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ABSTRACT

Reputation and Entry in Procurement*

There is widespread concern that favoring suppliers with good past performance, a standard practice in private procurement, may hinder entry by new firms in public procurement markets. In this paper we report results from a laboratory experiment exploring the relationship between reputation and entry in procurement. We implement a repeated procurement game with reputational incentives for quality and the possibility of entry. We allow also the entrant to start off with a positive reputational score. Our results suggest that while some past-performance based reputational mechanisms do reduce the frequency of entry, appropriately designed mechanisms can significantly increase it. Moreover, the reputational mechanism we investigate typically increases quality but not prices, suggesting that well designed mechanisms may generate very large gains for buyers and taxpayers.

JEL Classification: H57, L14 and L15
Keywords: bid preferences, entry, feedback mechanisms, outsourcing, past performance, procurement, quality assurance, reputation and vendor rating

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1 Introduction

Does reputation deter entry? If buyers are allowed to use reputational indicators based on past performance in selecting among sellers, does this necessarily reduce the ability of sellers with no history of past performance—start-ups, small and foreign suppliers—to enter the market? In the US the Federal Acquisition Regulation (FAR) *requires* government agencies to consider past performance when awarding contracts. This requirement has drawn recent criticism, however, as a handful of prominent US Senators have voiced their concern that it may hinder the ability of small businesses to enter into and win competitions for public contracts. The debate led the General Accountability Office to study dozens of procurement decisions across multiple government agencies in 2011. The resulting report, while inconclusive, contains some intriguing support for the Senators' concern.[1] Despite extensive and costly policies aimed at fostering small business' access to US procurement markets,[2] the report "...identified only one procurement in which offerors ...lacked relevant past performance."

On the other side of the pond, European regulators appear to have always been convinced that allowing the use of reputational indicators as criteria for selecting among contractors leads to manipulations in favor of local incumbents, hindering entry, cross-border procurement and common market integration—the main objective of the EU. For this reason, EU Procurement Directives *explicitly prohibit* taking suppliers' track records into account when comparing their bids. Moreover, EU regulators continue to resist requests to permit their use coming from most public buyers.[3]

The main reason why European public buyers are pushing to permit the use of past-performance indicators in selecting among contractors is that they consider reputational indicators essential to obtain good value for the taxpayers' money. If, however, these indicators deter entry, there may be a trade-off between the improvement in price/quality ratios buyers can secure using reputational indicators and the decrease in the likelihood that new suppliers will enter the market as EU regulators and US senators fear.

To shed light on this controversial issue, we implement a repeated procurement game with reputational incentives for quality and the possibility of entry in the lab. We focus on reputation as an incentive system to limit moral hazard in the quality dimension as well as its effect on selection through entry.

We develop a simple three-period model of competitive procurement with non-contractible quality provision/investment that incorporates the possibility of entry by a more efficient com-

[1] See *Prior Experience and Past Performance as Evaluation Criteria in the Award of Federal Construction Contracts*, Oct. 2011, available at `http://www.gao.gov/products/GAO-12-102R`. The inquiry had a qualitative nature and did not reach clear conclusions in our reading.

[2] See e.g. Athey, Dominique and Levin (2013), and references therein.

[3] See the EU Green Book for the *Consultation on the Modernisation of EU Public Procurement Policy*, 2011, and the Replies to the Consultation available at `http://ec.europa.eu/internal_market/publicprocurement/modernising_rules/consultations/index_en.htm`.

petitor in the third and final period. We then allow reputation to matter by adding a simple and transparent past-performance-based mechanism akin to widely-used vendor rating systems: past provision of high quality yields an advantage in the current stage. We implement this advantage in the form of a bid subsidy, a mechanism which Athey et al. (2013) single out as being particularly promising in real-world procurement auctions. Across treatments we vary both the existence of a reputational mechanism and, when a reputational mechanism is present, the relative size of the bid subsidy potential entrants enjoy. We use this framework, first and foremost, to ask whether reputation-based procurement must necessarily deter entry.

We then dig deeper to investigate precisely how the relative size of the entrant's reputational advantage (bid subsidy) affects both the quality level produced by sellers and the total costs paid by the buyer/procurer. We also evaluate the effects of these mechanisms on welfare functions with different weights. Reputational mechanisms that reward past performance are an important governance mechanism for private transactions (Bannejee and Duflo, 2000).

In the real world direct and indirect litigation costs are high and court-enforced contracts are often not sufficient to achieve a satisfactory governance of the exchange. Since procurement is rarely occasional, reputational forces complement and improve substantially on what formal contracting can achieve. Private buyers, however, are typically only concerned about the price and quality of the goods they buy. Regulators in charge of public procurement may be, instead, also interested in objectives other than the price/quality ratio of publicly purchased goods. For example, they are also usually concerned that the public procurement process is transparent and open for obvious accountability reasons although this may not always the case in practice.[4] In addition, regulators may want to ensure that small businesses are not excluded from public procurement, a concern that in the US led to large programs like the Small Business Act, with its rules limiting bundling, the establishment of the Small Business Agency and "set aside" programs trying to stimulate small business entry in many procurement markets.[5] This leads us to consider different weights for quality, price and entry in our welfare function.

A main novelty of our reputational mechanism is the provision of a bid subsidy to the potential entrant. This aspect of our design is meant to address a common misconception. It is often taken as granted in the policy debate that reputational mechanisms must be designed so that entrant firms with no history of production would start with "zero reputation"—i.e., on equal footing with an incumbent firm having the worst possible track record—which would obviously give incumbent firms an advantage that might deter new entrants. However, in the

[4]Djankow et al. (2002), in a cross section comparison of 85 counties, show stricter regulation of entry is associated with higher levels of corruption and greater size of unofficial economic, suggesting entry is often regulated in the interest of regulators and not of the consumers. See also Bandiera, Prat and Valletti (2009) as well as Coviello and Gagliarducci (2010).

[5]Athey, Coey and Levine (2013) provide empirical evidence that such "set-asides" typically foster entry by smaller firms at the cost of lower efficiency and revenues. They go on to show that an alternative policy similar to the one we study, i.e., subsidizing small bidders, may foster entry without reducing efficiency or revenues.

case of public procurement and of firms' vendor rating systems, reputational mechanisms may feasibly be based on formal public rules that give commitment power to the buyer and can be designed in many different ways, as the economic literature on eBay's reputational mechanism testifies. A buyer with some commitment power on its rules for selecting suppliers, as well as for information aggregation and diffusion, may well award a positive rating to new entrants—e.g., the maximum possible rating, or the average rating in the market, putting entrants at less of a disadvantage—and ensure that this is taken into account by the scoring rule that selects the contractor, even if the contractor has never before interacted with the buyer.

Our findings suggest there need not be a trade-off between reputation and entry. We find that reputational mechanisms increase quality and reduce entry when an entrant starts off with a zero reputational score, confirming that the concerns of the US senators and the EU regulators discussed earlier are in principle justified. However, when the mechanism awards a positive reputational score to new entrants, we find that entry increases significantly relative to the benchmark treatment without a reputational mechanism while quality remains as high as in other treatments with reputation only for incumbents.

Our study is admittedly confined to a simple procurement game tested in a stylized laboratory setting. However, if confirmed by further empirical and experimental evidence our results imply that the dual goals of providing incentives for quality provision and increasing entry are not mutually exclusive—they are both achievable through an appropriately designed reputational mechanism. Moreover, since the reaction of prices to the presence of bid subsidies that we observe is weak, it seems that the increase in quality and entry may come at little cost for the buyer or the taxpayer.

The remainder of the paper proceeds as follows. In the next section, we discuss our theoretical model and, in the following section, present our experimental design. In Section 4, we present the results from our experiment. Section 5 discusses how our results relate to the existing literature. Section 6 provides some concluding remarks.

2 Theoretical framework

2.1 The game

We develop a simple dynamic game consisting of a sequence of three stages of homogeneous goods price competition on a discrete price grid with each static stage similar—if we abstract from the reputational mechanism, the repetition, and the possibility of entry—to the game studied in Dufwenberg and Gneezy (2000, 2002). Each stage in this sequence can be interpreted as a Bertrand competition game. Alternatively, each stage in our setting can be viewed as a first-price simultaneous-bid procurement auction for a contract with known common value.[6] This framework also mimics cases in which quality is only verifiable ex-post at high costs for the buyer or where enforcement is highly expensive, time consuming and detrimental for the long-run relations between buyers and sellers.

There are three players: two Incumbent firms and one Entrant firm. Incumbent firms participate in all three stages, while Entrant firms may participate only in the third stage. We give the entrant a cost advantage to create an efficiency justification to incentivize entry. The advantage is only on low quality provision since for the entrant the game ends after its decision and there is no reason for it to incur the additional cost of providing high quality. We choose a three-stage sequence to make the theory and experiment as simple as possible while still allowing for the features in which we are primarily interested. In particular, three is the minimum number of competitive stages allowing for investing in reputation (Stage 1) and potentially reaping the gains from such investment (Stage 2) before a new, more efficient, firm has the option of entering the market (Stage 3).

In each of the three stages comprising the sequence, bids are discrete and submitted simultaneously with the lowest bid winning. Ties are broken by selecting a winner (uniformly) randomly from among the firms submitting the lowest bid. The winning firm must produce the good, but can choose whether to produce a high quality good at a relatively high cost, or to produce a low quality good at a lower cost. The Entrant firm has a cost advantage in producing low quality: it can produce low quality at cost $c_L^e = c_L - k$, where c_L is the Incumbent firms' (common) cost of producing low quality, and $k > 0$ is a constant capturing the Entrant firms' higher efficiency. Both Incumbent firms and the Entrant firm face a cost of $c_H > c_L$ to produce a high quality good or service.

