SUPPLIERS' BEHAVIOR IN COMPETITIVE TENDERING: EVIDENCE FROM THE ITALIAN MINISTRY OF ECONOMY AND FINANCE'S ACQUISITIONS OF IT SERVICES

Gian Luigi Albano, Federico Dini and Roberto Zampino*

ABSTRACT. In this paper we explore the determinants of suppliers' bidding behavior in public procurement competitive tendering for IT services. We exploit a unique dataset of contracts awarded by the Italian Public Procurement Agency (Consip S.p.A.) on behalf of the Italian Ministry of Economy and Finance. We have several results. First, both the nature of the scoring rule and firms' past experience appear to influence submitted price-quality ratios, although the magnitude of the former is much stronger than the latter. In particular, experience is worth suppliers a 6% increase in the technical score for any additional awarded contract, and up to 8.6% improvement in the price-quality ratios. The property of predictability of the scoring rule is worth the buyer 26%-33% of reduced price-quality ratios. Second, we find no evidence of a tension between price and (ex-ante) quality in submitted tenders. Quite surprisingly, price and quality appear negatively related. Third, we find that the distribution of scores for technical proposals are less dispersed when evaluating committees include "outsiders" (non-IT persons). With respect to insiders, outsiders appear more generous (over-reward quality), shifting competition towards price more than what the buyer would desire ex-ante. These results allow us to draft some policy indications for public (and private) tender designers.

INTRODUCTION

Governments and Public authorities put considerable attention to the procurement of ICT services as these can significantly impact the

---

* *Gian Luigi Albano, Ph.D., Federico Dini, Ph.D., and Roberto Zampino, MSc., are Head of Research, Senior Economist, and Junior Economist, respectively, Italian Public Procurement Agency (Consip S.p.A.).*

Copyright © 2008 by Gian Luigi Albano, Federico Dini and Roberto Zampino

effectiveness of Governments in monitoring the public accounts and maintaining accountability.[1] More than in the past technological evolutions and new applications allow a more rapid and accurate monitoring of public spending.[2] Contracts are often awarded through open procedures to ensure transparency, reduce favoritism and to promote full competition among all potential suppliers.[3] The most economically advantageous tender (MEAT) is a common criterion to deal with procurements where price and quality both matter. Such criterion allows the buyer to select the best "value for money" supplier, making participants to allocate effort between price and quality attributes on the basis of a pre-defined scoring rule. The scoring rule incorporates the buyer's price/technical tradeoffs, and assesses whether one proposal's technical superiority is worth the higher price. However, bidding for large/complex IT projects is not as easy as bidding for standardized items. In this latter case, e.g., "Laptops", any supplier easily computes the monetary cost of improving his score on the basis of his internal cost/efficiency. If increasing the score of 1 point implies lowering price of $500 or, alternatively, offering X additional power (e.g. RAM) at the cost $400, the supplier will of course opt for the latter to save $100.[4] Bidding for the provision of highly customized services, such as IT solutions/services to large organizations, may be, instead, a rather complex task for any supplier. A critical input of a competitive strategy are information about the buyer's IT environment, necessary for suppliers to identify feasible developments (and related costs), but difficult/costly to be exhaustively described in solicitation documents.

In Italy, the Ministry of Economy and Finance (MEF) selects IT services contractors through competitive bidding.[5] IT services contracts are often "general purpose", or "framework contracts", i.e., include a large variety of activities – from simple maintenance to developments of new applications, from IT consultancy to integration of complex systems. Quality proposals consist in providing effective and flexible teams of professionals and technological solutions to best fit the MEF's various needs. Suppliers face several sources of uncertainty when bidding for these contracts: technological evolutions, changing buyers' needs, legislative innovations, heterogeneity of tasks, non-contractible quality, geographical dispersion of the MEF's departments/structures. General purpose contracts also require the supplier to adapt its initial organizational set-up to future tasks/effort that are only roughly specified in the contract. In such a procurement environment the set up of a

working organizational proposal as well as the estimation of costs and mark-up may end up difficult.[6] Evaluation "at the margin" is also uneasy. For instance, in trading-off quality and price it might be not so clear how much one supplier would modify its bid when offering *a different organizational arrangement*.

The presence of relevant non-contractible dimensions of quality complicate things even further. It often implies discretional evaluation of technical proposals, that enhances the uncertainty about the success of bidding strategies (the suppliers does not know ex-ante the score associated to alternative quality proposals), as well as hard/costly monitoring, which provides suppliers incentives to submit ex-ante outstanding technical proposals that will not be fully implemented ex-post. As we will see later, these elements may alter the classical tension between quality and price and may give room to other factors explaining bidding behavior.

The environment described above suggests us to investigate several issues. First, how do suppliers actually bid for (highly incomplete) contracts whose main object is the acquisition of human capital? What are the factors mostly explaining bidding behavior? What is the role of scoring rules? Does the level of expertise of evaluating committees have any impact in the distribution of the total number of points to competing suppliers?

