in the contract, and more in general in the auction design, as many important aspects related to the market as possible. Together with the duration of the contract, the buyer can specify the geographical areas where the contract applies, maximum and/or minimum quantities to be supplied and any other aspects helping bidders to properly evaluate the cost of the contract. This discussion leads us to

Practical Conclusion 2

When uncertainty about the common component is believed to have a great impact in the bidders' production costs, the buyer should provide bidders with as much relevant information on the contract as possible.

4 STREAMLINING DYNAMIC AUCTIONS

If allowing suppliers to observe and learn from each other's bidding behaviour is considered important, we wrote, a dynamic auction should be preferred to sealed-bid tendering. Learning takes time, however, and so do dynamic auctions. The higher the number of rounds in a multi-round auction, the more time to think is left to bidders between the rounds, the more bidders can learn from each other's bids and the more likely is for participants to avoid underbidding or overbidding, but the longer is the auction.

Long lasting auctions, however, may substantially increase organizational costs for running the bidding process and wages/fees of the specialized personnel working on behalf of suppliers. If the buyer organizes a high number of auctions per year, it may be unfeasible to have many auctions running for a very long time at the same time. These considerations apply to standard dynamic formats as well as to on-line dynamic auctions. The latter have become increasingly more widespread, since in many instances they proved to be a flexible and powerful way to conduct procurement activity. They allow auctions to take place while bidders are located in different places, thus inducing higher participation. However, the extensive use of new information and communication technologies to auctions may have played a crucial role in *stretching* auctions length.

We can summarize three main drawbacks associated to “*long*” dynamic auctions. We will then discuss how the buyer can overcome such problems by keeping the auction length under control.

Information circulation and collusion

Collusion can be sustained more easily in a dynamic auction for a single contract rather than in a sealed-bid tendering since members of a bidding ring may punish immediately a defecting bidder. In the case of multiple contracts, bidders may also use bids as communication devices. In general, the longer a dynamic auction the easier coordination among bidders since they have a higher number of opportunities (for example, in the various rounds) of agreeing on the allocation of contracts.

Bidders’ psychological costs during the auction

Long-lasting auctions may be psychologically exhausting for participants, even when they are experienced and skilful[13].

Costs of specialized personnel.

Public procurement activity typically contemplates the presence of an awarding committee[14] that is in charge of the regularity of the auction procedure. Should a dynamic auction be too long such costs would increase as well as those concerning personnel specifically dedicated by the participants to the auction. This last point could make the auction too costly for some bidders, who may choose not to participate.

5 SHORTENING MULTI-ROUND DESCENDING AUCTIONS

In this paragraph we present and discuss a few dynamic formats among those most commonly observed in practice, and we suggest how their length could be kept under control. To concentrate on the main ideas we focus on the design of auctions with a single supply contract.

5.1 Multi-Round Descending Auctions

.

Multi-round auctions are a combination of dynamic and sealed-bid formats. They are normally run on-line by using an e-platform. At each round, and within a specified time interval, participants submit their offers to the system secretly, without knowing whether or not other bidders have made an offer. In order to be considered valid, bids have to be below a predetermined price level. In the first round, the threshold is the buyer's reserve price. In subsequent rounds, the threshold may be each participant's bid submitted in the previous round minus a fixed amount, or tick. Alternatively, the threshold may be the same to all bidders and equal the lowest price submitted in the previous round minus the tick. In order to be considered active participants, bidders have to submit a valid bid at each round; if, at some round, they fail to submit a valid bid they can no longer bid.

At the end of each round, the buyer publicly reveals all valid offers keeping bidders' identities anonymous. Hence, each participant knows the whole set of valid offers but does not know who offered what. The auction ends when only one valid bid is received. This is the awarding price and the winning bidder is the participant who submitted the last valid bid. It is easy to see that this set of rules also comprises, as a special case, the English (reverse) auction in which the validity rule requires any bidder to outbid the standing lowest bid.

Since the number of rounds is undetermined the auction can be lengthy enough to let information circulate, thus favoring the learning process which helps mitigate problems related to the Winner's Curse. If delegates are under pressure, pauses between rounds can lower the risk of bidding mistakes. However, the auction can turn out to be too long, simply because the last two active bidders may decide to slow down the pace at which the auction evolves by submitting at each round offer bids just below the validity threshold. Moreover, if participation is costly inexperienced and poorly informed bidders may be deterred from entering if they believe that more experienced and better informed ones will sooner or later outbid them. Tacit collusion may also arise since bidders can use prices to send signals to each other, although collusion-via-prices becomes more feasible to bidders in multi-lot (or multi-contract) dynamic auctions than in the single lot (or single contract) version.