While producing high quality is relatively costly, it may yield reputational benefits. The essential characteristic of a reputational benefit is that, holding bids constant, it puts a firm with "good reputation" at an advantage by subsidizing its bid relative to that of competitors with poor reputation. We introduce a reputational benefit in a simple transparent way: by instituting a direct bid multiplier that applies for the immediately subsequent stage only. Specifically, for $t \in \{2, 3\}$, if the winning Incumbent firm in stage $t-1$ delivered the high quality good and also wins in stage t, this firm is paid a multiple B of its stage t bid, with $B \geq 1$. In this way, Incumbent firms that choose to produce high quality today enjoy a bid advantage in tomorrow's stage, since for them the minimum bid required to win and recoup the past investment in high

[6] We adopt Dufwenberg and Gneezy's (2000, 2002) assumption that firms are fully informed because it simplifies the environment, allowing us and the subjects to better focus on the per se complex dynamic choices of price, quality provision and entry under different reputational regimes. However, the assumption may not be far from reality in the procurement environments we are focusing on, where reputation/past performance may be important. These are typically characterized by a more or less stable group of firms regularly competing to win contracts from several common buyers. Such a frequent and prolonged interaction offers ample opportunities for learning about each other even if we abstract from the effects of the natural turnover of employees between firms in the same industry.

quality is lower.[7]

To investigate the effects of a reputational mechanism on Entrant firms' behavior while incorporating the idea that such a mechanism may well assign a positive reputational score to a new firm or potential entrant, we assign a bid multiplier, $\beta \geq 1$, to the Entrant firm. We consider three main cases: i) an Entrant firm bid multiplier equal to the maximum possible for an Incumbent firm ($\beta = B$, "High Bonus" treatment); ii) an Entrant firm bid multiplier equal to half of that of an incumbent that produced high quality in the previous period ($\beta = \frac{(B+1)}{2}$, "Middle Bonus" treatment), corresponding to the average market reputation when one of the incumbents has high reputation; and finally, iii) an Entrant firm bid multiplier equal to the minimum possible for an Incumbent firm, i.e. no reputation at all ($\beta = 1$, "Low Bonus" treatment). The first case is analogous to supplier qualification and quality assurance systems common in the private sector where all qualified suppliers start with a fixed maximum number of points, lose points for bad performance and may regain them through good performance but only up to the initial, maximal level. Points-based driver's license incentive systems are also designed this way in many countries. The last case corresponds to a more standard reputational system where new firms without track records start out with "zero" reputation. The second case represents a compromise between these two extremes. These rules are common knowledge among all players. Finally, as a baseline case, we also consider the above sequential three-stage game with no reputational mechanism at all. That is to say, in this baseline case we set both the Incumbent firms' and the Entrant firm's bid multipliers equal to 1 ($B = \beta = 1$).

2.2 Solution and parameterization

2.2.1 Without a reputational mechanism (Baseline)

In the case where no reputational mechanism exists, equilibrium predictions are straightforward. This is simply a case of repeated homogeneous good Bertrand competition with discrete prices, augmented by the possibility of entry in the third and last round—symmetric in the first round, possibly asymmetric in the last two because of the entrant's efficiency advantage. High quality production yields no advantage to any firm and is consequently never produced. Winning bids are driven down to the Incumbent firms' marginal cost of producing low quality (c_L) in each of the first two stages. In the third stage, the Entrant firm enters and bids c_L only if its efficiency advantage is high enough relative to its reservation wage ($k \geq w$).[8]

[7] Note that the bid advantage lasts only for one stage. One way to interpret this is that the length of the buyer's memory about seller's past performance is only one stage.

[8] The Entrant firm's profit from winning must be at least as large as its reservation wage in order to justify entry: $c_L - (c_L - k) \geq w$.

2.2.2 With a reputational mechanism

When a reputational mechanism is implemented, equilibrium predictions become slightly more complicated. While multiple equilibria are possible, we restrict attention to two particular pure strategy subgame perfect Nash equilibria that seem particularly intuitive and relevant to the conjecture we aim to test.[9] In the first equilibrium—"entry-accommodation"—the Incumbent firm that wins the first stage provides high quality in that stage and then goes on to exploit its reputational advantage by winning the second stage, receiving its (multiplied) winning bid and producing low quality.[10] In doing so, the incumbent firm accommodates entry in the third and last stage since it arrives there without a reputational bid advantage. The more efficient Entrant firm optimally enters and wins in the last stage, provided its reservation wage is not too tempting—i.e., $k \geq w$—producing low quality.

In the second equilibrium—"entry deterrence"—the Incumbent firm that wins in Stage 1 produces high quality and then uses its reputational advantage to win in Stage 2 as well. However, unlike the previous equilibrium, this Incumbent firm preserves its reputational advantage into Stage 3 by producing high quality in the second stage. Consequently, the Entrant firm finds it optimal to not enter. Obviously, the existence of this latter equilibrium depends on both the Entrant firm's bid multiplier, β, and its efficiency advantage, k.

We solve the model and find parameter values simple enough to incorporate into our experimental design which ensure that equilibrium predictions vary across the three broad levels of reputation assigned to Entrant firms under consideration: $\beta = B$; $\beta = \frac{(B+1)}{2}$; and $\beta = 1$. Accordingly, we implement the following parameter values in our experiment: $B = 2$; $c_L = 1.5$; $c_H = 2$; $w = 1$; and $k = 1.375$. These parameters make the entry deterrence equilibrium, the entry accommodation equilibrium, or both, possible in the low bonus, high bonus and middle bonus treatments, respectively.

3 Experimental Design

3.1 The basic structure

The experiment consisted of four different treatments. In all four treatments, participants played from twelve to fifteen rounds of the game described above, where a complete three-stage sequence constitutes a round. Before each round, participants were randomly and anonymously divided into groups of three and then randomly assigned one of two roles: two participants in each three-person group were assigned the role of "Incumbent firm", while the third person in

[9]Reassuringly, the data from the experiment turn out to be consistent with subjects mainly focusing on these two pure strategy equilibria.

[10]Note that the existence of a second stage allows a virtuous incumbent to recoup the initial (reputational) investment in high quality production in the absence of the entry threat.

each group was assigned the role of "Entrant firm".[11] Participants were instructed that at the end of the experiment one round would be randomly chosen to count toward their experimental earnings.

Within each round and each group of three, play proceeded as follows. Incumbent firms participated in all three stages of a round. By contrast, Entrant firms did not participate in the first two stages but did observe all bids and outcomes of the first two stages within their 3-person group. For each of the first two stages, Entrant firms earned a fixed outside wage of $w = 1$ euro. Before the third stage of the round began, Entrant firms decided whether to participate in this last stage and forgo their outside wage, w, or to stay out of even this last stage and earn w. Incumbent firms never earned an outside wage in any period.

Within each stage, bids were submitted simultaneously with the lowest bid winning in that stage. All bids within the set $\{0.00, \ldots, 4.50\}$ were permitted.[12] Ties were broken by randomly choosing among the firms submitting the lowest bid. The winning firm then decided to produce either a low quality good at cost c_L ($c_L^e = c_L - k$ for Entrant firms), or a high quality good at cost $c_H > c_L$. Losing firms earned nothing, while the earnings of winning firms varied by treatment (detailed below). At the end of each stage, participants learned the bids of the other firm(s) in their own three-person groups, as well as the production decision of the winning firm in their group. Before the third stage began, participants were informed of the entry decision of the Entrant firm in their group. Participants were not informed about choices in groups other than their own.

The basic structure just outlined was common to all four treatments. Three of these treatments involved a formal reputational mechanism while in the fourth, "Baseline," treatment no formal reputational mechanism was implemented. Let us first consider the treatments with a reputational mechanism.

3.2 Treatments with reputation

The reputational mechanism we implemented took the form of the simple bid multiplier described earlier. Incumbent firms' bid multiplier, B, was the same in all treatments involving reputation. In these treatments, we set $B = 2$: an incumbent firm that wins in Stage $t \geq 1$, produces high quality and then subsequently wins in Stage $t + 1$ with winning bid b is paid $2b$ by the buyer, resulting in Stage $t + 1$ profits of $2b - c$, where $c \in \{c_H, c_L\}$, according to the firm's quality production decision in Stage $t+1$. In Stage 1, no firm received any bid multiplier.

[11] We use the terms "Incumbent" and "Entrant" here for clarity of exposition. Neutral language was used in the experiment. Specifically, roles were referred to as "Firm A", "Firm B" and "Firm C", with the first two being incumbents and the latter the entrant.

[12] We capped allowable bids at 4.50 euros as a precaution against the unlikely possibility of firms colluding on very high bids. This maximum was set to be substantially higher than would be expected in any equilibrium of the game. The precaution turned out to be unnecessary, as even though setting an explicit upper bound on bids in all likelihood enhanced the opportunity for collusion by creating a focal point, successful collusion on bids of 4.50 euros was essentially non-existent in the data.

What we varied across the three treatments involving a reputational mechanism was the bid multiplier for Entrant firms: β. In the High Bonus (HB) treatment, we set $\beta = B = 2$, giving entrants the same reputation as an incumbent that produced high quality in the previous stage. In the Low Bonus (LB) treatment we set $\beta = 1$ so that entrants, like incumbents that produced low quality just prior, enjoyed no strict bid subsidy. In the Medium Bonus (MB) treatment we set $\beta = 1.5$, providing entrants an intermediate level of reputational advantage. Since Entrant firms participated in at most the third stage, their bid multiplier was not contingent on previous production decisions. Specifically, an Entrant firm winning in Stage 3 with bid b earned $\beta b - c$, where $c \in \{c_H, c_L^e\}$, according to the Entrant firm's quality production decision.

3.3 Baseline treatment

In our baseline treatment, we omitted the bid multiplier for both Incumbent firms and Entrant firms (i.e., we set $\beta = B = 1$). Hence, this baseline treatment involved no formal reputational mechanism. Otherwise, the design was identical to the three treatments (HB, MB, LB) detailed above. Winning Incumbent (Entrant) firms earned their bid minus the cost of production, $b-c$, where $c \in \{c_H, c_L\}$ ($c \in \{c_H, c_L^e\}$), depending on the firm's production decision.

