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"Relational" Procurement Contracts: A Simple Model of Reputation Mechanism*

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Abstract

We show how repeatedly awarded procurement contracts where unverifiable quality dimensions are relevant can be reinterpreted as relational contracts between a buyer and a contractor that is threatened by a potentially less efficient competitor. We compare two scenarios: 1) Under *freedom of choices* the (public) buyer freely chooses the contractor, the price and the (unverifiable) quality it should stick to, 2) in a *competitive discretionary tendering* the buyer evaluates differently the bids of the suppliers by means of a handicap, based on the firm's past performance. We show that, if firms' costs are common knowledge, relational *discriminatory tenderings* replicates the results of long term contracting (*freedom of choice*). The handicap ensures the existence of a relational contract under which the buyer selects the more efficient firm and pays it a price higher than its cost, and the firm delivers the required quality. This outcome is an equilibrium when the cost of quality is not too high, and the players' discount factor and the

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valuation of quality are not small. A self-enforcing relational contract entails an handicap which is closer to the difference between the firms' specific-cost, the lower is the variable cost of quality and the higher is the players' discount factor.

Keywords: public procurement, relational contracts, unverifiable quality, handicap.

1 Introduction

Procurement contracts often require selected contractor(s) to fulfil several, possibly heterogenous, tasks. Throughout the execution of the project, opportunistic behaviour may arise in terms of lower-than-promised quality standards. When quality is verifiable by a third party at a reasonable cost, fines can be specified so as to deter the contractor from breaching contract clauses.[1] There exist, though, quality dimensions that are relevant to the completion of the project, and that are also observable by contracting parties albeit hard, if not impossible, to verify. Examples would include IT or management consulting services where the quality of human capital is a multidimensional variable comprising unverifiable dimensions such as a consultant's proactiveness. Lack of verifiability may also affect quality dimensions such as a software' degree of friendliness.

When quality is unverifiable (and thus non-contractible), extant results show that the buyer should avoid using a competitive procedure to award a procurement contract (Manelli and Vincent, 1995, and Bajari, McMillan and Tadelis, 2004); rather, she should rely on negotiation-like procedures with a restricted set of highly reputable suppliers.[2] Negotiation helps reduce opportunism because it provides a more flexible framework for buyers and suppliers to establish the terms of the contract. Also, in a repeated procurement context, it allows to exploit potential suppliers' *reputation* to restrict the set of potential candidates and create a long-term relationship with some specific suppliers. In many situations, however, the buyer cannot

[1] Under the main assumptions that i) contract management practices are not corrupt and that ii) the system of law enforcement works effectively.

[2] Empirical support to this result is provided by Bajari, McMillan and Tadelis (2008) who find that from 1995 to 2000 almost the 50% of non-resident private sector building contracts in Northern California were awarded using negotiations. Also, the DIRECTIVE 2004/18/EC of 31 March 2004 *on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts* says that "certain works contracts and certain service contracts having as their subject-matter intellectual performances, such as the design of works, should not be the object of electronic auctions."

negotiate *directly* - that is, without any competitive process - possibly long-term contracts since the latter are deemed to create monopolistic positions.

This paper therefore raises the question whether, in a repeated procurement framework, a public buyer can still implement the same outcome resulting from a negotiated long-term contract by rather using an open, competitive procedure. We show that, in order to reproduce the long-term contract outcome, the buyer has to craft a reputation mechanism linking the likelihood that any supplier gets the contract today to its performance (provided that there was any) in the past. Using past performance in the evaluation of firms' tender proposal is envisaged, for instance, by the the U.S. Federal Acquisition Regulation, which prescribes that "[p]ast performance should be an important element of every evaluation and contract award for commercial items. Contracting officers should consider past performance data from a wide variety of sources both inside and outside the Federal Government[...]."[3] A reputation mechanism would in principle allow any public buyer to differently evaluate otherwise like tenders by using participating firms' different track (performance) records.

However, not all public procurement regulatory systems contain explicit provisions for discriminating suppliers' tenders according to past performance. While such a provision is stated in the US FAR, the use of such discriminatory evaluation criteria in the EU may conflict with articles 3 and 87 of the EC Treaty (Maasland, Montangie and Van den Bergh, 2004).

This paper shows that, in repeatedly procurement contracts awarded by means of an open competitive procedure, the buyer may (optimally) distort the price bids according to the suppliers' previous (if any) past performance so to induce the contractor to deliver the same level of unverifiable quality obtained within an individual, long-term, negotiation. The distortion of the price bids occurs through a handicap, based on the firm's past performance.

We obtain this result showing that, in a full information context, repeatedly awarded procurement contracts where unverifiable quality dimensions

[3] See FAR, 12.206.

are relevant can in fact be reinterpreted as relational contracts between a buyer and a contractor that is threatened by a potentially less efficient competitor. Relational contracts have been pioneered by Bull (1987) and MacLeod and Malcomson (1989), and more recently extended by Baker et al. (2002), MacLeod (2003), Rayo (2007) and Fuchs (2007). Their elegant formalization under adverse selection and moral hazard is due to Levin (2003) while MacLeod (2007) represents the most recent survey. Such contracts are informal agreements and unwritten codes of conduct that are sustained by the value of future relationships, and are applicable in the cases where the outcome of a repeated relationship is based on some unverifiable variables. They fit in naturally with the nature of interaction over a tendering between the buyer and potential suppliers. This is a relationship which is typically repeated over time, and in which both parties have quite large discretionary space of manoeuvre, are well informed on many, sometimes not contractible upon, variables affecting the outcome of the relationship, and may have mutual gains from concerted behaviour.