To answer these questions we estimate the impact of various elements of the tender design on bidding for IT services contracts. We consider a set of fixed-price contracts for IT development and consultancy that Consip (the Italian Public Procurement Agency) awarded – by means of the MEAT (Most Economically Advantageous Tender) criterion – on behalf of the MEF. In particular, we use the complete set of 20 contracts awarded by Consip in the period 1999–2007 in the sector of software development and maintenance of IT applications, and web sites. These amount to 136 observations (price-quality pairs). Basic descriptive correlation between price and quality bids indicates that higher quality is associated to lower prices. More in-depth regression analysis show that the nature of the scoring rule and past experience are important determinants of submitted quality/price ratios. Second, we find no evidence of a tension between price and quality in submitted price/technical bids: data exhibit a significant negative correlation between quality and price bids. This might be

explained by to the presence of *opportunism* and/or *optimism*. Complexity of supply may lead suppliers to promise higher quality with respect to what will be effectively provided ex-post (opportunism) or to underestimate supply costs (optimism). A theoretical work of Kim (1998) suggests that ex-post opportunism may arise in a procurement context similar to the one we have considered. Sharp competition in the tendering stage may incentive bidders to submit prices for low-quality instead for high-quality, although they are well qualified ex ante to provide high-quality.

Finally, we find that the distribution of scores for technical proposals is significantly less dispersed when evaluation committees are composed of "outsiders" (mainly non-IT persons) rather than "insiders", suggesting that in the former case competition shifted more towards the economic aspect of the contract. Results offer several insights and are suitable for policy considerations on IT services tender design.

The rest of the paper is organized as follows. Section 2 surveys the related empirical literature. Section 3 describes the procurement environment, the characteristics of contracts and the role of Consip and the MEF. It also provides a description of the dataset and some basic descriptive statistics. Section 4 illustrates the results from regression analysis testing for price-quality trade-off in observed bids. Section 5 explores the determinants of price/quality ratios, while section 6 investigates the role of committees in the explaining the variability of technical scores. Section 7 concludes the paper and summarizes some policy indications.

RELATED LITERATURE

This paper is related to the empirical literature on bidding behavior in (public) procurement. Important results have been achieved in the field of structural approach to auctions. Several authors estimated structural auction models addressing the issue of common value vs. private value (e.g. Athey, Susan and Haile 2006, Paarsch 1992, Guerre, Perrigne and Vuong 2000), often finalized to find evidence of the *winner's curse* in both one dimensional and multidimensional procurement auctions (Hong and Shum 2002). This field of research exploits repeated auctions data (e.g., timber auctions), and relies on frameworks where bidders' behavior can be well enough incorporated in a structural model. A structural

approach allows the researcher to identify the distribution of bidders' values and thus to answer other relevant questions such as the optimality of reserve prices.

The cross-section nature of our data suggest, as well as the complexity of the environment prevent the use structural approach and suggests us to investigate different issues, to some extent closer to the literature analyzing bidding behavior for complex/incomplete contracts. There are several papers addressing the issues of renegotiation and adaptation costs – most of them bounded to the field of public works and construction industry. For instance, Bajari, Houghton and Tadelis (2008) attempt to measure such costs in the procurement of highways in the U.S.. Crocker and Reynolds (1993) use Air Force engine procurement contracts to show how the degree of observed contractual completeness reflects the desire of the parties to minimize the economic costs associated with ex-post contractual exchange. Several other papers have studied bidding for construction and highway contracts (e.g., Bajari Tadelis 2004 and 2001, Porter and Zona 1993) in the attempt to isolate transaction costs due to ex-post renegotiation. However, there is a lack of understanding of several other important issues in public procurement. For instance, while theoretical works advanced the research on the properties of multidimensional procurements (Dagupta Spulberg 1989, Che 1993, Branko 1997, Asker and Cantillon 2008), and studied the conditions under which scoring auctions can do better than other mechanisms as negotiations (Asker and Cantillon 2006), empirical investigations on the role of scoring rules on bidding behavior is completely absent. In particular, how bidders effectively trade-off price and quality and what is the role of critical elements of the tender design, such as the *nature* of the scoring rules, can affect the bidding behavior remains completely unexplored. Attempts to investigate the role of competitive tender design and scoring rules on bidders' behavior are in Lundberg (2005). In a framework where suppliers bid to supply cleaning services to local public administrations, the author does not find evidence of differences in winning bids depending on the auction format (simultaneous multiple lots vs. single lots). However, award rules – best value vs. lowest price matter showing the existence of trade-off between price and quality for the procuring administration, although this trade-off is kept secret (the award rule is not communicated to suppliers). To our knowledge, Zhong (2007) is the work most related to ours. The author explores some key issues in online procurement auctions for

manufacturing goods from a large buyer in the high-tech industry. He characterizes the suppliers' bidding behavior to examine the effect of incumbency on bidding. His most interesting finding are: i) the buyer bias towards the incumbent suppliers, although the buyer is not committed to the final tender raking; ii) incumbent has a price premium; iii) incumbent winners' quality is higher, on average, than the quality of buyer's had before the auction, while non-incumbent winner's quality is lower; iv) using field data of procurement auctions for legal services, he shows that prices are on average reduced after dynamic bidding events.