3.4 Implementation

All sessions of the experiment were conducted in the laboratory facilities at the Einaudi Institute for Economics and Finance in Rome, Italy, using the software *z-Tree* (Fischbacher, 2007). Twelve sessions were conducted involving a total of 243 participants. Average earnings in the experiment were approximately 12 euros, including payment for a risk elicitation task conducted after all rounds of the game were completed but *before* participants knew which round would be chosen to determine their earnings.[13] Participants did not know about this subsequent risk elicitation task when they were playing the game. Each session lasted about two hours. Information on all four treatments is summarized in Table 1.

Insert Table 1 about here.

4 Results

Our experimental outcomes of interest are the proportion of winning firms producing high quality, the cost to the buyer—which we call the "buyer's (total) transfer" to avoid confusion

[13] We included the risk elicitation task in order to insure participants made a reasonable amount of money, as our equilibrium predictions suggested they would make little money from the auctions—a common dilemma when implementing Bertrand competition games in the lab. The risk elicitation task involved a sequence of choices between a sure payment of €5 and a lottery involving a 50% chance of a low payoff (€2.50) and a 50% chance of a high payoff, which increased over the sequence from €7.50 to €17 in steps of €0.50. More risk averse individuals should switch from preferring the sure payment to the lottery later in the sequence, so we take this switch point as an index of each participant's risk aversion. If there were multiple switch points, we follow much of the literature using related mechanisms and only consider the first switch point. One choice in the sequence was randomly chosen to count, with uncertainty being resolved, if necessary, by flipping a coin.

with the sellers' costs of producing—as well as the proportion of Entrant firms choosing to enter. We first consider each of these outcomes in isolation and then consider buyers' welfare, which may incorporate some or all of these outcomes simultaneously.

4.1 Quality provision

Let us first examine quality provision, since encouraging high quality goods provision is a primary reason buyers might prefer to implement some form of reputational mechanism. In Table 2, we report the average proportion of winning firms providing high quality. We observe a remarkable increase in high quality provision in the first two stages in all treatments which involve a reputational mechanism relative to the baseline treatment, which lacks such a mechanism. For example, in Stage 1 about 80% of winning firms provide high quality whenever there is a reputational mechanism, whereas in the baseline treatment only 18% of winning firms provide high quality—a 340 percent increase in the likelihood of high quality provision. Averaging across all three stages (Table 2, last column), high quality provision is consistently about four times more likely with a reputational mechanism than without one.[14]

Insert Table 2 about here.

Result 1: *The introduction of a reputation mechanism significantly increases supplied quality.*

More formally, in Table 3 we estimate probit models of the binary decision to provide high quality in each of the stages separately (columns 1-3). In column 4, we pool observations from all three stages and estimate a Tobit model, using as the dependent variable the proportion of the three stages in which the winning firm provided high quality. In each of these estimates we control for dynamic effects, such as learning, by including the round of the observation as a control.[15] In these and all subsequent model estimates, unless otherwise noted we cluster standard errors by session to allow for arbitrary within-session correlation of behavior. Confirming appearances in the raw data, we find that high quality provision is significantly higher in all of our reputational mechanism treatments relative to the baseline treatment (the excluded category).

Finally, notice that in all treatments except the baseline, quality provision declines precipitously from the second stage to the third. This suggests that participants generally understood the strategic incentives inherent in each three-stage sequence, as there is no reputational incentive to produce high quality in Stage 3. At the same time, even in Stage 3 quality provision

[14] In the Appendix (Table A1), we report a battery of pairwise non-parametric Mann-Whitney tests confirming the statistical significance of many of the large differences observed in the raw numbers: in Stages 1 and 2, Mann-Whitney tests reveal that quality provision in the baseline treatment is significantly different from all other treatments; differences among the non-baseline treatments themselves are generally not significant.

[15] In the Appendix (Table B1), we allow for more flexible dynamic effects by introducing a full set of round dummies into our model estimates. Nothing changes either qualitatively or in terms of statistical significance.

is significantly lower in the baseline treatment than in any other treatment. One plausible explanation that would provide a further unintended benefit of implementing a reputational mechanism is that participants acquired a "habit" of high quality provision in the first two stages which carried over to the third stage. Other possible explanations include "framing" or symbolic effects generated by the reputational mechanism. In any event, the effect is relatively small in magnitude, so we do not focus on it here.

Insert Table 3 about here.

4.2 Entry

Having confirmed that introducing a reputational mechanism can substantially increase costly quality provision, we are now in a position to address the central question of our inquiry: is there necessarily a trade-off between reputation and entry? In Table 4, we report the proportion of Entrant firms choosing to enter Stage 3. These raw data suggest that a reputational mechanism which assigns no bid subsidy to the Entrant firm (LB) may indeed hinder entry, as feared by US Senators and EU regulators. At the same time, however, our data suggest that a *properly calibrated* reputational mechanism need not. Indeed, in both treatments where the Entrant firm is not assigned the worst possible reputation—MB and HB—our reputation mechanism tends to *increase* entry.[16]

Insert Table 4 about here.

To get a more formal sense of the significance of the effect of our reputational mechanism on entry, in Table 5 we report marginal effects estimates from a probit model using, as the dependent variable, an indicator taking the value one if the Entrant firm decided to enter Stage 3. On the right hand side, we include a set of treatment dummy variables with the baseline treatment as the excluded category. To account for dynamic patterns in a simple way, we control for the round of the observation.[17] We find that entry is significantly higher relative to the baseline treatment, both economically and statistically, whenever the Entrant firm is not assigned the worst possible reputation. In treatments MB and HB, the estimated marginal effect of a reputational mechanism is to increase entry by 8 to 10 percentage points. On the other hand, we also find that the decline in entry observed in the raw data when Entrant firms are assigned poor reputation (LB) is not statistically significant.

Insert Table 5 about here.

[16] As before, a battery of pairwise non-parametric tests of entry by treatment is reported in the Appendix (Table A2), supporting the notion that the introduction of a reputational mechanism can either significantly increase or decrease entry, depending on the relative reputational score assigned to the Entrant firm.

[17] A more flexible specification for dynamic patterns, incorporating a full set of round dummy variables, can be found in the Appendix, Table B2. This more flexible specification does not yield substantially different estimates.

Result 2a: *The introduction of a reputational mechanism that assigns no reputation to an entrant reduces the frequency of entry—although the effect is not statistically significant.*

Result 2b: *The introduction of an appropriately designed reputation mechanism that assigns a positive reputation score to an entrant significantly increases the frequency of entry relative to the benchmark treatment without reputation.*

4.3 Buyer's transfer

Because our results suggest that the effect of reputation on entry depends on the relative level of the Entrant firm's bid subsidy, a natural question to ask is whether the most desirable outcome of high quality coupled with high entry comes at a significant increase in costs to the buyer. To avoid confusion with firms' costs of production, in the discussion that follows we refer to the total amount the buyer pays to the winning seller, accounting for any relevant bid subsidy, as the "buyer's transfer."

In Table 6 we report average buyers' transfers by treatment and stage, as well as the average buyer's transfer across all three stages. Our data suggest there is only a mild effect of even large bid subsidies on buyers' transfers. Buyers' transfers are generally lower in the first stage when there is a reputational mechanism than when there is not, reflecting competition for the bid advantage that reputation entails in the subsequent stage. Competition is apparently fierce. Considering the average buyer's transfer across all three stages, there is a surprisingly mild effect of our reputational mechanism on buyers' transfers, even though costly quality provision increases dramatically, suggesting that sellers fully incorporate future reputational advantages when constructing their Stage 1 bids while competition on bids guarantees that prices for the buyer do not increase significantly.[18]

Insert Table 6 about here.

To confirm this appearance, in Table 7 we present OLS estimates of buyers' transfers across treatments and stages. As usual, we control for dynamic effects in a simple manner here and report estimates allowing for more flexible dynamic patterns in the Appendix (Table B3). In both specifications, we find that introducing a reputational mechanism significantly lowers buyers' transfers in Stage 1. In subsequent stages, buyers' transfers may be higher or lower depending on the size of the Entrant firm's bonus, but the effects are generally mild and statistically non-significant. Considering buyers' transfers averaged over all three stages (Column 4), introducing a reputational mechanism never has a significant effect. This latter finding strengthens

[18]Moreover, the result that high quality provision comes at no increased cost to the buyer suggests competition increased relative to our Baseline treatment. This is perhaps because the added complexity and dynamic considerations associated with our reputational mechanism made coordination more difficult and/or deviation/leadership more attractive, as in Gale and Sabourian (2005).

the interpretation that profit opportunities provided by bid subsidies are fully competed away and that, consequently, the increase in quality comes at no cost to the buyer.

Insert Table 7 about here.

Result 3: *The introduction of a reputational mechanism does not increase the transfer paid by the buyer.*

4.4 Buyer's preferences: theoretical and empirical welfare functions

As a final exercise before concluding, in this section we construct a welfare function for buyers and examine how buyer's welfare varies, both theoretically and empirically, over our treatments.[19] In particular, we suppose that the buyer derives utility from three additively separable components: buyer's transfer (negatively), quality and entry. We model this in a flexible manner by assuming buyer's welfare is a simple weighted average of these three components. We then compare the welfare generated by each of our treatments—both theoretically, using equilibrium predictions, and empirically, using the experimental data—in two cases: i) buyers place equal weight on entry, quality and buyer's transfer; and ii) the buyer does not care directly about entry, but rather divides all weight equally between the remaining two components. One can think of the first case as representing the situation in the EU, where increasing cross-border entry per se is a main political objective; the latter case may be closer to the US, where entry is valued only insofar as it increases efficiency and value-for-money for the taxpayer.

The welfare function we consider is $W = \alpha D + \delta Q + \gamma Pr(E)$, where $\alpha + \delta + \gamma \leq 1$; $D = \frac{4.5 - \frac{\sum_{t=1}^{3} T_t}{3}}{4.5}$; and T_t is the transfer from buyer to seller (i.e., [winning bid]*[relevant bid multiplier]) in Stage t. Notice that since 4.5 is the maximum allowable bid in the experiment, D is a measure of the "discount" below the maximum possible price buyers could pay excluding bid subsidies. This serves as a convenient normalization of the buyer's transfer component of welfare on a $0 - 1$ scale. The other two components of the welfare function are straightforward: Q is the proportion of the three stages in which high quality is produced; and $Pr(E)$ is the probability that—or the proportion of observations in which—entry occurs in the third stage. Weights are also normalized so that $\delta = (1 - \alpha - \gamma)$.[20]

Using the parameters chosen for the experiment, we calculate the buyer's theoretical welfare by computing the equilibrium values of D, Q and $Pr(E)$ for each treatment and then evaluating buyer's welfare in each treatment for the welfare function weights implied by the two cases

[19] We are grateful to Gary Charness for suggesting this last exercise.