More specifically, we set up two types of games according to whether the (public) buyer is free to choose the contractor or is constrained to use an open competitive auction: these games are referred to as *freedom of choice* and *competitive tendering*. Competitive tenderings can be *discretionary* or *nondiscretionary*, with the latter allowing the buyer to evaluate differently the bids of the suppliers by means of an handicap, based on the firm's past performance. The handicaps concur with the firms' bids to determine the firms' scores, on which basis the contractor is chosen. For both types of games, we set up a dynamic relational interaction, resulting from an infinite repetition of a sequential stage game. In the relational contracting under *freedom of choice*, in each period, the buyer chooses the contractor and sets the pair of price and (unverifiable) quality the contractor should stick to. The relational *discriminatory* procedure, instead, entails that in each period the buyer runs a competitive sealed-bid first price auction in which the winner is awarded the contract and has to deliver the required quality, otherwise its score in the next auction will be reduced by the handicap. We show that relational *discriminatory tenderings* replicates the results of long term contracting (*freedom of choice*). The handicap ensures the existence of a relational contract under which the buyer selects the more efficient firm and pays it a price higher than its cost, and the firm delivers the required quality. This outcome is an equilibrium provided that the cost of quality is not too high, and the players' discount factor and the valuation of quality are not too small. Whenever a self-enforcing relational contract exists, it entails setting an handicap which is closer to the difference between the firms' specific-cost, the lower is the variable cost of quality and the higher is the players' discount factor.

This paper is linked to others which already have explored the issue of opportunistic behavior in repeated procurement in the context of a long-term relationship. Klein and Leffer (1981) show that an optimal strategy for the buyer is to promise rents to the contractor under the threat of terminating the relationship in case of opportunistic behavior. More recently, the issue of unverifiable quality in procurement has been recognized by Kim (1998), Doni (2006) and Spagnolo and Calzolari (2009). They introduce a discretionary power of the buyer to design the competitive procedure and study the role of competition in multiple suppliers auctions when the buyer does not observe suppliers' costs. Kim (1998) allows the buyer to set the number of admitted participants and finds that bidders' commitment to high quality may decrease with the number of bidders. Spagnolo and Calzolari (2009) show that more frequent auctions (lower contract duration) and restrictions on the pool of participants enforce higher unverifiable quality. In particular, they also show that when noncontractible quality is very important then a negotiation with a single agent can characterize an optimal relational contract. Tunca and Zenios (2006) study the interaction between auctions and relational contracting when the buyer purchases both verifiable low-quality and unverifiable high-quality intermediate goods (jointly used for the final product). The former good is purchased by running a competitive auction while the latter by a relational contract. They show that the relational contract is sustainable when the parties interact frequently or when the high-quality supplier is sufficiently patient. They also find the conditions on quality premium and level of competition (in the market for the verifiable quality) such that both relational contract and competitive auction coexist or undermine each other. Our paper contributes to such a literature by showing that there exist circumstances under which a competitive tendering procedure plus a relational mechanism may achieve the efficient allocation of the contract.

Other solutions to the problem of unverifiable quality have been analyzed so far.[4] Taylor (1993) and Che and Hausch (1999) introduce an option contract whereby the supplier pays a fee to the buyer who then may accept or reject (at no penalty) the provision at price equal to its desired level of quality. The option of rejection serves a threat inducing the supplier to deliver a required level of unverifiable quality. In order to rule out the scenario where suppliers are not able to pay the fee, they propose a method known as pilot/research contest that hinges on suppliers competing on quality for a fixed-price reward. Che and Gale (2003) show that a buyer may be better off by allowing supplier to bid on their reward as in a standard auction.

The plan of the paper is as follows. After this introduction, the model is described in Section 2. Section 3 analyses the static setting, while Section 4 is devoted to the analysis of the dynamic games. Concluding remarks are in Section 5. Proofs are either relegated to the Appendix or omitted, when trivial.

2 The model

The players. A public buyer wants to procure a single project for an infinite number of periods, each denoted by t, with $t = 0, ..., \infty$; only fixed price contracts are available to the buyer.

[4] See Che (2008) for a review of possible solutions of the issues deriving from unverifiability of quality in procurement.

Only two firms, denoted by subscripts L and H for reasons that will be clear in the sequel, can deliver the project.[5] Projects may have different intrinsic quality levels: the cost of a project of quality q for firm i is $\theta_i + \psi(q)$, where $i = L, H$; that is, the cost has a fixed component, θ_i, which is firm-specific, and a component which varies with the delivered quality, $\psi(q)$, and which is identical across firms provided they produce the same quality level.[6] All cost components are time-invariant. We assume that the fixed cost components are strictly different across firms and write them as θ_L and θ_H, with $\theta_L < \theta_H$. We denote with $\Delta\theta$ the difference between the (firm-specific component of the) firms' cost, so that $\Delta\theta \equiv \theta_H - \theta_L$. We assume that quality can only take on two values, 0 and $\overline{q}$; that is, $q \in \{0, \overline{q}\}$, with $\psi(0) = 0$ and $\psi(\overline{q}) = \psi$.

The buyer derives from the project utility given by $U = v + q - p$, i.e. the value of the project plus the value of its quality minus the price paid to the firm in charge of the project. We assume that v is always sufficiently high to induce the buyer to procure the project, irrespective to the price and the quality level; for simplicity and without further loss of generality, we normalise to zero the value of v. On completion of the project, the buyer pays the awarded firm the price p. The profit of firm i is therefore given by $\pi_i \equiv \pi(\theta_i, p, q) = p - \theta_i - \psi(q)$.

The games. We analyse two types of games. The formal description of these games is postponed to the Sections where the games are analysed. It is sufficient here to say that, in a first type of game, the buyer can freely select the contractor for the project. Given this feature, we name this type of games *freedom of choice*. In a second type of games, the buyer is constrained to use an open competitive procedure to choose the contractor: these games are referred to as *competitive tendering*. We will also distinguish between *discriminatory* and *nondiscriminatory* competitive tendering procedures. In

[5] The buyer is referred to as *she*, while each firm is referred to as *it*.

[6] A separable cost function has been also used by Doni (2006) and Calzolari and Spagnolo (2009).

a *discriminatory* competitive tendering procedure, the buyer is allowed to evaluate differently the bids made by the participants to the tender. In practical terms, this is done by means of a handicap, based on the firm's past performance. The handicaps concur with the firms' bids to determine the firms' scores, on which basis the contractor is chosen (more details are in Section 4) . For all games analysed here, our main interest is on a dynamic game, resulting from an infinite repetition of a sequential stage game, fully described in the sequel.

Informational structure. The games we analyse are games of complete information; this implies that the buyer perfectly observes the firms' costs when she awards the project. Also, on completion of the project, the realisation of quality is fully observable by both players. However, quality is not enforceable in a court of law, so that the buyer cannot make the contractual price conditional to the level of quality delivered.