5.2 How to Shorten Multi-Round Descending Auctions

When length is a relevant concern, there are three possible ways to shorten the auction; they are not necessarily incompatible with each other.

1. Maximum Number of Rounds or Fixed-end Rule

One way to keep the auction length under control might be to introduce a maximum number of rounds, or to announce a fixed-end rule in an English (reverse) auction.

Suppose the number of rounds is fixed ex-ante. Its choice is mainly driven by considerations concerning organizational costs, the nature of the contract being procured, the nature of the information possessed by participants and the risk of collusion among them.

The winner is the bidder submitting the lowest bid at the final round or at any previous round if there is no further lower bid. Due to the fixed number of rounds, auction length is now under full control. Moreover, the presence of a last round may increase the amount of uncertainty that favours participation by small suppliers. since they may think that if they can make it to the final, sealed-bid, round they might have a chance to win the contract. However, information circulation is likely to be seriously undermined by the fixed-end or the last round effects[15]. When bidding behaviour reveals part of the bidders' information about the uncertain common component, bidders may be tempted to behave like "snakes in the grass" until the very last round of the auction in order to limit competitors' learning. In doing so, they transform *de facto* a multi-round dynamic auction into a (one round) sealed-bid format. If uncertainty about the common component, and thus the risk related to the Winner's Curse, led the buyer to choose a dynamic auction, the adoption of a fixed number of rounds or a fixed-end rule may jeopardize the buyer's goal and aggravate the Winner's Curse itself.

2. Increasing the Tick Size in the Validity Rule

Since a fixed number of rounds is most likely to be a counter-productive solution when the Winner's Curse is a serious concern, the buyer may opt for increasing the tick size in the validity rule in order to speed up the bidding process and thus shorten the auction. Although the auction length is not under full control, bidding can be rather fast: the greater the tick size the faster the auction. Participation by small suppliers may become more difficult since they can be systematically outbid by bigger ones.

Observing bidders' quitting times provides other participants with useful information. The accuracy of the learning process, however, decreases with the tick size. Suppose that the tick size is equal to Δ. Then a bidder, who has submitted a valid bid $b(t)$ at round t, and who does not submit at round $t+1$, reveals a less precise information about his experience and/or private signal on the common component than when the tick size is smaller, say, $\Delta/2$.

3. Anglo-Dutch

A third way to shorten a multiple round auction is its Anglo-Dutch modification. The Anglo-Dutch auction was first proposed by Paul Klemperer[16] to favour participation and deter collusion in the UK spectrum auction. Though keeping the auction length under control was not the major concern of the original proposal, the format has a natural connotation in this sense. The main innovation consists in interrupting the auction when only two bidders remain and calling a final, sealed-bid, round between them**.** Thus if at some round only two valid bids are received, then the following round becomes the last one. The bidder submitting the lowest price at the last round is awarded the contract and receives a payment equal to his own bid.

The number of rounds is undetermined until only two bidders remain in the contest. The final round prevents lengthy auctions caused, possibly, by the two "strongest" (that is, better informed and/or more experienced) bidders. The possibility of making it to the last stage may induce the participation of "weak" bidders (that is, poorly informed and/or more inexperienced), which may enhance competition and lower the risk of collusion. Moreover, if the tick size is relatively small, the learning process throughout the auction may be rather accurate. The auction may nonetheless remain lengthy.

Based on the above considerations, we are able to formulate

Practical Conclusion 3

To shorten the time length of a multiple-round, descending procurement auction, the buyer may adopt the "Anglo-Dutch" modification with a moderate tick size. If auction length is the biggest concern, the buyer may further increase the tick size.

Do not specify a fixed number of rounds.

We conclude this discussion with a warning. Although shortening a dynamic auction may be a desirable outcome for the buyer, observing a short auction is not necessarily "good news" for the buyer. Short auctions may result from some bidders being very aggressive early in the auction in order to intimidate their rivals and force them to quit. This is the so called "jump, or pre-emptive, bidding" phenomenon that some bidders may adopt to discourage rivals. A successful "jump bidding" reduces the auction length, but limits the extent to which learning takes place since most participants quit just for fear of being unable to compete against jump bidders. To limit the occurrence of such a phenomenon, the validity rule can be changed to include both an upper and a lower threshold for a bid to be considered valid. If the interval is not too narrow the auction could still be quite fast, while the speed would remain under control to promote learning and competition.

6 FASTER DYNAMIC AUCTIONS

We now consider three additional auction formats that have recently caught the attention of researchers and practitioners alike.

6.1 Descending Clock Auction

The on-line version becomes a *button auction*. The buyer starts from a high price which is decreased continuously. In order to remain active participants have to bid continuously. Depending upon the rules, this may happen either by keeping the assigned button pushed until a bidder decides to drop out, or otherwise by pushing it at the start of the auction and a second time to signal the exit.