[20] In the MB [$B = 2$; $\beta = 1.5$] and baseline [$B = \beta = 1$] treatments, both the entry accommodation equilibrium and the entry deterrence scenario are possible. In these treatments, we calculate the average expected welfare as $W = E(W) = \frac{w(acc)+w(det)}{2}$, where $w(acc)$ is the welfare generated from the entry accommodation and $w(det)$ is the welfare generated from the entry deterrence. In the other treatments, because we are assuming bids are discrete with bid increment $\epsilon > 0$, there are (essentially) unique predictions.

mentioned above: case i) $\alpha = \gamma = \frac{1}{3}$; and case ii) $\alpha = \gamma = \frac{1}{2}$. We report buyer's theoretical welfare levels in these two cases in Table 8.

Insert Table 8 about here.

In case i) where buyers care about entry, quality and transfers equally, we find the highest buyer welfare in the HB treatment (when $B = \beta = 2$, $W = 0.71$), where the theoretical equilibrium frequency of entry is largest. On the other hand, in case ii) where buyers do not care about entry directly, but, rather, only about quality and transfers, buyer's welfare is maximized in the LB treatment (when $B = 2$ and $\beta = 1$, $W = 0.73$), where the possibility of entry constrains bids and increases quality. Importantly, in both cases we consider, having a reputational mechanism in place increases buyer's welfare. To determine whether a similar result holds in our data, we next consider the empirical analogue of our theoretical buyer's welfare function. We measure quality, Q, by the average proportion of winning firms providing high quality across all three stages. We measure entry probability, $Pr(E)$, as the average proportion of Entrant firms entering in Stage 3. As our measure of buyer's transfers, we calculate D according to the formula described above. Table 9 reports our empirical estimates of buyer's welfare.

Insert Table 9 about here.

As with theoretical welfare, for both sets of weights considered buyers can always achieve higher welfare with a reputational mechanism than without. Differently from our theoretical analysis, however, buyer's welfare is always maximized in the MB treatment, where Entrant firms are given neither the highest nor lowest possible reputation score. This difference is likely due to Entrant firms basing their entry decisions on the bid subsidy to a lesser extent than our simple theoretical framework predicts. For example, entering Stage 3 with probability less than one when the Entrant firm's bid-subsidy is relatively high (HB), as we observe in the data, reduces the empirical welfare advantage of HB over MB when buyers care about entry directly.

Result 4: *Introducing a reputation mechanism increases buyer's welfare, whether or not the buyer cares directly about the likelihood of entry.*

5 Related literature

Our study is related to a large literature investigating reputation using laboratory or field experiments. One prominent strand of this literature implements games closely mirroring Kreps and Wilson (1982), according to which beliefs-based reputation can have a beneficial effect for a long-run player, allowing this player to earn higher equilibrium payoffs than possible without reputation. Early studies show that experimental participants' behavior fits reasonably well with theoretical predictions, lending credence to the importance and potential benefit of beliefs-based reputation (Camerer and Weigelt, 1988).[21] We sidestep the debate about the source and strength of reputation by considering a procurement game with complete and perfect information that implements a formal reputation mechanism in the form of a bid multiplier based on past quality provision. This explicit reputational mechanism is particularly relevant to the case of public procurement, where transparency and accountability concerns dictate formal rules-based mechanisms.

Brown, Falk and Fehr (2004, 2012) and Bartling, Fehr and Schmidt (2012) also study reputational incentives in the laboratory and find that competition may reinforce the effects of reputation and its interaction with social preferences. More closely related to our framework are the studies by Dufwenberg and Gneezy (2000, 2002)[22] who show that: i) only by increasing the number of competitors is the Bertrand equilibrium reached; and ii) if previous losing bids are observable, winning bids are higher (i.e., competitive forces are weaker), suggesting that reputation between bidders affects efficiency. The fact that we observe prices consistently above the Bertrand solution in our Baseline treatment, the most closely related to these prior studies, can be seen as consistent with their results, suggesting that with more competitors prices in our baseline treatment would possibly be lower. On the other hand, our finding that competition increases with the introduction of a reputation system that generates asymmetry and complexity, leading to higher quality but not higher prices, suggests that our reputational mechanism may have effects similar to an increase in the number of competitors.

More recently, Brosig and Heinrich (2011) implement different types of procurement games and find that when buyers have discretion to choose among sellers the latter invest in reputation by providing high quality. In contrast, when buyers lack discretion sellers do not invest in reputation. Consequently, buyer discretion increases market efficiency with the benefits accruing entirely to buyers. A paper in this vein that features entry is Morgan et al. (2010), which investigates how strategic risk and luck affect entrepreneurs' market entry decisions in a setting with repeated competition among persistent six-member groups with anonymous entry decisions. The authors find that when success depends on luck, there is excess entry. Differently from this strand of literature, we implement a formal, transparent, reputational mechanism lacking buyer discretion in auctions with complete and perfect information and the possibility of entry.

Reputation has also been studied in the context of exchange platforms, where buyers and sellers can leave public feedback about previous interactions. Familiar examples include many popular online trading platforms: eBay, Amazon, Cnet, etc. Results have been mixed as to

[21] For example, Bolton, Katok and Ockenfels (2004) show that reputation can be beneficial for the long-run player, whereas Grosskopf and Sarin (2010) show that beliefs-based reputational effects are weaker than theory predicts and that when reputational forces conflict with other-regarding preferences the latter tend to dominate.

[22] Their experiments feature 10 repetitions of a one-shot game with random and anonymous re-matching between repetitions that can be alternatively interpreted as homogeneous Bertrand competition with discrete prices or as a first-price sealed bid auction with known common value.

whether this type of reputation mechanism induces more honest behavior or more trade. Bolton et al. (2004) find reputational feedback provides weaker incentives for honest behavior than traditional markets with long-lasting relationships among agents, since benefits from honest behavior are not fully internalized by the agents. Bolton et al. (2007) conduct online market games and find that competition in strangers networks increases total gains from trade: with competition and reputation, buyers can discriminate between sellers, creating incentives for seller honesty. Finally, Bolton et al. (2011) provide experimental evidence for how reciprocity in feedback affects reputation exchange platforms in terms of reduced efficiency, even in the presence of blind feedback and a detailed seller rating system. Our paper differs from Bolton et al. (2004, 2007, 2011) in that we focus on reputation based on delivered quality rather than possibly false messages about past performance, and we consider the role of entry.

On the theoretical side, our work is related to the first formal analyses of reputation for quality in the 1980s, including Klein and Leffler (1981), Shapiro (1983), Allen (1984) and Stiglitz (1987), who were directly concerned with the relationship between the ability of reputational forces to curb moral hazard and the competitive conditions prevailing in the market. A central question that this literature tried to address is precisely how reputational forces, which require a future rent as reward for good behavior, could be compatible with free entry. Recent analyses in this direction include Kranton (2003), Bar-Isaac (2005) and Calzolari and Spagnolo (2009), who suggest that when important dimensions of the exchange are not contractible and there are many competing suppliers, limiting entry and competition may indeed be beneficial for the buyer. Hörner (2002) shows that if prices can be used as signals of quality, there are also equilibria in which competition strengthens reputational forces. The signaling aspect of prices is less applicable in the context of public procurement, however, where prices are a dimension of the scoring rule selecting the winner and are unlikely, therefore, to be used to signal quality.[23]

6 Concluding remarks

In this paper, we ask whether the use of reputational indicators based on past performance always entails a tradeoff between increased quality provision and reduced market entry in procurement. This question is open, timely and policy-relevant as current regulations in the US and Europe reflect differing answers. In the US, where reputational mechanisms are currently required in public procurement, the Senate recently expressed concerns that such past-performance-based selection criteria could hinder small businesses' ability to enter and successfully compete for public contracts. On the other hand, in Europe, where regulators were sufficiently convinced that allowing the use of reputational indicators as criteria for selecting contractors would dis-

[23]More indirectly related to our study are theories describing how an incumbent's reputation can be used to deter entry, like the classic studies by Kreps and Wilson (1982) and Milgrom and Roberts (1982), and the recent literature on when reputation may have permanent effects and under which condition it has stronger effects, which is well summarized in Bar-Isaac and Tadelis (2008) and Mailath and Samuelsson (2006).

criminate against cross-border entrants to explicitly prohibit it, public buyers and their national representatives are now pushing to overturn the prohibition.

We have investigated this question experimentally, developing a simple model of repeated procurement competition with limited enforcement of quality and potential entry by a more efficient supplier, and implementing it in the laboratory. Our treatments differed by the presence and design of a past-performance-based reputational mechanism. Our results indicate that poorly calibrated reputational mechanisms may indeed hinder entry, but that the tradeoff between quality and entry is not necessary. To the contrary, we find that a well calibrated reputational mechanism, in which new entrants with no history of past performance are awarded a moderate or high reputation score—as is often the case in the private sector or, e.g., with point systems for drivers' licenses—actually *fosters* entry and, at the same time, delivers a substantial increase in high quality goods provision. Our results also suggest that the increased quality and entry made possible by properly calibrated reputational mechanisms may come at little public expense. In our data, the total cost to buyers does not increase significantly when a reputational mechanism is introduced, even in cases where costly quality provision and entry increase substantially. The introduction of bid subsidies for good past performance appears to benefit the buyer/taxpayer by increasing competition for incumbency, driving winning bids down enough to offset the potential increase in procurement costs due to bid subsidies and the costly quality provision they generate.