2.1 Discussion of main hypotheses

While the European regulation provides for both restricted and open procedures,[7] the latter are usually considered more in line with the objective of opening up the public procurement market. Also, long-term procurement contracts for standard goods, services and civil works are considered anti-competitive by the relevant (administrative) courts as they induce monopolistic positions.[8] The necessity of a transparent accountability of public funds also exerts pressure on public buyers and induces them to run procedures that guarantee the correct allocation of public funds in (public) procurement processes.

[7] According to art. 10.a and 10.b of the Directive 2004/18/CE 'Open procedures' means those procedures whereby any interested economic operator may submit a tender; 'Restricted procedures' means those procedures in which any economic operator may request to participate and whereby only those economic operators invited by the contracting authority may submit a tender.

[8] For instance, a ten-year or longer public contract would fall in the category of concessions, thus triggering an additional set of provisions.

These two types of games are meant to illustrate two different institutional and legislative solutions to the same problem. While in the first type of games, the buyer has the ability to freely choose as contractor one of the two firms, in the second type of games the buyer faces some unspecified institutional and/or legislative constraints which forces it to use a competitive procedure to select the firm to which award the project.

In particular, handicapping is a form of discriminatory policy that allows a direct favour, as bidding credits, only for some bidders. The use of discriminatory action is admitted in the US[9] whereas the EU legislation is not clear about its applicability.[10] Although the EU also admits the use of past performance criteria, as pointed out by Maasland, Montangie and Van den Bergh (2004) the application of a discriminatory policy may conflict with the Articles 3 and 87 of the EC Treaty. The Article 3, in fact, requires "...a system ensuring that competition in the internal market is not distorted", while Article 87 prohibits aid through State resources that distorts competition by favouring certain participants. They explain how bidding credits/debits are applicable only when belonging to some categories of State aids (defined by the Article 87 as well) whose applicability is conditional on a discretionary decision of the European Commission.[11] The Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 seems sufficiently clear about the use of discriminatory policies. It says that "Contracting authorities which carry out particularly

[9] Past performance measures are a crucial component of any competing supplier's "responsivess" to the subject matter of the public contract. See Racca, Cavallo Perin and Albano (2011) for more on this.

[10] The federal American Act in the US admits explicit discrimination like price bid preferences toward small and medium-size firms. The Federal Communications Commission (FCC) also assigned bidding credits to some designated entities (owned by members of minority groups and women) when they competed in the mobile telecommunications auctions. See Marion (2007) for the analysis of this favoritism in the US.

[11] Maasland, Montangie and Van den Bergh (2004) presents some examples, taken from decisions of the Commission and of the Court of Justice, according to which EC law seems to consider discriminatory policy as State aids.

complex projects.." as "..the implementation of important integrated transport infrastructure projects, large computer networks or projects involving complex and structured financing the financial and legal make-up of which cannot be defined in advance.." must use procedures that do not "..restrict or distort competition, particularly by altering any fundamental aspects of the offers, or by imposing substantial new requirements on the successful tenderer..".

There might exist, though, a more fundamental criticism towards evaluating firms' tenders by using past performance indicators. The European Court of Justice and legal scholars alike are inclined to consider firms' past performance as a firm-specific attribute that should be used by public buyers at the selection stage, that is, at the stage where any firm learns whether or not it will be admitted to the competitive process. Therefore past performance should not, at least in principle, be part of the *evaluation* process where firms' tenders are ranked according to price and possibly quality dimensions. This solution seems to be more coherent with the overarching principle of nondiscrimination

Our hypothesis of complete information is justified by our focus on a problem of repeated procurement with a limited number of suppliers, a case in which it is relatively easy for the buyer to obtain a great deal of information on the firms operating in the market. We are particularly interested in those procurement markets for specialized services in which i) the human capital component is more relevant than physical capital, and ii) the nature of quality is to a great extent unverifiable. These are certainly the main features of the consultancy services market where production costs are mainly explained by partners', senior and junior managers' wage levels. In that market, thanks also to the high turn-over rates, a public buyer is in a position to learn over time different firms' production costs. Also, the assumption of complete information will sharpen the link between the relational bilateral contract and the repeated competitive procurement setting with a reputational mechanism.

3 The game with *freedom of choice*

We focus here on the games with *freedom of choice*, in which the buyer can freely select the contractor.

We denote with Γ^f an infinitely repeated game given by an infinite repetition of the following sequential stage game:

Stage game G^f ***(freedom of choice)***

Stage 1 The buyer selects one of the two firms and makes it an offer in which she asks the firm to provide the project of quality $\overline{q}$ and sets the price p to be paid for the project;

Stage 2 the selected firm chooses the quality level and delivers the project. The buyer pays the price and all payoffs are collected.

We solve for the subgame perfect Nash equilibrium of this infinitely repeated game Γ^f. As a preliminary step, we first solve for the subgame perfect Nash equilibrium of the corresponding sequential stage game G^f; we obtain it by solving the game backwards. Equilibrium variables are denoted with a tilde in the static game and with a hat in the dynamic game.

3.1 The static game G^f

In the static game G^f, in stage 2, since the payment is not conditional on the quality level of the project, firm i (with $i = L, H$) in charge of the project behaves opportunistically regardless the price, and delivers a quality equal to zero. In stage 1, the buyer anticipates this opportunistic behaviour and offers to firm i a price θ_i so as to cover the firm's (fixed) cost; the quality delivered by the firm is 0 and players' equilibrium payoffs are $-\theta_i$ and 0, for the buyer and the firm respectively. The buyer is trivially better off by selecting the more efficient firm and offering it a contract at price equal to its cost. In other words, a utility maximising buyer chooses firm L and offers to pay it $\tilde{p}^f = \theta_L$. The players' equilibrium payoffs are $\tilde{U}^f = -\theta_L$ and $\tilde{\pi}_L^f = 0$, which take into account that firm L offers a quality equal to 0.[12]

Notice that the equilibrium outcome of the game is heavily affected by the unverifiability of quality. While the freedom of action ensures that the buyer awards the project to the efficient firm, unverifiability of quality implies that the selected firm cannot be induced to deliver the required quality level.

3.2 The dynamic game Γ^f

In this section, we study the dynamic game Γ^f. In this and all the following dynamic games, let δ be the discount factor common to all players.