The Role of Consip

Consip is one of the first European Central purchasing bodies to raise the challenge of rationalization in procurement. It was created in 1997 to provide the MEF with ICT solutions, technologies and services, and to promote IT change management within its Departments and peripheral offices, as well as towards all other public administrations.

One important task of Consip is to manage ICT acquisitions to maintain the whole IT infrastructure supporting the MEF activities. The 2000 Financial Law (December 23, 1999 n.488) laid down the foundations for the "Rationalization Program for Public Spending on Goods and Services", charging Consip with the additional task of implementing the program and working as central procurement agency for all the public administrations. The program is currently carried out through two main tools: framework contracts and the Public Administration's Marketplace (MEPA), an online e-platforms for low-value purchases. Framework contracts are stipulated for higher- volume acquisitions from suppliers who are awarded the contract as a result of an open competitive procedure. The online marketplace (MEPA), instead, allows public administrations to procure low-value items with fast and "slim" procedures (request for quotation and one-stop orders).

IT Acquisitions: Consip and the MEF

The traditional activity of Consip is to promote ICT developments and innovation and to manage the procurement of IT goods and services on behalf of the MEF. A specific three-year based agreement regulates such an outsourcing relationship. The agreement mandates Consip to perform several activities, from demand analysis and identification of key IT solutions to suppliers selection and contract management and monitoring. With regard to suppliers selection, Consip is mandated to:

- define needs/solutions;
- organize the tender;
- appoint the evaluating committee;
- evaluate the suppliers' proposals;
- award the contract;
- managing the contract and monitor suppliers' performance.

Contracts either refer to specific/small activities, e.g., development services for a single MEF Department or over a specific MEF architecture ("vertical projects"), or to larger projects involving many activities merged into a big cross-Departments contract. Some of the most important contracts are of the second type, that is "framework contracts" or "general purpose", including a large variety of activities, such as IT consultancy, development and maintenance of IT applications, databases, internet and intranet websites. Our dataset is essentially based on these general purpose contracts.

In compliance with the EU Directive 2004/18 all these contracts are awarded through open competitive tendering. The Italian law qualifies the EU rules establishing the most economically advantageous offer as the main criterion to award contracts for services.

Quality is crucial for every IT services contract. Very often the weight of the technical side is equal or above 50% and evaluation of proposals is always based on a significant discretional component.

The "typical" contract requires the contractor to set up an adequate team of professionals, resources, IT equipments and technological solutions to achieve both high quality standards and sufficient flexibility to manage heterogeneous activities. The three milestones of evaluation criteria are the organizational proposal (teams), technological solutions and improvements over key performance indicators. To each milestone is assigned a weight (score/points). Within each single milestone points are allocated to several sub-criteria. Basically, the milestones are:

- **Organization**, e.g., how resources are organized and deployed to best perform tasks; solutions to maintain stability and provide flexibility to working teams, how activities are split among partners in case of joint bidding or subcontracting;

- **Solutions**, e.g. softwares, methodologies and tests for development activities, best practices for the implementation of big projects involving many "Function Points";[7]
- **Quality**, e.g., quality plans, documents released, improvements over Key Performance Indicators (KPI), skills of professionals and consultants, etc.

Contracts are fixed-price, providing for some performance incentives based on the achievement of certain KPI thresholds.

As anticipated above, the contracts provide for a large variety of activities, e.g.:

- evolutionary and corrective maintenance of applications;
- development over existing applications;
- development of new applications;
- consultancy on IT services and data monitoring;
- management of websites (development of new accessible websites, publishing, etc.);
- management of data warehouse and databases;
- help-desk and end-user assistance/support levels;
- corporate assistance/support/consultancy (Ministry of Economy and its cabinet)

To best manage all activities, contracts usually require the contractor to deploy different types of professionals. How these are organized in order to best fit the needs of the Ministry is evaluated in the milestone "organization". Beside the Chief of the project and a list of selected senior consultants, teams are usually composed of several other professionals, such as junior consultants, function analysts, programmers, product/technology specialists, data warehouse designers and enterprise data administrators.

Depending on the size of the contract and the number of departments/users involved, supplier's team may be composed of even more than 100 professionals. The contractor's team operate in harness with dedicated people from the MEF and Consip project managers and

monitoring unit. The monitoring unit is in charge of monitoring that the contractor fulfills all obligations.

Technical Proposals Evaluation: The Role of Committees

Following the Italian procurement laws, proposals are evaluated by *ad-hoc* committees. The committee checks whether competing suppliers have the minimum technical/economic requirements indicated in the solicitation documents. All suppliers fulfilling the requirements are admitted to the subsequent phase. In this phase, the committee evaluates the technical proposals of all the admitted bidders, as well as their price offers.