Each bidder knows at any time how many rivals are still in the auction, although participants' identities are normally kept anonymous. The auction ends when only one bidder remains: he is awarded the contract at a price equal to the one at which the last bidder has quitted.

The buyer has full control on the speed at which the price decreases, hence the bidding process may end very quickly. Since bidders can observe the exact prices at which rivals quit, the learning process is, in principle, very accurate. However, if the speed is high, and the auction short, the specialized personnel bidding on behalf of interested companies may find themselves under strong time pressure and the probability of mistakes may increase considerably.

Similarly to multiple round and to English (reverse) auctions with no predefined length weaker bidders may be discouraged to participate and competition may be softened. It is also difficult to implement a descending clock format electronically by using Internet. Slow connections, analogous to the ones emerging in the e-Bay last minute bidding, may create legal problems. These are partially solvable by making time discrete, that is, every *t* minutes the price goes down by a tick diminishing in size; and by offering bidders a limited number of waivers they can use to interrupt the clock for some minutes (like "Time-outs" in basket) to think or communicate with head-quarters about the developments in the auction.

The descending clock format may appear difficult to implement for scoring auctions of complex goods-services contracts where a thermometer, measuring the quality dimension, has to be lowered together with the price of the contract. However, the thermometer can represent directly the score, without the exact specification of how the score (price/quality ratio) is achieved.

The following practical conclusion provides some guidelines to correct the main drawbacks of the descending clock format.

Practical Conclusion 5

In order to reduce the risk of bidding mistakes in a descending clock auction the buyer may modify the format in a series of dimensions, not necessarily incompatible with each other:

- **introducing a pause after each exit;**
- **making exit revocable for a limited number of times;**
- **introducing a number of waivers, that is, allowing bidders to be inactive for a limited period and to come back at a lower price;**

decreasing price by using discrete ticks.

6.2 Survival Auctions

The Survival Auction is also organized in multiple rounds[17]. The number of bidders remaining active from one round to the next one is determined according to the so called "survival rule". This keeps under full control its time duration. More precisely, at each round participants submit sealed-bid tenders. A bid is considered valid if it is lower than a certain threshold: at the first round, this threshold is the buyer's reserve price; from the second round onwards the threshold is the highest bid submitted in the previous round. At each round, the buyer only announces the highest submitted bid and the bidder having submitted that bid is excluded irrevocably from the auction, while all other "surviving" bidders proceed to the next round. Thus if N is the number of participants, the auction lasts $N-1$ rounds at most. The winner is the last surviving bidder who is awarded the contract at a price equal to the bid of the last excluded participant.

Since the number of rounds has an upper bound[18] of $N-1$, the auction length is under full control. Moreover, adopting a "wait and see" strategy by submitting a bid marginally lower than the highest admissible one may be too risky. Indeed the most "cautious" bidder would be irrevocably excluded from the contest.

Surprisingly enough, the strategic properties of the Survival and the descending clock auctions are exactly the same[19]. Hence if the on-line version of the Japanese auction cannot be implemented because of, say, poor internet connection among the participants, the buyer can safely adopt the Survival design. In some countries, however, the Survival auction may raise legal problems.

6.3 Two Stage Sealed-Bid Tendering

This is an extreme case of Survival Auction in which all bidders, except those who submitted the two lowest prices, are excluded after the first round. The two surviving bidders challenge each other in the second and final round. Such a design reduces the time length to a minimal number of sessions, a lower number of rounds being feasible only if the auction format is lowest-price, sealed-bid. Although the two-stage, sealed-bid tendering has been used in a variety of situations[20], it is only recently that some of its properties have been understood. In particular, the two-stage tendering generates the same expected revenue of an English (reverse)[21] auction when bidders' private pieces of information about the contract are (statistically) linked as in our explanatory example of the cleaning contract in Section 2. The two-stage tendering may be also coupled with "Indicative Bidding".[22] This variant is frequently used for the sales of assets: participants are first asked to provide non-binding indications on their willingness to pay and then, on the basis of such information, the auctioneer selects a subset of bidders for the second and final sealed-bid stage in which bidders' offers are binding.

Due to its potentials for practical applications, we conclude this Paper by illustrating in the following table a one-object, two-stage sealed bid tendering with five participants. Bidders submit discount percentages with respect to a reserve price. Figures in the upper row are bidders' discounts in the first stage. Bidder 4's and 5's discounts are the two highest, so they proceed to the second round. As explained above, the two highest discounts are not disclosed at the end of the first round, whereas rejected bids are publicly announced. This information could be useful to bidder 4 and 5 in the next round. In the second stage, they cannot lower their first-round discounts. In our example, bidder 4's and 5's offers in the second stage are valid only if higher than, respectively, *15%* and *18%*; in the second round they are indeed valid. Bidder 5 is awarded the contract at a *20%* discount of the reserve price.