In the game Γ^f, a procurement relational contract is a strategy profile such that, in each period, the buyer sets a price p^f and the selected firm delivers the quality $\overline{q}$. This procurement relational contract is self-enforcing if the strategy profile is a perfect equilibrium of the repeated game.

In order to define the price p^f chosen by the buyer and the firms' behaviour off the equilibrium path, we concentrate on the following trigger strategies with Nash reversal (see, for instance, in a similar context, MacLeod and Malcomson, 1989 and 1998):

- **buyer**: the buyer begins the game by selecting firm i and offering it a price p^f. In subsequent periods, the buyer keeps selecting this firm and offering the same price as long as the firm delivered the quality $\overline{q}$ in previous periods; otherwise, it reverts indefinitely to its equilibrium strategy in the stage game;

- **firm *L***: if selected, firm L delivers the project, offering quality $\overline{q}$ whenever the buyer has set a price p^f in the past; otherwise, it reverts indefinitely to its equilibrium strategy in the stage game; if not selected, stay put;

[12]These results come from an immediate application of backward induction solution methods: the formal proof is therefore omitted. The same applies to the equilibria of the other static games presented in the paper.

- **firm *H***: same as firm L.

In what follows, these strategies are referred to as $s_B^f(i, p^f, q)$, $s_L^f((i, p^f, q))$ and $s_H^f((i, p^f, q))$ respectively. Notice the somewhat different nature of the strategies between the selected firm and the buyer, due to the sequential nature of the stage game; while a choice of the quality level different from $\overline{q}$ is detected by the buyer only in the following period, a price different from p^f by the buyer is immediately observed by the contractor and triggers a reaction in the same period.

The Folk Theorem ensures that, when the combination of player's actions in the stage game is such that the players' payoffs are feasible and individually rational, these trigger strategies are a subgame perfect equilibrium of the game under analysis provided that the players are sufficiently patient.[13] This implies that, for any given set of parameters of the model, at the equilibrium players' actions, there exists a high enough discount factor δ such that:

$$\frac{1}{1-\delta}\left(p^f - \theta_i - \psi\right) \geq p^f - \theta_i \tag{1}$$

Observe also that, in principle, an incentive compatibility constraint needs to hold also for the buyer. However, there is no short-term gain for the buyer in deviating from its trigger strategy, because this is observed and punished by the contractor in the same period before payoffs are realized. The buyer's incentive compatibility constraint is therefore simply satisfied provided that the value of the project is sufficiently high, which is assumed throughout.

[13] Fudenberg and Maskin (1986) show that the Folk theorem holds also for infinitely repeated games with more than 2 players provided that full dimensionality condition (FDC) holds. This requires that the convex hull of the set of feasible payoff vectors of the stage game must have dimension equal to the number of players, or equivalently a nonempty interior. Sorin (1995) extends this result to infinitely repeated sequential games. FDC is clearly satisfied in our model, so we can appeal to the Folk theorem. For milder requirements for the applicability of the Folk theorem, see Abreu et al. (1994) and Wen (1994, 2002).

Given the values of the other parameters, an entire range of values of p^f ensures that (1) holds and, as a consequence, that a self-enforcing relational contract exists. The buyer's *optimal* price within this range is obtained as the solution to the following problem:

$$\max_{p} \sum_{t=0}^{\infty} \delta^t (\overline{q} - p) = \frac{1}{1-\delta} (\overline{q} - p) \tag{2}$$
$$\text{s.t. } \frac{1}{1-\delta} (p - \theta_i - \psi) \geq p - \theta_i$$

The buyer's optimal price offer and the resulting equilibrium are formally characterized in the following Proposition:

Proposition 1. *The equilibrium of game Γ^f is with the buyer selecting firm L and offering it a price $\hat{p}^f = \theta_L + \frac{\psi}{\delta}$. At this price, $s^f_B(\hat{p}^f)$, $s^f_L(\hat{p}^f)$ and $s^f_H(\hat{p}^f)$, is a self-enforcing profile in which the project is awarded at price $\hat{p}^f$ to firm L, which delivers quality $\overline{q}$. The discounted present value of the players' payoffs are $\hat{U}^f = \frac{1}{1-\delta}\left(\overline{q} - \theta_L - \frac{\psi}{\delta}\right)$, $\hat{\pi}^f_L = \frac{\psi}{\delta}$ and $\hat{\pi}^f_H = 0$.*

Proposition 1 shows that the buyer can induce the selected firm to deliver the required quality by negotiating directly with a firm and exploiting the long-term nature of the relationship. To increase the firm's long-term gains from the relationship, the buyer pays a price above the firm's cost. As expected, this price is decreasing in the firm's discount factor: the lower the discount factor, the lower is the present value of the firm's profits after "cheating" on quality and therefore the higher is the reward to be offered to the firm for delivering a high level of quality. A utility-maximiser buyer would then prefer selecting the more efficient firm, namely firm L. Proposition 1 illustrates that in a direct long-term relationship with a contractor the buyer is able to solve the problem of unverifiable quality by exploiting the repeated nature of the relationship. This clearly comes at a cost: the outcome is not fully efficient, because of the need to reward the firm to induce it to offer the required quality level. An appropriate selection of the more efficient firm reduces this cost and ensures the highest possible utility for the buyer. Proposition 1 formally states the equilibrium outcome, using it a benchmark case to compare the buyer's optimal choices when she is bound to carry out an open and competitive procurement process.

4 The games with *competitive tendering*

In this section the buyer selects the contractor by means of a open procedure. We analyse two different competitive procedures, a *nondiscriminatory* and a *discriminatory competitive tendering procedure*. The former describes a model of stylized procurement in which the buyer simply runs a standard lowest-price sealed-bid auction, while in the latter, the buyer is free to distort the bids according to the supplier's (if any) past performance.

The competitive procedure requires each firm i to submit a bid on p_i, denoted as ρ_i. Notice that the bid submitted by each firm does not include the quality of the project. Both firms, in fact, would always find it optimal to bid the highest possible level of quality, wiping out all the effects of the quality component of the two bids.