The composition of the committees is regulated by the law. Until 2006 the legislation established members to be selected among both public administration's employee ("insiders") and external professionals, such as university professors or recognized experts ("outsiders"). Since 2007 committees are of all insiders. The number of members can be either 3 or 5 depending on the complexity of the supply.[8]

Our dataset enables us to make some comparisons between the two regimes and to see whether, other things being equal, there is a difference in evaluating technical proposals. The first contracts (1999-2002) and than the latest ones (2007) were evaluated by insiders committees, and all the others by mixed committees (insiders and outsiders). Our conjecture is that, being in depth with the details of the contract, internal committees are likely to evaluate technical proposals with more accuracy than mixed committees. As we will see, some patterns arise in the analysis of technical scores distribution.

OVERVIEW OF THE DATASET

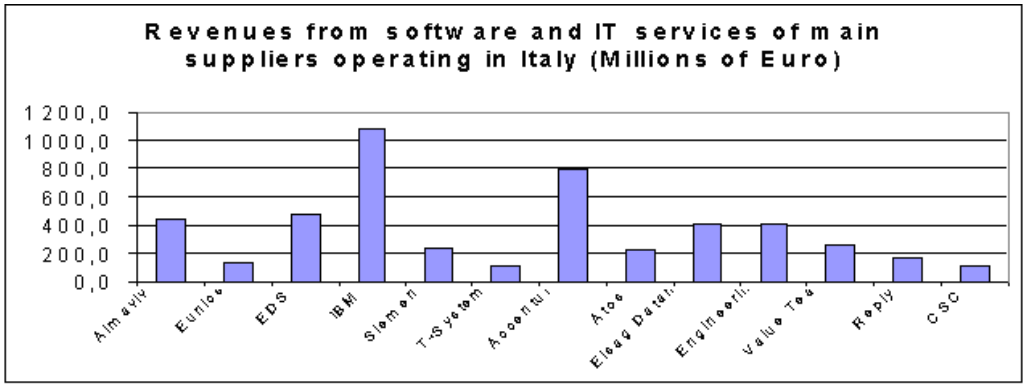
Our analysis is based on a unique set of 20 contracts[9] that Consip awarded in the period 1998–2007. The total value of the contracts analyzed amounts to €428,7 millions, 4,6% of total Italian expenditure on IT services in 2006 (private and public sector amount to €9,3 billions).

Economic value is only one aspect characterizing the importance of such contracts. There are several other key elements suggesting to this analysis. First, we are able to address many issues not yet empirically explored. Second, contracts we analyze are for strategic activities, as

they often relate to critical (IT) MEF infrastructures, such as the ones supporting the Public Balance Sheet. Third, the nature of the database. The set of 20 contracts yields 132 observation points,[10] namely 132 price/technical pairs. Although the analysis is not based on a very large number of observations, these are the whole set of procurements on IT services run by Consip in behalf of MEF since its creation in 1997. In other words, we do not deal with observations "drawn" from a sample of contracts, rather with *the whole* existing population.

One last elements worth stressing is the number and the importance of bidding suppliers. Bidders include the major worldwide players in IT, such as Accenture, Almaviva, Enterprise Digital Architects (EDA), EDS, Engineering, IBM, Siemens. These are the most important suppliers in the IT sector, covering almost the entire market share in Italy and Europe, as reported in Figure 1 and Figure 2. Figure 3 reports the number of times these suppliers submitted a bid in set of contracts we considered. As the reader can note, the most important IT services provision companies do compete to provide IT services to the MEF.

FIGURES 1 & 2
Revenues from Main IT Services Suppliers Operating in Italy (2006)