Table 3

Rounds	**Bidder 1**	**Bidder 2**	**Bidder 3**	**Bidder 4**	**Bidder 5**

1	10 %	8 %	13 %	***15 %***	***18 %***
2				*20 %*	*22 %*

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[1] This is an example of fixed-price contract.

[2] We are implicitly assuming that the open format takes the form of a Japanese auction rather than an English auction.

[3] This means that the pool of competing firms have unit costs for the two types of surfaces lying in small interval around *40€/m²* and *80€/m²*. Hence, uncertainty concerning the common component is more relevant to firms than the private component in determining their bids for the contract.

[4] Capen, Clapp and Campbell (1971) first noticed this problem. For a more sophisticated analysis of the Winner’s Curse in a general model of competitive bidding see Milgrom and Weber (1982).

[5] The computation of the “optimal” mark-up is far from being a straightforward task. Intuitively, PROPER has to weigh a higher mark-up that would generate higher profit, conditional on winning, and a lower probability of winning since the higher the mark-up the higher the chances that another competitor submits a lower bid.

[6] Kagel and Levin (2002) discuss experimental evidence showing that the magnitude of the Winner’s Curse typically increases with the number of participants in sealed-bid, common value tendering. The explanation rests in the increased level of competition and the higher likelihood that some bidders rely on private information (that is, signals about the value of the object) which is far away from the “true” common value.

[7] See again Kagel and Levin (2002). In particular, throughout the Paper we assume that “experienced” means being both aware of the Winner's Curse and better informed, “less experienced” being not so well informed but aware of the Winner's Curse, and “inexperienced” being both unaware of the Winner's Curse and poorly informed. Accordingly, we show that an experienced bidder (i.e. CLEANFAST) is expected to slightly underbid, a less experienced bidder (i.e. CHIEF) to meaningfully underbid, and an unexperienced bidder (i.e. PROPER) to overbid. Then, our explanation of underbidding-overbidding depends on our definitition of experience. However, despite the availability of a long time series concerning previous awarded contracts, a bidder so well informed may wrongly use the data not adjusting his bid upwardly for the Winner's Curse, thus overbidding. We could refer to such a bidder as being naïve. Alternatively a supplier, with very little information and no experience in suppliying any contracts, may underbid since he might have come to know about the possibility of the Winner’s Curse from other sources, rather than personal experience, and adjust his bid accordingly. We could refer to such a bidder as being rational. However we think our definition of experience to be very plausible and useful to explain underbidding-overbidding in procurement practice.

[8] In our illustrative example, an unpredictable, period-specific shock affects the demand for cleaning services. Thus observing the realized demand over ten years certainly helps CLEANFAST form a better idea about, say, the variance of the shock.

[9] This is a rather simple way of introducing "affiliated" information among bidders. In their seminal paper on auctions with affiliated information, Milgrom and Weber (1982) show that the seller (the buyer in procurement) benefits more from an English than from a sealed-bid, second-price auction.

[10] The dynamic format we consider here is not an English (reverse) auction, rather a descending clock auction in which the price is exogenously lowered by using a clock at a speed, say, of 0.5€/sec. Bidders are considered active as long as they keep a light switched on. Switching off the same light implies that the corresponding bidder has irrevocably quit the auction. The contract is awarded to the last active bidder at the price the last bidder quits the auction. See Section 5 for more on the properties of both the English (reverse) and the Japanese formats.

[11] See, for instance, Fishman (1988) and Avery (1998).

[12] In our example of contract for cleaning services, there would be a reserve price for type-A surfaces and a different one for type-B surfaces.

[13] See List and Lucking-Reiley (2000).

[14] This is, for instance, the case in Italy.

[15] See Roth-Ockenfels (2002) for an analysis of late bids in e-Bay auctions.

[16] See Klemperer (1998, 2004).

[17] See, for instance, Fujishima, McAdams and Shoham (1999) and Kagel, Pevnitskaya and Ye (2004).

[18] The actual number of rounds could, in principle, be lower than *N-1* if at some round two bidders submit the two highest offers, in which case both of them are excluded.

[19] The reader interested in the analytical details is referred to Fujishima, McAdams, and Shoham (1999).

[20] One noticeable example is the privatization in Italy of the formerly state owned industrial conglomerate ENI.

[21] The technical details are in Perry, Wolfstetter and Zamir (2000).

[22] See Ye (2004).

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