In the competitive procedure, each bid ρ_i is evaluated by the buyer by means of a scoring rule, $S_i(\rho_i)$: in case of tie, so that $S_L(\rho_L) = S_H(\rho_H)$, the project is awarded to the least-cost firm, firm L. Despite the bid being mono-dimensional, the scoring rule is needed to reflect some particular features of the competitive tender. In the first place, we assume that there exists a price floor: this is set to the level of the more efficient firm's fixed cost θ_L (known to the bidder by assumption, see below): if any firm's price bid is below this cost, the price bid is taken as equal to the floor.[14]

We also allow the scoring rule to reflect a handicap (that is, a bid distortion) imposed on the firm making the bid: a handicap h_i on firm i is simply a positive real number to be subtracted from the score related to firm i's

[14] The tie-breaking rule and this assumption are in line with the complete information scenario in which the buyer knows the cost of each firm. As to the price floor, knowing the firms' costs, the buyer anticipates that a bid lower than these floors would be too aggressive because it would imply a negative profit for the bidders. This is what occurs in practice when public buyers do not accept too low price bids, usually defined “anomalous".

bid. Clearly, the buyer can use a handicap only if she adopts a *discriminatory competitive tendering*; in the case of the *nondiscriminatory competitive tendering*, the handicap for both firms is simply equal to zero.

Formally, the scoring rule is such that any bid submitted by firm i is transformed into

$$S_i(\rho_i) = max\{\rho_i, \theta_L\} - h_i$$

The simple nature of the scoring rule allows us a further simplification: since a handicap imposed on either firm enters the scoring rule as a pure additive component, only the difference between the values of the two handicaps is relevant to the actual bids evaluation, therefore any pair of strictly positive handicaps can be transformed into a pair in which either of the two is normalised to zero. We therefore set $h_H = 0$, that is only firm L can be handicapped, and, for a further sake of notation, let $h_L \equiv h$; to ensure that the handicap can, in principle, favour or punish either firm, we allow h to take on negative values – i.e. $h \in \Re$. Clearly, in the case of the *nondiscriminatory competitive tendering*, we simply have $h = 0$.

In what follows, we present and solve the *nondiscriminatory* and *discriminatory* competitive tendering games. For ease of exposition, we start from analyzing the *discriminatory* game.

4.1 *Discriminatory* competitive tendering

In this section, we introduce a dynamic game in which the buyer runs a discriminatory competitive tendering over an infinite time horizon. The competitive procedure is discriminatory in the sense that the buyer has the possibility to set a handicap, based on firm's past performance, which alters the evaluation of the players' bids.

4.1.1 The static game G^d

The dynamic game comes from an infinite repetition of the stage game G^d, defined by the following sequence of actions:

Stage game G^d (Discriminatory competitive tendering)

Stage 0 The buyer sets a handicap h;

Stage 1 one of the two firms is selected by means of a sealed-bid competitive tendering in which the two firms submit their bids, the buyer evaluates their scores and awards the project to the lowest score;

Stage 2 the selected firm delivers the project, by choosing the level of quality. The buyer pays the contractor a price equal to its score and all payoffs are collected.[15]

In the stage 2 of this game, the firm awarded the project delivers a quality equal to zero. In the previous stage 1, the equilibrium bids of the two players are described in the following Lemma:

Lemma 1. *The equilibrium bids of the two firms depend on $\Delta\theta$ and h, and are as follows:*

- $\rho_L = \theta_H - h$ *and* $\rho_H = \theta_H$, *when* $h \leq \Delta\theta$;
- $\rho_L = \theta_L$ *and* $\rho_H = \theta_L + h$, *when* $\Delta\theta < h$.

These optimal bids derive from a simple application of standard results for the case of an asymmetric Bertrand auction, and the proof of the Lemma is therefore omitted. The firm with a bidding advantage, as it results from the cost asymmetry and from the handicap h, just outbids the rival. It is then straightforward to characterize the equilibrium of the subgame given by the last two stages of the game; for future use, we characterise it in the following Lemma:

[15] In principle, both games should allow the selected/nominated firm not to accept the project. In practice, since the buyer always gives a positive value to the completion of the project, she will make sure to make offers or select a level of the handicap such that the firm's participation constraint is always satisfied.

Lemma 2. *Let h be exogenously given. The equilibrium of the subgame given by the last two stages of game G^d is such that, in Stage 2, firms always bid as in Lemma 1, and, in Stage 3,*

- *when $h \leq \Delta\theta$, the project is awarded to firm L at price equal to $\theta_H - h$ and firm L delivers the project choosing quality equal to 0. The payoffs of the players are $-\theta_H + h$ for the buyer, and $\Delta\theta - h$ and 0 for firm L and H respectively;*
- *when $\Delta\theta < h$, the project is awarded to firm H at price equal to $\theta_L + h$ and firm H delivers the project choosing quality equal to 0. The payoffs of the players are $-\theta_L - h$ for the buyer, and 0 and $h - \Delta\theta$ for firm L and H respectively.*

It is then possible to use these two Lemmata to immediately characterize the equilibrium of game G^d:

Proposition 2. *The equilibrium of the stage game G^d is as follows:*

Stage 0 *The buyer sets the handicap $\tilde{h}^d = \Delta\theta$;*

Stage 1 *The two firms bid $\tilde{\rho}_L^d = \theta_H - \tilde{h}^d = \theta_L$ and $\tilde{\rho}_H^d = \theta_H$, and the buyer awards the project to the firm L;*

Stage 2 *Firm L delivers the project, choosing $\tilde{q}_L^d = 0$. The payoffs of the players are $\tilde{U}^d = -\theta_L$ and $\tilde{\pi}_L^d = \tilde{\pi}_H^d = 0$.*

The proof of this Proposition comes from an immediate application of standard backward induction methods. The equilibrium handicap is such that the buyer creates a level playing field for the two firms by levelling out the cost advantage of the efficient firm. The low cost firm exploits its bidding advantage by bidding the highest price which, given the handicap, ensures it is awarded the project. The project is indeed awarded to the more efficient firm; this firm however makes zero profits, despite offering a quality level equal to zero.

4.1.2 The dynamic game Γ^d

In this dynamic game, a procurement relational contract is a strategy profile such that the buyer sets a handicap h and the firm which is awarded the project delivers quality $\overline{q}$. This procurement relational contract is self enforcing if the strategy profile is a perfect equilibrium of the repeated game.