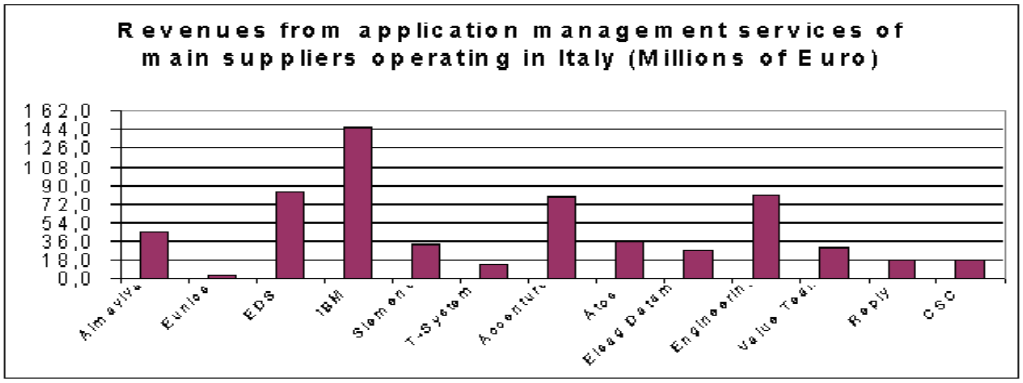
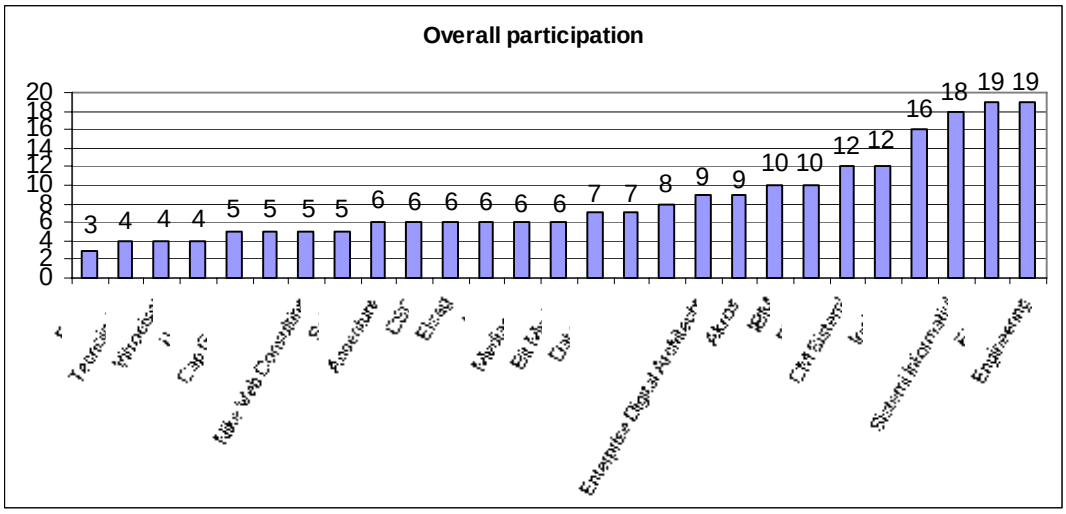


FIGURE 3
Overall Tender Participation from Main IT Services Suppliers Operating in Italy.



Basic Statistics

Bids and Scores

The simple ranking of contracts by technical scores[11] shows that quality is very important. We note that 60% are skewed on technical

side. In the majority of contracts/lots quality weights at least 60%. Contracts in which quality is at least 50% are 85% of total contracts.

TABLE 1
Frequency Distribution of Level of Technical Score

	<50	50-59	60-69	>=70
N.	3	5	8	4
%	0.15	0.25	0.40	0.20
Table 2 – Frequency distribution of level of Financial Score				
	<30	30-40	41-50	>=50
N.	2	10	5	3
%	0.1	0.5	0.25	0.15

Symmetrically, the frequency distribution of financial scores shows that 60% of lots has been face with scores until 40 points, or 85% under 50 financial score.

Table 3 and 4 show the frequency distribution of observed relative scores effectively achieved by the competitors. Relative score is = actual score/maximum score. The cumulated distribution is plotted in Figure 4. The median technical score (51-60 and 61-70) represents the 50% of technical proposals, whereas 62% of technical proposals obtained scores over 60. Overall average technical score is 66.17, median is 65. Standard deviation is 14.67, showing a significant dispersion if we consider the best and the worst technical proposals.

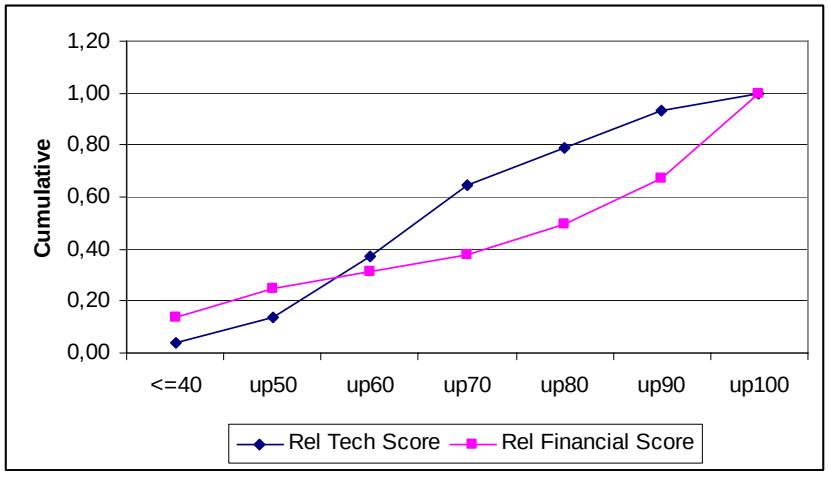
TABLE 3
Frequency Distribution of Relative Technical Score

rank	<=40	41-50	51-60	61-70	71-80	81-90	91-100
N.	5	13	31	36	19	19	9
%	0.04	0.10	0.23	0.27	0.14	0.14	0.07
Summary Statistics							
Mean			*Median*		*St. Deviation*		
66.17			65		14.67		