Summing up, our results imply that there need not be a trade-off between the use of appropriately designed past-performance-based reputational mechanisms and entry by new firms into a market. In our experiment a well calibrated reputational mechanism may increase entry and quality provision simultaneously, without increasing the cost for the procurer. If confirmed in further studies, our study suggests that the emphasis placed on past performance by the revised Federal Acquisition Regulation is fully justified. Our findings suggest that European regulators may be imposing large unjustified deadweight losses on their citizens by forbidding the use of past performance indicators as selection criteria in public procurement. Consequently, policy makers should probably stop quarrelling about whether a generic past-performance-based reputational mechanism should be introduced, and focus instead on *how* such a mechanism should be designed in different contexts.

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Tables and Figures

Table 1: Summary of Treatments

Treatment	Incumbent			Entrant			Participants	Sessions
	Bonus	c_H	c_L	Bonus	c_H	c_L		
HB	2	2	1.5	2	2	0.125	51	3
MB	2	2	1.5	1.5	2	0.125	60	3
LB	2	2	1.5	1	2	0.125	42	2
Baseline	1	2	1.5	1	2	0.125	90	4

Table 2: Proportion of winning firms producing high quality

	Stage 1	Stage 2	Stage 3	All Stages
Baseline	0.18	0.09	0.06	0.11
	(0.047)	(0.034)	(0.035)	(0.037)
Low Bonus (LB)	0.82	0.57	0.14	0.51
	(0.018)	(0.048)	(0.024)	(0.018)
Medium Bonus (MB)	0.77	0.49	0.17	0.48
	(0.010)	(0.075)	(0.026)	(0.031)
High Bonus (HB)	0.78	0.60	0.09	0.49
	(0.04)	(0.025)	(0.040)	(0.018)
Observations	1,011	1,011	1,011	1,011

Notes: [1] Robust standard errors, clustered by session, appear in parentheses. [2] The last column, "All Stages," reports the total number of times high quality was produced by the winning firm divided by the total number of stages.

Table 3: Quality provision, by stage and treatment

	Stage 1	Stage 2	Stage 3	All Stages
Low Bonus (LB)	0.51***	0.55***	0.10*	0.73***
	(0.043)	(0.063)	(0.061)	(0.110)
Medium Bonus (MB)	0.53***	0.50***	0.14**	0.69***
	(0.050)	(0.075)	(0.060)	(0.116)
High Bonus (HB)	0.52***	0.58***	0.04	0.69***
	(0.049)	(0.059)	(0.067)	(0.111)
Round	-0.01*	-0.01**	-0.01**	-0.02***
	(0.006)	(0.006)	(0.003)	(0.005)
Observations	1,011	1,011	1,011	1,011

Notes: [1] Columns 1-3 present marginal effects estimates from a (separate) probit model, using as a dependent variable a dummy taking the value one whenever the winning firm produced high quality in the relevant stage (column heading). [2] The fourth column presents results of a tobit regression in which the dependent variable is the n. of times high quality has been produced by the winning firm standardized by the n. of stages. [3] Robust standard errors, clustered by session, appear in parentheses. [4] *** p<0.01, ** p<0.05, * p<0.1

Table 4: Entry propensity

	Stage 3
Baseline	0.61
	(0.019)
Low Bonus (LB)	0.42
	(0.161)
Medium Bonus (MB)	0.69
	(0.046)
High Bonus (HB)	0.67
	(0.033)
Observations	1,011

Notes: Robust standard errors, clustered by session, appear in parentheses.

Table 5: Entry, by treatment

Low Bonus (LB)	-0.19
	(0.125)
Medium Bonus (MB)	0.10**
	(0.040)
High Bonus (HB)	0.08**
	(0.031)
Round	-0.02***
	(0.006)
Observations	1,011

Notes: [1] Reported values are marginal effects from a probit model, using as a dependent variable a dummy taking the value one whenever the Entrant firm entered Stage 3 rather than staying out. [2] Robust standard errors, clustered by session, appear in parentheses. [3] *** p<0.01, ** p<0.05, * p<0.1

Table 6: Buyer's transfer, by stage and treatments

	Stage 1	Stage 2	Stage 3	Average Over Stages 1 to 3
Baseline	2.14	1.97	1.57	1.90
	(0.071)	(0.083)	(0.093)	(0.081)
Low Bonus (LB)	1.87	2.02	1.75	1.88
	(0.085)	(0.080)	(0.113)	(0.017)
Medium Bonus (MB)	1.67	1.92	1.62	1.74
	(0.067)	(0.066)	(0.091)	(0.073)
High Bonus (HB)	1.91	1.95	1.82	1.90
	(0.073)	(0.092)	(0.084)	(0.082)
Observations	1,011	1,011	1,011	1,011

Notes: Robust standard errors, clustered by session, appear in parentheses.

Table 7: Average buyer's transfer, by stage and treatment

	Stage 1	Stage 2	Stage 3	Average Over Stages 1 to 3
Low Bonus (LB)	-0.28**	0.05	0.18	-0.02
	(0.111)	(0.116)	(0.147)	(0.083)
Medium Bonus (MB)	-0.46***	-0.03	0.07	-0.14
	(0.103)	(0.114)	(0.141)	(0.117)
High Bonus (HB)	-0.22**	0.00	0.27*	0.02
	(0.101)	(0.120)	(0.123)	(0.113)
Round	-0.02***	-0.04***	-0.04***	-0.03***
	(0.006)	(0.008)	(0.007)	(0.006)
Constant	2.27***	2.21***	1.80***	2.09***
	(0.084)	(0.104)	(0.114)	(0.096)
Observations	1,011	1,011	1,011	1,011
R-squared	0.191	0.040	0.060	0.087

Notes: [1] Each column presents a simple OLS regression using as the dependent variable winning bids in the relevant stage (column heading). [2] Robust standard errors, clustered by session, appear in parentheses. [3] ***p<0.01, **p<0.05, *p<0.1.[4] The dependent variable in this table is the average buyer costs (transfers) over the tree stages.

Table 8: Buyer's theoretical welfare

	Baseline	*LB*	*MB*	*HB*
$\alpha = \gamma = \delta = 1/3$	0.389	0.488	0.599	0.710
$\alpha = \gamma = ½; \delta = 0$	0.333	0.731	0.648	0.565

Notes: [1] Each cell reports buyer's theoretical welfare evaluated according to the model (described in text). [2] In this theoretical welfare function: α is the weight the buyer places on total transfer, expressed as a discount below the maximum possible transfer without bid subsidies; γ is the weight the buyer places on high quality provision; and δ is the weight placed on entry *per se.*

Table 9: Buyer's empirical welfare

	Baseline	*LB*	*MB*	*HB*
$\alpha = \gamma = \delta = 1/3$	0.432	0.505	0.594	0.580
$\alpha = \gamma = ½; \delta = 0$	0.344	0.546	0.547	0.534

Notes: [1] Each cell reports buyer's empirical welfare (described in text) evaluated using our experimental data. [2] In this empirical welfare function: α is the weight the buyer places on total transfer, expressed as a discount below the maximum possible transfer without bid subsidies; γ is the weight the buyer places on high quality provision; and δ is the weight placed on entry *per se.*

<u>Not For Publication</u>

Appendix

Section A: Pairwise Mann-Whitney tests

Table A1:Mann-Whitney tests on quality provision

Pairwise comparison	Obs		Stage 1	Stage 2	Stage 3
BA vs LB	360	*z-stat*	-14.118	-11.839	-3.099
	168	*Prob>|z|*	0.000	0.000	0.002
LB vs. MB	168	*z-stat*	1.061	1.601	-0.862
	264	*Prob>|z|*	0.289	0.109	0.389
MB vs. HB	264	*z-stat*	-0.212	-2.319	2.639
	219	*Prob>|z|*	0.832	0.020	0.008
BA vs. MB	360	*z-stat*	-14.897	-11.150	-4.477
	264	*Prob>|z|*	0.000	0.000	0.000
BA vs. HB	360	*z-stat*	-14.393	-13.010	-1.358
	219	*Prob>|z|*	0.000	0.000	0.174
LB vs. HB	168	*z-stat*	0.837	-0.529	1.581
	219	*Prob>|z|*	0.402	0.597	0.114

Notes: [1] Pairwise Mann-Whitney tests reported, using the following labelling conventions: Ba = "Baseline" treatment; LB = "Low Bonus" treatment; MB = "Medium Bonus" treatment; HB = "High Bonus" Treatment.

Table A2: Mann-Whitney tests on entry

Pairwise comparison	Obs	Non-par test (z, p)
BA vs LB	360	3.991
	168	0.000
LB vs. MB	168	-5.481
	264	0.000
MB vs. HB	264	0.426
	219	0.670
BA vs. MB	360	-2.086
	264	0.037
BA vs. HB	360	-1.521
	219	0.128
LB vs. HB	168	-4.881
	219	0.000

Notes: Pairwise Mann-Whitney tests reported, using the following labeling conventions: Ba = "Baseline" treatment; LB = "Low Bonus" treatment; MB = "Medium Bonus" treatment; HB = "High Bonus" Treatment.

Table A3: Mann-Whitney tests on buyers' transfers

Pairwise comparison	Obs		Stage 1	Stage 2	Stage 3
BA vs LB	360	*z-stat*	7.584	3.381	0.072
	168	*Prob>|z|*	0.000	0.001	0.943
LB vs. MB	168	*z-stat*	4.011	0.790	0.445
	264	*Prob>|z|*	0.000	0.429	0.656
MB vs. HB	264	*z-stat*	-5.492	-0.422	-2.290
	219	*Prob>|z|*	0.000	0.673	0.022
BA vs. MB	360	*z-stat*	12.258	5.800	-0.531
	264	*Prob>|z|*	0.000	0.000	0.595
BA vs. HB	360	*z-stat*	7.316	4.120	-2.563
	219	*Prob>|z|*	0.000	0.000	0.010
LB vs. HB	168	*z-stat*	-1.285	0.586	-1.074
	219	*Prob>|z|*	0.199	0.558	0.283

Notes: [1] Pairwise Mann-Whitney tests reported, using the following labeling conventions: Ba = "Baseline" treatment; LB = "Low Bonus" treatment; MB = "Medium Bonus" treatment; HB = "High Bonus" Treatment.