The definition leaves undefined two elements of the players' strategies, the handicap h chosen by the buyer and the parties' behaviour off the equilibrium path. We make them precise concentrating on the following trigger strategies with Nash reversal:

- **buyer**: the buyer begins the game by setting an handicap h^d and keeps setting this handicap as long as the firm awarded the project has delivered the quality $\overline{q}$ in previous periods; otherwise, it reverts indefinitely to its equilibrium strategy in the stage game;
- **firm** L: firm L bids as in Lemma 1 and, if awarded the project, offers quality $\overline{q}$ whenever the buyer has set an handicap h^d in the past; otherwise, it reverts indefinitely to its equilibrium strategy in the stage game.
- **firm** H: firm H bids as in Lemma 1 and, if awarded the project, offers quality $\overline{q}$ whenever the buyer has set an handicap h^d in the past; otherwise, it reverts indefinitely to its equilibrium strategy in the stage game.

In what follows, these strategies are referred to as $s_B^d(h^d)$, $s_L^d(h^d)$ and $s_H^d(h^d)$ respectively.[16]

As in the dynamic game analysed in Section 3.2, the Folk Theorem ensures the existence of an equilibrium in these trigger strategies, provided

[16] As in the dynamic game analysed in Section 3.2, notice the somewhat different nature of the strategies between the firms and the buyer, due to the sequential nature of the stage game; while a choice of the quality level different from $\overline{q}$ is detected by the buyer only in the following period, a handicap different from h^d is immediately observed by the firms and triggers a reaction in the same period.

that the players are sufficiently patient. However, the incentive compatibility constraint for the two firms is not straightforward since it depends on the level of the handicap chosen by the buyer and, in turn, on which firm is awarded the project. Full details are contained in the Appendix: it suffices here to say that, when the handicap is sufficiently low, the project is awarded to the efficient firm which delivers the buyer's desidered level of quality; the less efficient firm is instead awarded the project and adheres to the required quality when the handicap is sufficiently large. Intermediate values of the handicap trigger instead a defection by the firm awarded the project. A low/intermediate handicap shrinks too much the profit for the efficient contractor whereas a high/intermediate handicap, thought awarding the contract to less efficient firm, it does not ensure enough reward for the contractor.

The optimal level of the handicap and the resulting equilibrium of the game are characterised in the following Proposition:

Proposition 3. *When the buyer optimally chooses the handicap to maximise its utility,*

- *if* $\psi \leq \delta\overline{q}$, *the buyer sets* $\hat{h}^d = \Delta\theta - \frac{\psi}{\delta}$, *and* $s_B^d(\hat{h}^d)$, $s_L^d(\hat{h}^d)$ *and* $s_H^d(\hat{h}^d)$ *is a self-enforcing profile in which the project is awarded to firm L, which delivers quality* $\overline{q}$. *The discounted present value of the players' payoffs are* $\hat{U}_B^d = \frac{1}{1-\delta}\left(\overline{q} - \theta_L - \frac{\psi}{\delta}\right)$, $\hat{\pi}_L^d = \frac{\psi}{\delta}$ *and* $\hat{\pi}_H^d = 0$;
- *if* $\psi > \delta\overline{q}$, *all players revert to their short-run equilibrium strategy. The discounted present value of the players' payoff are* $\hat{U}_B^d = -\frac{1}{1-\delta}\theta_L$ *and* $\hat{\pi}_L^d = \hat{\pi}_H^d = 0$.

The Proposition shows that, in case of a repeated procurement relation with discriminatory competitive tendering, the use of a handicap ensures the existence of a relational contract whereby the buyer selects the more efficient firm and pays it a price higher than its cost, and the firm delivers the required level of quality. This outcome is an equilibrium provided that the cost of quality is not too high, and the players' discount factor and the valuation of quality are not too small.

Whenever a self-enforcing relational contract exists, it entails setting a handicap which is closer to the static equilibrium level the lower is the variable cost of quality and the higher is the players' discount factor. This ensures that firm L is awarded the project and obtains strictly positive profits, which are used to reward it for delivering the required quality level. These profits, as the handicap, are increasing with the variable cost of quality and decreasing with the players' discount factor. This is because the firm's rent increases the value of the repeated relation and reduces the incentive to cheat on quality; indeed, delivering a quality level lower than required triggers a punishment from the buyer and is therefore less attractive the higher is the firm's discount factor.

4.2 *Nondiscriminatory* competitive tendering

We now analyse the *nondiscriminatory* competitive tendering dynamic game. This dynamic game is denoted with Γ^n and it is given by an infinite repetition of a stage game G^n. This stage game is identical to stage game G^d, with the only difference that, in stage 0, the buyer is constrained to set $h = 0$.

We first solve for the equilibrium of the stage game, making use of Lemmata 1 and 2, in which we simply set $h = 0$. Then, the equilibrium of the game is such that firms' bids are $\tilde{\rho}^n_L = \tilde{\rho}^n_H = \theta_H$ and the project is awarded to firm L at price $\tilde{p}^n = \theta_H$. Firm L delivers the project, choosing $\tilde{q}^n_L = 0$. The payoffs of the players are $\tilde{U}^n = -\theta_H$, and $\tilde{\pi}^n_L = \Delta\theta$ and $\tilde{\pi}^n_H = 0$.

Consider now the dynamic game Γ^n given by an infinite repetition of the static game G_n. We concentrate on trigger strategies and denote them as $s^n_B(0)$, $s^n_L(0)$ and $s^n_H(0)$ for the buyer, firm L and firm H respectively. The firm's strategies are identical as in the previous dynamic competitive game, Γ^d; for the buyer, given the constraint on a *nondiscriminatory* competitive tendering the strategy is as follows:

- **buyer**: the buyer chooses an handicap equal to 0 in all repetitions of the game;

The equilibrium of this game is characterised in the following Proposition

Proposition 4. *For any admissible value of the model's parameters, the equilibrium of game* Γ^n *is with all players reverting to their short-run equilibrium strategy. The discounted present value of the players' payoff are* $\hat{U}_B^n = -\frac{1}{1-\delta}\theta_H$ *and* $\hat{\pi}_L^n = \frac{1}{1-\delta}\Delta\theta$ *and* $\hat{\pi}_H^n = 0$.