TABLE 4
Frequency Distribution of Relative Financial Score

rank	<=40	41-50	51-60	61-70	71-80	81-90	91-100
N.	18	15	8	9	15	24	43
%	0.14	0.11	0.06	0.07	0.11	0.18	0.33
Summary Statistics							
Mean			*Median*		*St. Deviation*		
72.60			80.81		25.43		

FIGURE 4
Cumulative Function of Relative Technical and Financial Scores



Things are quite different if we analyze the frequency distribution of relative financial scores. The first two higher ranks (81-90 and 91-100) together account for the 51% of proposals, while the 75% are over 50. Furthermore both the mean and the standard deviation (72.60 and 25.43 respectively) are greater with respect to the technical scores. This might also be due to a sort of "bias" in the mapping from price to score when using interdependent scoring. For instance, although one bids slightly

above the average, the score differential between her bid and the average can be very large when using "average scoring". The same can occur with "interdependent scoring" when bids are only slightly above the lowest bid.[12] See paragraph 4.1.3 for more details on scoring rules.

However, this does not imply that the suppliers win just through outstanding financial proposals. The score matrix below shows that the winner obtain the highest technical score in 16 cases out of 20, whereas only in 7 cases out of 20 she gets the highest financial score. This suggests that suppliers mainly win contracts by providing relatively more (ex-ante) quality rather than lower price.

Score Matrix

Winners' Financial Score	Winners' Technical Score		
		Best score	*Not best*
	Best score	5	2
	Not best	11	2

Participation

(a) Participation and contract value

As the contract value increases, the economic and technical requirements become more binding for suppliers. This may adversely affects participation of smaller firms and encourage joint bidding, as we will see in more detail in the next paragraph.

We have run a simple OLS estimation in order to test for a negative correlation between the number of actual bidders and the reserve price/contract value, controlling for some other factors likely to affect participation. Regression analysis confirms the intuition: negative relationship is relevant (-0,57) and statistically significant (t-statistic = -2.92).

Figure 5 shows that starting from low values, an increase in the reserve price is associated with lower participation. Instead, above a certain threshold (€40 millions) participation slightly increases with the reserve price. This could be explained by assuming that the participation

FIGURE 5
Smoother of number of actual bidders on contract values[13]

of the biggest and most experienced suppliers is, to some extent, "value independent". In particular, the two outlier tenders have been competed by 4 and 6 bidders respectively, 4 of which are joint bidders including the largest and more experienced players of the IT sector (Almaviva, EDS, IBM, Engineering).

(b) Participation and joint bidding

Partnership is a common form of participation to tenders when contracts are "big". Joint bidding can be an appropriate strategy for small as well as for big firms. The latter might be skeptic about going autonomously: especially at their first bidding, they may prefer to share risks with other (possibly more expert) firms. The former do not always have enough economical/technical capacity for individual bidding, so participation necessarily requires partnership.[14] Figure 6-7 support this hypothesis: joint participation is more frequent for large contracts – indeed, the correlation with the contract value of both the absolute number of joint bids and their share over the number of bids in each lot is relevant and statistically significant. Also, notice the effect of extreme values in Figure 7. As the contract value increases, the relationship tends to be less steep since the overall participation becomes lower due more stringent economic requirements.