Table A4: Mann-Whitney tests on profits, pooling over roles

	Including *w*				Excluding *w*			
Pairwise comparison	Stage 1	Stage 2	Stage 3	All 3 stages	Stage 1	Stage 2	Stage 3	All 3 stages
BA vs LB	7.180	-0.518	-2.590	2.234	11.837	2.989	-0.425	5.703
	(0.000)	(0.604)	(0.010)	(0.026)	(0.000)	(0.003)	(0.671)	(0.000)
LB vs. MB	1.307	-0.137	3.111	1.447	2.203	-0.207	0.929	0.162
	(0.191)	(0.891)	(0.002)	(0.148)	(0.028)	(0.836)	(0.353)	(0.871)
MB vs. HB	-1.558	0.384	-1.191	-1.234	-2.274	0.961	-1.002	-1.431
	(0.119)	(0.701)	(0.234)	(0.217)	(0.023)	(0.337)	(0.317)	(0.153)
BA vs. MB	9.396	-0.693	1.103	4.234	15.779	3.273	0.655	6.058
	(0.000)	(0.488)	(0.270)	(0.000)	(0.000)	(0.001)	(0.513)	(0.000)
BA vs. HB	7.686	-0.420	-0.106	2.670	13.035	3.922	-0.277	4.252
	(0.000)	(0.675)	(0.915)	(0.008)	(0.000)	(0.000)	(0.782)	(0.000)
LB vs. HB	-0.171	0.242	1.985	0.463	0.039	0.696	0.126	-0.900
	(0.864)	(0.809)	(0.047)	(0.644)	(0.969)	(0.487)	(0.900)	(0.368)

Notes: [1] Pairwise Mann-Whitney tests reported, using the following labeling conventions: Ba = "Baseline" treatment; LB = "Low Bonus" treatment; MB = "Medium Bonus" treatment; HB = "High Bonus" Treatment. [2] z-scores from Mann-Whitney tests reported; Prob > |z| appears in parentheses.

Section B: Dynamic trends in our main variables, allowing for non-linear variation

Table B1: Quality Provision

	Stage 1	Stage 2	Stage3	All Stages
Low Bonus (LB)	0.51***	0.56***	0.10*	0.72***
	(0.045)	(0.065)	(0.061)	(0.109)
Med Bonus (MB)	0.54***	0.52***	0.14**	0.69***
	(0.053)	(0.074)	(0.059)	(0.114)
High Bonus (HB)	0.52***	0.60***	0.04	0.69***
	(0.052)	(0.060)	(0.065)	(0.110)
Period 2 (dummy)	-0.23***	-0.23***	-0.06***	-0.26***
	(0.079)	(0.034)	(0.018)	(0.062)
Period 3 (dummy)	-0.26***	-0.25***	-0.06***	-0.29***
	(0.096)	(0.052)	(0.019)	(0.070)
Period 4 (dummy)	-0.35***	-0.26***	-0.08***	-0.37***
	(0.075)	(0.047)	(0.022)	(0.073)
Period 5 (dummy)	-0.23***	-0.29***	-0.10***	-0.36***
	(0.062)	(0.039)	(0.020)	(0.066)
Period 6 (dummy)	-0.36***	-0.29***	-0.09***	-0.41***
	(0.060)	(0.039)	(0.019)	(0.076)
Period 7 (dummy)	-0.34***	-0.28***	-0.08***	-0.39***
	(0.069)	(0.032)	(0.015)	(0.075)
Period 8 (dummy)	-0.25***	-0.21***	-0.09***	-0.30***
	(0.070)	(0.051)	(0.022)	(0.068)
Period 9 (dummy)	-0.31***	-0.26***	-0.08***	-0.36***
	(0.071)	(0.053)	(0.019)	(0.082)
Period 10 (dummy)	-0.28***	-0.24***	-0.07***	-0.31***
	(0.094)	(0.039)	(0.017)	(0.080)
Period 11 (dummy)	-0.33***	-0.25***	-0.07***	-0.35***
	(0.075)	(0.040)	(0.018)	(0.078)
Period 12 (dummy)	-0.26***	-0.25***	-0.07***	-0.32***
	(0.089)	(0.024)	(0.012)	(0.061)
Period 13 (dummy)	-0.29*	-0.30***	-0.07***	-0.39***
	(0.169)	(0.033)	(0.022)	(0.077)
Period 14 (dummy)	-0.18	-0.30***	-0.09***	-0.37***
	(0.167)	(0.056)	(0.017)	(0.127)
Period 15 (dummy)	-0.42***	-0.33***	-0.09***	-0.58***
	(0.086)	(0.027)	(0.017)	(0.117)
Observations	1,011	1,011	1,011	1,011

Notes: [1] Columns 1-3 present the marginal effects from an estimated probit model using as the dependent variable winning firms' (binary) decision to provide high quality. [2] The fourth column presents results of a tobit regression in which the dependent variable is the n. of times high quality has been produced by the winning firm standardized by the n. of stages. [3] Robust standard errors, clustered by session, appear in parentheses. [4] *** p<0.01, ** p<0.05, * p<0.1

Table B2: Entry decision

	Stage 3
Low Bonus (LB)	-0.19
	(0.126)
Med Bonus (MB)	0.09**
	(0.044)
High Bonus (HB)	0.07**
	(0.033)
Period 2 (dummy)	-0.13**
	(0.057)
Period 3 (dummy)	-0.17***
	(0.036)
Period 4 (dummy)	-0.15**
	(0.065)
Period 5 (dummy)	-0.27***
	(0.040)
Period 6 (dummy)	-0.25***
	(0.046)
Period 7 (dummy)	-0.24***
	(0.057)
Period 8 (dummy)	-0.34***
	(0.063)
Period 9 (dummy)	-0.33***
	(0.052)
Period 10 (dummy)	-0.31***
	(0.059)
Period 11 (dummy)	-0.35***
	(0.054)
Period 12 (dummy)	-0.34***
	(0.076)
Period 13 (dummy)	-0.15***
	(0.048)
Period 14 (dummy)	-0.25***
	(0.083)
Period 15 (dummy)	-0.49***
	(0.026)
Observations	1,011

Notes: [1] Each column presents the marginal effects from an estimated probit model using as the dependent variable Entrant firms' (binary) decisions to enter Stage 3. [2] Robust standard errors, clustered by session, appear in parentheses. [3] *** p<0.01, ** p<0.05, * p<0.1

Table B3: Buyers' Total Transfers

	Stage 1	Stage 2	Stage3	Average Over All Stages
Low Bonus (LB)	-0.28**	0.05	0.18	-0.02
	(0.112)	(0.116)	(0.147)	(0.084)
Med Bonus (MB)	-0.47***	-0.04	0.06	-0.15
	(0.098)	(0.109)	(0.139)	(0.113)
High Bonus (HB)	-0.24**	-0.01	0.26*	0.00
	(0.104)	(0.123)	(0.126)	(0.116)
Period 2 (dummy)	-0.23***	-0.35**	-0.28*	-0.29***
	(0.056)	(0.148)	(0.138)	(0.069)
Period 3 (dummy)	-0.43***	-0.52***	-0.42***	-0.46***
	(0.064)	(0.117)	(0.121)	(0.067)
Period 4 (dummy)	-0.43***	-0.61***	-0.48***	-0.51***
	(0.075)	(0.114)	(0.110)	(0.070)
Period 5 (dummy)	-0.45***	-0.59***	-0.56***	-0.53***
	(0.077)	(0.139)	(0.119)	(0.086)
Period 6 (dummy)	-0.42***	-0.57***	-0.50**	-0.50***
	(0.093)	(0.128)	(0.171)	(0.092)
Period 7 (dummy)	-0.44***	-0.67***	-0.52***	-0.54***
	(0.083)	(0.139)	(0.109)	(0.092)
Period 8 (dummy)	-0.42***	-0.58***	-0.51***	-0.51***
	(0.091)	(0.100)	(0.120)	(0.076)
Period 9 (dummy)	-0.40***	-0.70***	-0.54***	-0.55***
	(0.074)	(0.128)	(0.080)	(0.067)
Period 10 (dummy)	-0.45***	-0.72***	-0.61***	-0.59***
	(0.081)	(0.141)	(0.122)	(0.083)
Period 11 (dummy)	-0.43***	-0.61***	-0.56***	-0.53***
	(0.083)	(0.153)	(0.154)	(0.100)
Period 12 (dummy)	-0.47***	-0.67***	-0.63***	-0.59***
	(0.069)	(0.125)	(0.137)	(0.084)
Period 13 (dummy)	-0.30***	-0.57***	-0.74***	-0.54***
	(0.086)	(0.114)	(0.229)	(0.082)
Period 14 (dummy)	-0.35***	-0.80***	-0.69***	-0.62***
	(0.099)	(0.181)	(0.118)	(0.108)
Period 15 (dummy)	-0.38***	-0.59**	-0.42***	-0.46***
	(0.096)	(0.251)	(0.110)	(0.117)
Constant	2.52***	2.52***	2.04***	2.36***
	(0.106)	(0.139)	(0.140)	(0.110)
Observations	1,011	1,011	1,011	1,011
R-squared	0.245	0.076	0.086	0.151

Notes: [1] Columns 1-3 present simple OLS estimates using as the dependent variable buyers' total payments (transfers) to winning firms in stage in the column heading. [2] The fourth column presents a similar OLS estimate, but using average buyers' transfer across all three stages as the dependent variable. [3] Robust standard errors, clustered by session, appear in parentheses. [4] *** p<0.01, ** p<0.05, * p<0.1