The derivation of this result is immediate and the proof is omitted. Indeed, this equilibrium immediately follows from the application of a "degenerate" IC for the more efficient firm, so that

$$\frac{1}{1-\delta}\left(\theta_H - \theta_L - \psi\right) \geq \frac{1}{1-\delta}\left(\theta_H - \theta_L\right) \tag{3}$$

This equilibrium is a trivial repetition of the equilibrium of the stage game. Since the buyer is, on the one hand, constrained to use a competitive procedure, and can use neither the price nor the handicap to reward and/or punish the firm's past actions, the firm finds it optimal to "cheat" on the quality level.

5 Discussion of the results

The comparison among the equilibria of the stage games G^f, G^d and G^n confirms some well known results. First, when quality is not verifiable, neither a direct negotiation nor a competitive procedure - either discriminatory or not - is able to induce the contractor to deliver the required quality level. However, our analysis confirms that, when quality is not verifiable, a buyer is better off by relying on individual negotiations rather than on "simple" competitive procedures (Vincent and Manelli, 1995; and McMillan and Tadelis, 2004). This is because the cost of the project (and, therefore, the buyer's utility) is reduced in the case of individual negotiation relatively to the case of non discriminatory competitive procedure. Instead, the use of a discriminatory competitive procedure allows the buyer to replicate the (still suboptimal) outcome obtained under a direct relationship with the procurer.

In a dynamic setting, the buyer can exploit the repeated nature o the interaction and, not surprisingly, improve the outcome relatively to the static case. Also in this dynamic setting, the best outcome is the one obtained in the context of a direct long-term relation: the desired quality level of the project is obtained, with the only loss in efficiency due to the rent left to the firm to induce it to deliver the required quality. We find however, that an identical outcome can be replicated by using a discriminatory competitive procedure. The handicap here plays a dual role: on one hand, it allows to select the most efficient firm and, on the other hand, it acts as a reward in inducing the required quality level; this last function is identical to the one of the price in the direct relation. This equivalence result is however limited only to those cases in which the social benefits of quality are sufficiently high and/or the discount factor of the firm is sufficiently low. Absent this condition, inducing the same outcome as the direct relation would either be too costly or not worthwhile the rent left to the firm.

6 Conclusions

Competitive tendering and individual negotiation have been put in head-to-head competition when unverifiable quality has to be procured. Competition has been recognized to improve transparency and reduce the procurement cost whereas negotiation procedures are more appropriate when awarding complex services whose quality is unverifiable. If competitive procedures were the only possible instrument in the hands of a (public) procurer, would it be possible to obtain a "reasonable" level of unverifiable quality? Our paper answers this question. Introducing a relational contracting in a competitive auction, in which the buyer distorts the price bids according to the suppliers' previous past performance, induces the contractor to deliver the same level of unverifiable quality obtained with an individual long term negotiation. We, indeed, reconcile the seminal results in Vincent and Manelli

(1995) and McMillan and Tadelis (2004) with the "practical" and "legal" necessity of applying competitive procedures when goods and services whose quality is unverifiable have to be procured.

Appendix

This appendix contains the proofs of the main Propositions of the paper.

Proof of Proposition 1. The Langrangian of problem (2) is:

$$L = \frac{1}{1-\delta}\left(\overline{q}-p\right) + \mu\left(\frac{1}{1-\delta}\left(p-\theta_L-\psi\right) - p + \theta_L\right) \quad (4)$$

FOCs of this problem are

$$\frac{\partial L}{\partial \hat{p}^f} = -\frac{1}{1-\delta} + \hat{\mu}^f\left(\frac{1}{1-\delta} - 1\right) = 0 \quad (5)$$

$$\frac{\partial L}{\partial \hat{\mu}^f} = \frac{1}{1-\delta}\left(\hat{p}^f - \theta - \psi\right) - \hat{p}^f + \theta \geq 0;\ \hat{\mu}^f \geq 0;\ \frac{\partial L}{\partial \hat{\mu}^f}\hat{\mu}^f = 0 \quad (6)$$

From (5), we have $\hat{\mu}^f = \frac{1}{\delta}$; using this in (6), we write $\frac{1}{1-\delta}\left(\hat{p}^f - \theta - \psi\right) - \hat{p}^f + \theta = 0$, which, after rearranging, gives the result.

□

Proof of Proposition 3. The proof proceeds in two steps. First, we prove a Lemma in which we explicit the range of the handicap under which different equilibrium profiles exist. We then characterise the optimal value of the handicap.

Lemma 3. *The strategies profile $s_B^d(h)$, $s_L^d(h)$ and $s_H^d(h)$ is an equilibrium of game Γ^d and the projects is awarded to firm L if*

$$\Delta\theta - \overline{q} \leq h \leq \Delta\theta - \frac{\psi}{\delta}; \quad (7)$$

the strategy profile $s_B^d(h)$, $s_L^d(h)$ and $s_H^d(h)$ is an equilibrium of game Γ^d and the projects is awarded to firm H if

$$\Delta\theta + \frac{\psi}{\delta} \leq h \leq \overline{q}. \quad (8)$$

Proof. Assume the buyer adopts the strategy $s_B^d(h)$ and, in the first stage of period t, chooses an handicap $h \leq \Delta\theta$. If adopting strategies $s_L^d(h)$ and $s_H^d(h)$, the two firms bid $\rho_L = \theta_H - h$ and $\rho_H = \theta_H$, and the project gets awarded to firm L, which gets a payoff equal to

$$\pi_L^C = \theta_H - h - \theta_L - \psi = \Delta\theta - h - \psi. \quad (9)$$