FIGURE 6
Individual and Joint Bidding Patterns

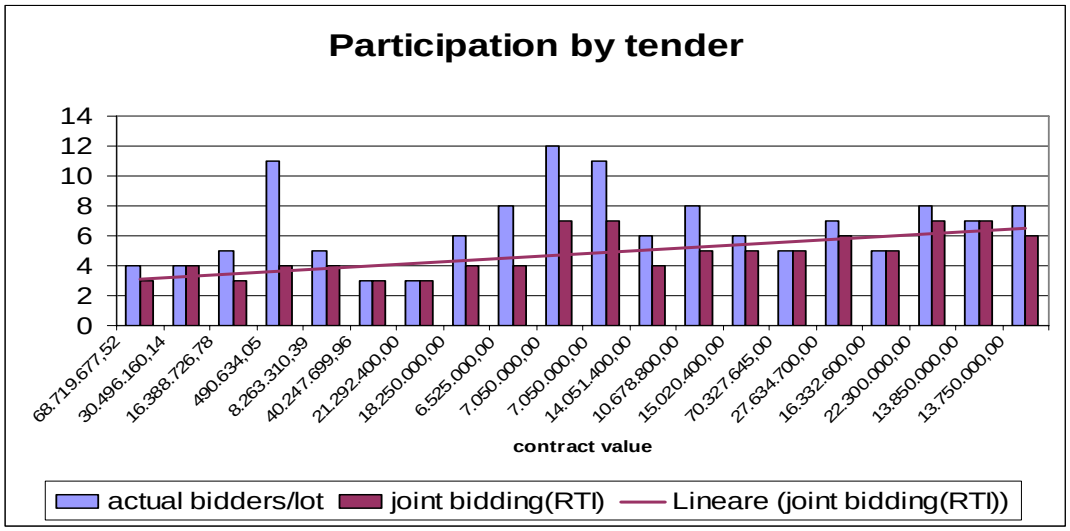
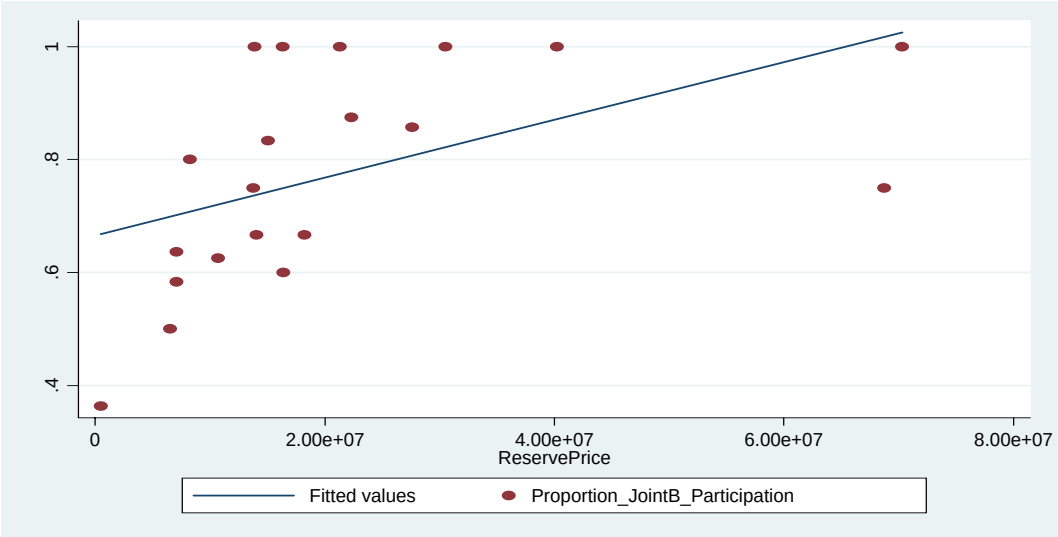


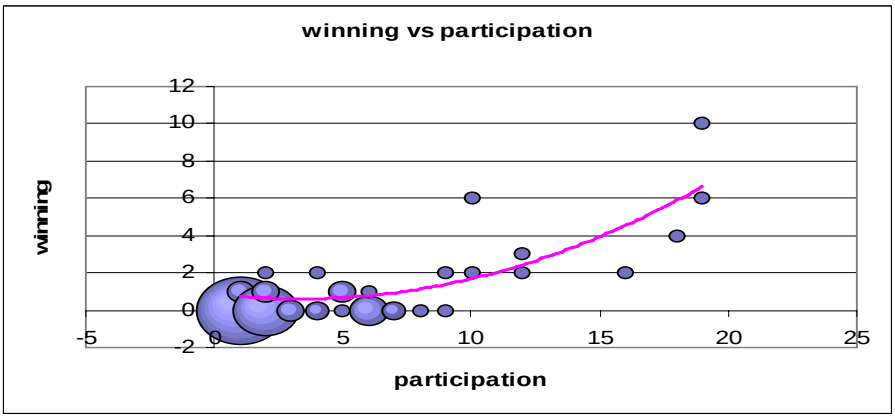
FIGURE 7
Correlation between Proportion (Joint Bids/Number of Bids) and Contract Value



(c) Participation and winning

Figure 8 shows the correlation between winning and participation. The number of participations for each supplier is the number of contracts/lots for which she has submitted an offer.

FIGURE 8
Contract Award and Participation



Each ball in the graph represents the number of suppliers (the size of the ball) with a given pair participations-wins. On the one hand, we observe that most of the suppliers never win a contract: 26 suppliers bid once and did not get the contract; 15 firms bid twice without winning any contract. There are even suppliers facing with 9 bids and still facing with 0 contracts awarded.

On the other hand, there is a smaller number of suppliers winning quite frequently. The relationship between participations and number of contracts won seems to be exponential. Not only the number of contracts awarded, but even the probability of winning a contract seems to increase with the participation. The more frequently any supplier bids, the greater her chances to win a contract.[15]

One explanation to this puzzle is that after winning and supplying a contract bidders acquire an informational advantage over potential competitors. Such an advantage is then exploited in subsequent tenders,

allowing experienced suppliers to become more efficient and so increase (more-than proportionally) their probability to win a contract.