Table B4: Firms' Profits

	Including w				Excluding w			
	Stage 1	Stage 2	Stage 3	All Stages	Stage 1	Stage 2	Stage 3	All Stages
Low Bonus (LB)	-0.20***	0.06	0.10	-0.02	-0.20***	0.06	0.04	-0.04
	(0.040)	(0.050)	(0.068)	(0.035)	(0.040)	(0.050)	(0.046)	(0.039)
Med Bonus (MB)	-0.26***	0.05	0.03	-0.06	-0.26***	0.05	0.06	-0.05
	(0.037)	(0.040)	(0.055)	(0.042)	(0.037)	(0.040)	(0.055)	(0.042)
High Bonus (HB)	-0.18***	0.05	0.13**	0.00	-0.18***	0.05	0.15**	0.01
	(0.040)	(0.038)	(0.053)	(0.041)	(0.040)	(0.038)	(0.051)	(0.039)
Period 2 (dummy)	-0.05**	-0.02	0.02	-0.02	-0.05**	-0.02	-0.02	-0.03*
	(0.020)	(0.044)	(0.041)	(0.017)	(0.020)	(0.044)	(0.041)	(0.016)
Period 3 (dummy)	-0.12***	-0.11**	-0.06	-0.09***	-0.12***	-0.11**	-0.11**	-0.11***
	(0.021)	(0.037)	(0.038)	(0.021)	(0.021)	(0.037)	(0.035)	(0.020)
Period 4 (dummy)	-0.10***	-0.15***	-0.03	-0.10***	-0.10***	-0.15***	-0.07	-0.11***
	(0.024)	(0.044)	(0.038)	(0.026)	(0.024)	(0.044)	(0.044)	(0.024)
Period 5 (dummy)	-0.13***	-0.16***	-0.09*	-0.12***	-0.13***	-0.16***	-0.16***	-0.15***
	(0.027)	(0.042)	(0.046)	(0.032)	(0.027)	(0.042)	(0.042)	(0.030)
Period 6 (dummy)	-0.10**	-0.14**	-0.09**	-0.11**	-0.10**	-0.14**	-0.16***	-0.13***
	(0.033)	(0.059)	(0.034)	(0.037)	(0.033)	(0.059)	(0.033)	(0.035)
Period 7 (dummy)	-0.11***	-0.13**	-0.06	-0.10**	-0.11***	-0.13**	-0.12**	-0.12***
	(0.032)	(0.052)	(0.051)	(0.035)	(0.032)	(0.052)	(0.050)	(0.037)
Period 8 (dummy)	-0.11***	-0.13**	-0.04	-0.10**	-0.11***	-0.13**	-0.14***	-0.13***
	(0.032)	(0.054)	(0.035)	(0.032)	(0.032)	(0.054)	(0.037)	(0.034)
Period 9 (dummy)	-0.10***	-0.15***	-0.04	-0.10***	-0.10***	-0.15***	-0.14***	-0.13***
	(0.030)	(0.047)	(0.036)	(0.024)	(0.030)	(0.047)	(0.029)	(0.026)
Period 10 (dummy)	-0.12***	-0.15**	-0.03	-0.10**	-0.12***	-0.15**	-0.12**	-0.13***
	(0.033)	(0.055)	(0.050)	(0.034)	(0.033)	(0.055)	(0.056)	(0.039)
Period 11 (dummy)	-0.11***	-0.14**	-0.05	-0.10**	-0.11***	-0.14**	-0.15**	-0.13***
	(0.031)	(0.048)	(0.053)	(0.034)	(0.031)	(0.048)	(0.053)	(0.037)
Period 12 (dummy)	-0.13***	-0.14**	-0.13**	-0.13***	-0.13***	-0.14**	-0.23***	-0.16***
	(0.025)	(0.054)	(0.056)	(0.030)	(0.025)	(0.054)	(0.044)	(0.030)
Period 13 (dummy)	-0.07**	-0.02	-0.05	-0.05	-0.07**	-0.02	-0.09	-0.06
	(0.023)	(0.036)	(0.091)	(0.040)	(0.023)	(0.036)	(0.083)	(0.038)
Period 14 (dummy)	-0.10*	-0.12	-0.15*	-0.12	-0.10*	-0.12	-0.22***	-0.15*
	(0.047)	(0.117)	(0.077)	(0.076)	(0.047)	(0.117)	(0.057)	(0.069)
Period 15 (dummy)	-0.07	-0.10***	-0.01	-0.06**	-0.07	-0.10***	-0.18***	-0.11***
	(0.049)	(0.029)	(0.038)	(0.026)	(0.049)	(0.029)	(0.036)	(0.025)
Constant	0.62***	0.59***	0.36***	0.52***	0.28***	0.26***	0.30***	0.28***
	(0.039)	(0.054)	(0.056)	(0.046)	(0.039)	(0.054)	(0.054)	(0.045)
Observations	3,033	3,033	3,033	3,033	3,033	3,033	3,033	3,033
R-squared	0.042	0.008	0.008	0.008	0.119	0.011	0.015	0.027

Notes: [1] Each column presents a simple OLS regression using as the dependent variable firms' profits. [2] The first four columns include in this calculation Entrant firms' reservation wage, w = 1, in Stages 1 and 2. The last four columns exclude the reservation wage from profit calculations . [3] Robust standard errors, clustered by session, appear in parentheses. [4] *** p<0.01, ** p<0.05, * p<0.1

Not For Publication

Instructions Appendix

(Translated into English)

A. Instructions

Welcome!

This is a study about how people make decisions. The study is being financed by the Swedish Competition Authority and by EIEF. In this experiment you will participate in auctions allocating contracts for the production of a good or service. If you pay attention to the instructions they will help you make decisions and earn a reasonable amount of money. Your earnings from this experiment will be paid to you in cash at the end of today's session.

We ask you to please turn off your cell phones and to refrain from talking with other persons present in the room until the end of the experiment. If you have questions, please raise your hand and one of the experimenters will respond to you privately.

Today's experiment consists of [12,15] rounds. Every round is composed of three auctions. At the beginning of each round every participant in the room will be assigned randomly and anonymously two other participants. Each of the resulting groups of three participants will take part in a sequence of three auctions of which each round is composed. After the three auctions are concluded, a new round will begin by again randomly and anonymously re-assigning participants into groups of three. This process continues until all [12, 15] round have been completed.

At the beginning of each round, each of the three participants in a group will be assigned (as always, randomly) the role of one of three firms: Firm A, Firm B or Firm C. Firms A and B will participate in all three auctions comprising the round. Firm C, on the other hand, can participate in the third auction if they choose to do so, but cannot participate in the first two auctions. Firm C must wait for Firms A and B to complete the first two auctions. The institution that conducts the auctions and that acquires the good or service produced by the firms is the computer.

Auction 1

At the beginning of the first auction Firms A and B submit a bid, i.e. the price in return for which they are willing to produce the good requested by the purchaser, bearing in mind that the maximum allowable bid is 4.5:

- The firm that submits the lowest bid (i.e., that offers to produce the good or service for the lowest price) wins the auction.
- If both firms submit the same bid, the winning firm will be selected randomly.

The winning firm must also make a production decision: which quality level to produce. For Firm A and Firm B it is possible to produce a high quality good/service at a cost of 2, or to produce low quality at a cost of 1.5. An auction is over when all the participating firms have submitted their bids and the winning firm has made its production decision.

The earnings for the winning firm from the first auction will be the winning firm's bid minus the cost of production. If, for example, the winning firm submitted a bid of 3 and decided to produce high quality at a cost of 2, then this firm's profit will be 3 – 2 = 1. The firm that did not win the auction will (submitted a bid higher than 3) will earn a profit of 0 from this auction.

The buyer prefers high quality to low quality and, as explained in more detail below, rewards in the subsequent auction firms with a good reputation—i.e., those that in the previous period produced high quality—with a bonus on their bid when they win.

At the end of each auction, including this first auction, all three firms will be shown all submitted bids and the quality level which the winning firm decided to produce.

<u>Auction 2</u>

As in the first auction, only Firm A and Firm B participate in Auction 2. Both Firms A and B must submit a bid keeping in mind that the maximum possible bid is 4.5:

- The firm that submits the lowest bid (i.e., that offers to produce the good or service for the lowest price) wins the auction.
- If both firms submit the same bid, the winning firm will be selected randomly.

The firm that won Auction 1, if they produced high quality in that auction, has a good reputation in this second auction. What this means is that if this same firm wins Auction 2 they will be given a bonus equal to 100% of their winning bid. For example, if the bid submitted by a firm with good reputation is 2 and this bid wins Auction 2 (e.g., because the other firm submitted a bid larger than 2) the bonus paid to the winning firm with good reputation will be 100% of 2, i.e., 2, and the price paid to this winning firm for producing by the purchaser will be 2 + 2 = 4.

The firm winning Auction 2 must choose whether to produce high quality, at a cost of 2, or to produce low-quality at a cost of 1.5, exactly as in Auction 1. The winning firm's profit from this second auction will be the price offered plus the bonus (if the winning firm has a good reputation, i.e. had won auction 1 produced high quality there), minus the cost of production. Continuing with the previous example: if the firm with good reputation wins Auction 2 with a bid of 2, it receives its bid plus the bonus of 2, for a total revenue of 2 + 2 = 4; it must then decide whether to produce high or low quality in this second auction. If it decides to produce high quality also in this second race, its profit will be equal to the price with the bonus, minus the cost of producing high quality, that is, 4-2 = 2, and it will also have good reputation in the subsequent, third, auction. If it decides instead to produce low quality Auction 2, it will now have a profit of 4 - 1.5 = 2.5, but will not have a good reputation (nor a bonus) in the third auction.

If the winning firm in the Auction 2 does not have a good reputation (because it did not win the first auction or because it did not produce high quality there) it will not receive a bonus. In this case, its profit from the second auction will be its winning bid minus the cost of production. For example, if its winning bid was 2 and it decides to produce low quality, it will earn a profit of 2 - 1.5 = 0.5 and will not have a good reputation in Auction 3. On the other hand, if it decides to produce high quality its profit in the second auction will be 2 - 2 = 0, but it will have a good reputation in the third auction.

Consequently, if both neither Firm A nor Firm B have a good reputation at the beginning Auction 2, they will compete on equal footing. If one of them has a good reputation, however, the firm with good reputation will have an advantage: getting a bonus if it wins this second period.