Because of the handicap, firm H cannot make an offer which ensures it gets the project and gets zero profits under both strategies available. On the other hand, firm L could choose to maximise its short run profit: since the optimal bid is identical, this would imply only a different behavior in the third stage of the game and, because of the buyer's punishment, of course in the following periods. Formally, firm L's profits from this alternative strategy are, in the first period (the "deviation" phase), given by

$$\pi_L^D = \theta_H - h - \theta_L = \Delta\theta - h, \tag{10}$$

and in the each of the following periods (the "punishment" phase):

$$\pi_L^P = 0. \tag{11}$$

Therefore, combining (9), (10) and (11), firm L chooses $s_L^d(h)$ whenever the following incentive compatibility constraint holds

$$\frac{1}{1-\delta}\left(\Delta\theta - h - \psi\right) \geq \Delta\theta - h, \tag{12}$$

which could be rewritten as the right inequality in (7). Last, it remains to check that choosing $s_B^d(h)$ is for the buyer the best reply to firm L and H choosing strategies $s_L^d(h)$ and $s_H^d(h)$ respectively; given the timing of the stage game, if the buyer does not choose the handicap h, it is immediately punished by firm L. Then, it suffices to compare the "cooperative" utility $U_B^C = q - (\theta_H - h)$ with the utility in the "punishment" phase, $U_B^P = -\theta_L$, equal to the static utility. This "degenerate" IC reduces to $q - (\theta_H - h) \geq -\theta_L$, equivalent to the left inequality in (7). Assume now the buyer adopts the strategy $s_B^d(h)$ but that, in the first stage of the period of t, chooses an handicap $h > \Delta\theta$. If adopting strategies $s_L^d(h)$ and $s_H^d(h)$, the two firms bid $\rho_L = \theta_L$ and $\rho_H = \theta_L + h$, and the project gets awarded to firm H, which gets a payoff equal to

$$\pi_H^C = \theta_L + h - \theta_H - \psi = h - \Delta\theta - \psi. \tag{13}$$

Because of the initial handicap, firm L cannot make an offer which ensures it gets the project. On the other hand, firm H could choose the alternative strategy to maximise its short run profit: since the optimal bidding is identical, this would imply only a different behavior in the third stage of the game and, because of the buyer's punishment, of course in the following periods. Formally, firm H's profits from this alternative strategy are, in the first period (the "deviation" phase), given by

$$\pi_H^D = \theta_L + h - \theta_H = h - \Delta\theta, \tag{14}$$

After a deviation, the buyer reverses to the optimal static handicap and therefore the project is awarded to firm L. Because of this, the "punishment" payoff for firm H is

$$\pi_H^P = 0. \tag{15}$$

Therefore, combining (13), (14) and (15), firm H chooses $s_H^d(h)$ whenever

$$\frac{1}{1-\delta}(h - \Delta\theta - \psi) \geq h - \Delta\theta, \tag{16}$$

which is equivalent to the left inequality in (8). Last, it remains to check that choosing $s_B^d(h)$ is for the buyer the best reply to firm L and H choosing strategies $s_L^d(h)$ and $s_H^d(h)$ respectively; given the timing of the constituent game, any choice of handicap different from the one which ensures cooperation is immediately punished by the firm awarded the contract. Then, it suffices to compare the buyer's "cooperative" utility, $U_B^C = q - (\theta_L + h)$ with its utility in the "punishment" phase, $U_B^P = -\theta_L$, equal to the static utility. This "degenerate" IC reduces to $q - (\theta_L + h) \geq -\theta_L$, equivalent to the right inequality in (8). □

We now turn to characterising the optimal value of the handicap.

Assume (7) holds: refer to this case as I. The discounted utility for the buyer is $U = \frac{1}{1-\delta}(\overline{q} - \theta_H + h)$. Since the utility of the buyer is clearly increasing in h, the buyer chooses the highest possible value of h consistent with (7), so that $h^I = \Delta\theta - \frac{\psi}{\delta}$. This gives the buyer a discounted utility equal to

$$U_B^I = \frac{1}{1-\delta}\left(\overline{q} - \theta_L - \frac{\psi}{\delta}\right). \tag{17}$$

Given the handicap h_L^I, the left inequality in (7) reduces to

$$\psi \leq \delta\overline{q} \equiv \psi^I. \tag{18}$$

Assume now (8) holds: refer to this case as case *IV*. The discounted utility for the buyer is $U = \frac{1}{1-\delta}(\overline{q} - \theta_L - h)$. Since the utility of the buyer is clearly decreasing in h, the buyer chooses the lowest possible value of h consistent with (8), so that $h^{IV} = \Delta\theta + \frac{\psi}{\delta}$. This gives the buyer utility equal to

$$U_B^{IV} = \frac{\delta(\overline{q} - \theta_H) - \psi}{\delta(1-\delta)}. \tag{19}$$

Given the handicap h^{IV}, the right inequality in (8) reduces to

$$\psi \leq \delta(\overline{q} - \Delta\theta) \equiv \psi^{IV}. \tag{20}$$

Assume now that $\Delta\theta - \frac{\psi}{\delta} \leq h \leq \Delta\theta$: refer to this case as case *II*. Since neither (7) nor (8) hold, optimal strategy for firm L and H is to maximise their short run profits, i.e. they both bid according to Lemma 1 and firm L, which is awarded the project because of the handicap, does not deliver the bid quality. Anticipating this, also the buyer optimally chooses to maximise its short run utilities, i.e. chooses the handicap $h^{II} = \Delta\theta$. This equilibrium gives the buyer utility equal to

$$U_B^{II} = -\frac{1}{1-\delta}\theta_L. \tag{21}$$

Assume now that $\Delta\theta \leq h \leq \Delta\theta + \frac{\psi}{\delta}$: refer to this case as case *III*. Since neither (7) nor (8) hold, optimal strategy for firm L and H is to maximise their short run profits, i.e. they both bid according to Lemma 1 and firm H, which is awarded the project because of the handicap, does not deliver the bid quality. Since the buyer anticipates this, its optimal choice is to maximise its short run utilities, which however would entail choosing an handicap $h = \Delta\theta$, a contradiction. This proves that, under parametric conditions in this case, an equilibrium does not exist.

We now turn to compare the utility levels of the buyer under different candidate equilibria. We start by noting that $U_B^{II} \geq U_B^{IV}$ whenever $\psi \geq \psi^{IV}$; this implies that, whenever an equilibrium as in case *IV* is feasible, this is dominated by an equilibrium as in the case *II*. Also observe that $U_B^{I} \geq U_B^{II}$ whenever $\psi \leq \psi^{I}$; this implies that an equilibrium as in case *I*, when feasible, always dominates an equilibrium as in case *II*. Finally, noting that $\psi^{IV} < \psi^{I}$ establishes the result.

□

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