At the end of the second auction, all firms will be able to see all bids submitted, which firm won the auction and the quality level the winning firm chose to produce.

<u>Auction 3</u>

At the start of the third auction, having observed what happened in the two previous races, Firm C must decide whether to participate in Auction 3 along with Firms A and B. If Firm C decides to participate, it will receive a bonus equal to [100%, 50%, 0%] of its bid if it wins the auction. For example, if Firm C submits a bid of 2 and wins Auction 3, its bonus will be [2,1, 0], and it will be paid 2 +[2, 1, 0] = [4, 3, 2] by the purchaser. Firm C's profit from this third race will be [4, 3, 2] minus the cost of production which, as will be explained below, may be different from the production costs of Firms A and B. If, instead, Firm C decides to not participate in Auction 3, it will earn 1 euro. If Firm C decides to participate in Auction 3 it will have to submit a bid in the same manner as Firms A and B with a maximum possible bid of 4.5.

In this third auction:

- The firm submitting the lowest bid (i.e, has offered to produce the good or service at the lowest price) wins;
- If more than one firm submits the same lowest bid, the winner will be randomly selected among these firms.

The winning firm must decide the quality level at which to produce. If Firm C is the winning firm, it costs of production are as follows:

- producing low quality entails a production cost of 0.125
- producing high quality entails a production cost of 2.

If either Firm A or Firm B win the third auction, its production costs are as before: producing high quality costs the firm 2, while the cost of producing low quality is 1.5.

Total Earnings

At the end of today's session, one of the [12, 15] rounds will be randomly selected and each participant will be paid their earnings overall all three auctions comprising this randomly-chosen round. Participants assigned the role of Firm A or B will be paid the total euros earned in the three auctions. Participants assigned the role of Firm C will be paid 1 euro for each of the first two auctions plus 1 euro for the third auction if he/she decided not to participate. If he/she did participate in Auction 3, his or her earnings from this third auction will be either 0 if he or she did not win, or his or her bid plus the bonus minus the costs of production.

In addition to the earnings in randomly-selected round, all participants will be paid 5 euros as compensation for participation.

INSTRUCTIONS FOR FIRMS A and B

You are Firm A or Firm B. In this experiment you will take part in a series of auctions to award the production of a good or a service. The experiment consists of [12, 15] rounds. In each round you will participate in three auctions taking place one after the other. At the start of the first auction you must submit a bid—the price for which you will produce a good or service. When both you and the other firm have submitted your bids:

- The company submitting the lowest bid (i.e., has offered to produce the good or service at the lowest price) wins the auction.
- If both firms submit the same bid, one firm will be randomly selected to win the auction.

If you are the firm that wins, you must make a production decision. You can either produce a high level of quality at a cost of 2, or you can produce a low quality good or service at a cost of 1.5.

When all bids are submitted and production decisions are made, the auction is over and all firms will learn all bids that were submitted as well as the quality level production decision of the winning firm.

You will then begin the second auction. Again, in Auction 2 only Firms A and B participate. As in the first auction, you submit a bid. If the firm that won the first auction produced high quality in Auction 1, in this second auction it will have a good reputation. This good reputation gives the firm a bonus of 100% of its (winning) bid, if it wins Auction 2. For example, if the bid submitted by a firm with good reputation in the second auction is 2, and this bid wins the auction, the bonus will also be 2 and the amount that this firm will be paid by the purchaser is 4. Its profit will be its bid plus the bonus minus the cost of production.

If the firm that won the first auction did not produce high quality, it will not have a good reputation in Auction 2 and it will not receive a bonus for winning. I.e., Firms A and B will participate on equal footing in the second auction.

When both you and the other firm have submitted your bids:

- The company submitting the lowest bid (i.e., has offered to produce the good or service at the lowest price) wins the auction.
- If both firms submit the same bid, one firm will be randomly selected to win the auction.

If you are the firm that wins, you must make a production decision. You can either produce a high level of quality at a cost of 2, or you can produce a low quality good or service at a cost of 1.5.

When all bids are submitted and production decisions are made, the auction is over and all firms will learn all bids that were submitted as well as the quality level production decision of the winning firm.

At the start of the third auction, Firm C must decide whether or not to participate. If Firm C decides to participate, you will have two competitors in Auction 3. In the third auction, you submit a bid (as before):

- The company submitting the lowest bid (i.e., has offered to produce the good or service at the lowest price) wins the auction.
- If more than one firm submits the same lowest bid, one firm will be randomly selected from among those submitting the lowest bid to win the auction.

If you win this third auction and you also won the second auction and produced high quality there, you have good reputation. You will be paid the bonus for good reputation, as described above, in addition to your winning bid by the purchaser.

Your earnings in a round is the sum of what earned over all three auctions comprising a round.

In summary, if you win the first auction your earnings from Auction 1 will be your bid minus the cost of production. If you choose to produce with high quality in Auction 1, in the subsequent auction (Auction 2) you will have a good reputation and will be given a bonus if you win: your earnings in Auction 2 will be your winning bid plus the bonus minus the cost of production. If you choose to produce low quality in Auction 1, in the subsequent auction (Auction 2) you will not have a good reputation and will receive no bonus for winning the second auction. If you win the second auction and choose to produce high quality there, you will have a good reputation in the third auction and again receive a bonus for winning Auction 3. If, however, you win Auction 2 and produce low quality, you will not have good reputation in Auction 3 and, so, receive no bonus for winning the third auction.

INSTRUCTIONS FOR FIRM C

You are Firm C. In this experiment you will take part in a series of auctions to award the production of a good or a service. The experiment consists of [12, 15] rounds. Since you are Firm C you cannot participate in the first two auction of each round but will earn 1 euro for each of these auctions. You can, however, participate in the third auction if you choose to.

If you decide not to participate in the third auction, you will earn an additional 1 euro. If you decide to participate in Auction 3, you forgo this 1 euro and must submit a bid. If your bid is the lowest of the three bids made (yours and those of Firms A and B), you win the auction and get will be paid your winning bid plus a bonus equal to [100%, 50%, 0%] of you bid. For example, if your winning bid is is 2, 2 + [2, 1 , 0] = [4, 3, 2] will be the amount you are paid by the purchaser.

If you are the winning firm, you must decide the level of quality to produce. You face the following production costs:

- producing low quality costs 0.125
- producing high quality costs 2

Your earnings in a round will be: 1 euro for the first auction, 1 euro for the second auction. For Auction 3, if you decide not to participate you will again earn 1 euro for the third auction. If, however, you participate in the third auction, your earnings from Auction 3 will be either: 0, if you lose; or your bid plus the bonus minus the cost of production if you win.

B. Individual Screens

[Screen 1A: shown to Incumbent firms only]:

- You have been assigned the role of [Firm A, Firm B]
- Click "Proceed" to begin

[Screen 1B: shown to Entrant firms only]:

- You have been assigned the role of Firm C.
- You can only participate in the third auction.
- Click "Proceed," then please wait patiently for the first two auctions to conclude.
- You will be informed when the third auction is about to begin.

[Screen 2: Auction 1 bid submission screen]:

- Please enter your bid below.
- Then, click "Submit bid."

Your bid: ___

[Screen 3: Auction 1 waiting screen, shown to losing Incumbent firm only]

- You did not win the auction.
- Please click "Proceed" and wait while the winning firm makes its production decision.

[Screen 4: shown to winning firm only]

- You won the auction.
- Please select which quality level to produce below.
- Then, click "Proceed."

Produce:

[order of options randomized]

  - High quality
  - Low quality

[Screen 5: Auction 1 summary, shown to all three firms]

Results of Auction 1

- Firm A bid: __
- Firm B bid: __
- The winning firm was [Firm A, Firm B]
- The winning firm produced [low quality, high quality]

[Screen 7]: Auction 2 bid screen, shown to Incumbent firms only]

- You [have, do not have] reputation.
- Please enter your bid below
- Then, click "Submit bid."

Your bid: ___

[Screen 8]: Auction 2 waiting screen, shown to losing Incumbent firm only]

- You did not win the auction.
- Please click "Proceed" and wait while the winning firm makes its production decision.

[Screen 9]: shown to winning firm only]

- You won the auction.
- Please select which quality level to produce below.
- Then, click "Proceed."

Produce:

[order of options randomized]

  - High quality
  - Low quality

[Screen 10]: Auction 2 summary, shown to all three firms]

Results of Auction 2

- Firm A bid: __
- Firm B bid: __

- The winning firm was [Firm A, Firm B]
- The winning firm produced [low quality, high quality]

[Screen 11]: Auction 3 Entry decision screen, shown only to Entrant firm]

- Auction 3 is now about to take place.
- Please choose whether you will enter auction 3 below.
- After you have chosen, please click "Proceed."

[order of options randomized]

  - o Do not enter
  - o Enter the auction

[Screen 12]: Auction 3 Entry decision announcement, shown to all three firms]

- Firm C decided [not to enter, to enter] the auction.
- Please click "Proceed."

[Screen 13A]: Entrant firm Auction 3 bid submission screen, shown only to Entrant firm]

- Your entrant multiplier is __.
- Please enter your bid below.
- Then, click Submit bid.

Your bid: ___

[Screen 13B]: Incumbent firm Auction 3 bid submission screen, shown only to Incumbent firms]

- Your entrant multiplier is __.
- Please enter your bid below.
- Then, click Submit bid.

Your bid: ___

[Screen 14]: Auction 3 summary, shown to all three firms]

Results of Auction 3

- Firm A bid __
- Firm B bid __
- Firm C [entered / did not enter]
- The winning firm was [Firm A, Firm B, Firm C]
- The winning firm produced [low quality, high quality]

[Screen 15]: Profit summary over all three auctions, shown to all three firms]

- If this round is selected, you will earn __ euro
- You earned __ from auction 1
- You earned __ from auction 2
- You earned __ from auction 3

- Please click "Proceed" and wait for the next round to begin.

[Screen 16]: Profit summary waiting screen, shown to all three firms]

- Please wait for all other participants to view their potential profits for this round. The next round will automatically start when everyone has clicked "Proceed."