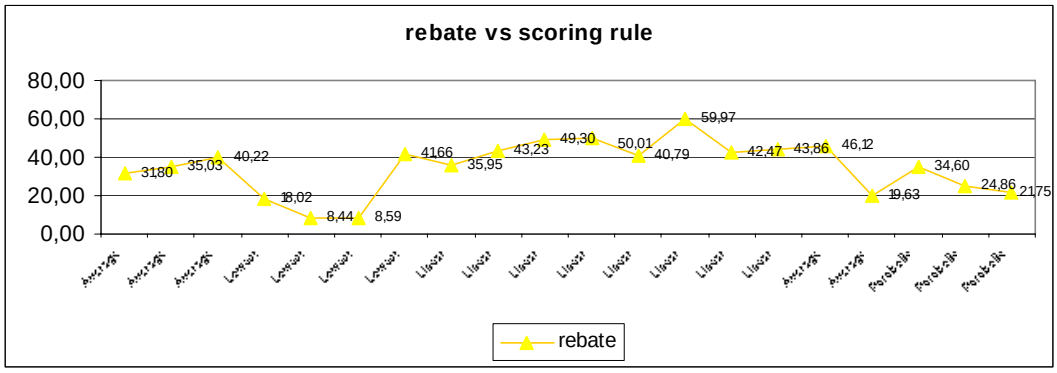
Scoring Rules

The contracts we are dealing with include various measures of quality. Most of the times, such a multidimensional problem is treated with MEATs. As well known, MEATs are usually performed by scoring rules that transform price (and/or other quality aspects) into a score. The highest score wins the contract.[16] As a preliminary analysis, Figure 9 shows how rebates of winners increase on average when the scoring rule is "linear" with respect to other rules.[17] A scoring rule is said to be linear if score increases linearly/proportionally as the price declines. This type of scoring rule belongs to the family of the so called *independent scoring rules*. *Independent scoring rules* are such that one bidder's score depends on her bid *only*. Interdependent scoring rules, instead, are such that the score of any bidder also depends on some (or all) other bids (e.g. the lowest bid, the highest bid, the average bid, etc.).

We will see below that the former type of rule leads to lower submitted prices on average. The difficulty or the impossibility to fully infer the buyer's preferences in terms of price-quality trade-off in the case of interdependent rule may be at the root of such a difference. With linear scoring rules, at the contrary, computing the score associated to any possible price bid and thus defining the appropriate price/quality strategy is much easier for suppliers. Simplicity of the rule and predictability of the score might then stimulate price competition, as Figure 9 seems to suggest.

Interdependent scoring rules tend to yield significant lower rebates on average – about 27% with respect to 46% – than independent scoring rules.[18] In particular, "lowest and/or average" scoring rules induce suppliers to submit bids as close as possible to what they expect the best or average price will be. The more precise this estimate is, the more chances the supplier will have in achieving a high score. The uncertainty, however, may trigger a precautionary or not aggressive bidders' behavior on the price side.

FIGURE 9
Rebates of awarded bidders and scoring Rules



EMPIRICAL ANALYSIS: THE REDUCED FORM APPROACH

In this section we use the dataset to explore the main factors explaining suppliers' bidding behavior. Before going through the analysis we briefly illustrate approach and motivations.

Our estimates are based on a non-structural (or reduced form) regression approach. As mentioned in the literature section we do not aim at – but also cannot buck for estimating the whole process generating data, that is the distribution of bidders' value. We are not interested in assessing optimality of reserve price or whether if there is some common value component in the underlying environment.

We believe the environment we consider to be too complex for structural modeling. Buyer and suppliers behavior would be very hard to describe in multidimensional procurement environments where, contracts are highly incomplete, quality is non-contractible and bids and discretionally evaluated by the committee.[19] Also, optimization should account for several factors, often unobservable to the econometrician or observable at prohibitive costs. These could be the description of a large set of complex legislative constraints or the multiplicity of buyers' needs "dispersed" in the contract clauses. The reduced form approach, however, allows us to focus on the *directions rather than magnitude effects*.

There are several advantages in using a reduced form approach. First, it still enables the researcher to address some key basic issues, such as

how one variable affects another. And despite we maintain agnostic on how the data is generated, economic theory of auctions suggests the choice of the relevant explanatory variables, as well as their expected sign. Second, reduced forms are easier to construct and estimate than structural models (Davidson and MacKinnon 1993), that require to derive an explicit form economic model and try to identify the structural parameters.

With reduced form analysis, for instance, we address the issue of the direction of the effect of selected covariates on the submitted price/quality ratio.

A standard reduced form regression model is the following:

$$[\text{dependent variable}_i] = \text{constant} + \beta_k\,[\text{independent variable}_{ik}] + \varepsilon_i$$

Where:

$k = 1, \ldots K$ indexes all our explanatory variables, while $i = 1, \ldots N$ indexes our observation units.

A cross-section estimate is carried out on 132 observations-bids. We estimate equations using standard OLS.

The analysis of bidding behavior is split in 3 main parts. In the first we test for the existence of a relationship between price and quality in submitted bids. We do this running two regressions on quality and price separately, controlling for some other variable incorporating key aspects of the tender design and the bidding behavior.

In the second part we address the issue of what are the main determinants of the price/quality bids submitted by suppliers. In the third one we investigate the determinants of the dispersion of technical scores in relation with the composition of the evaluating committee.

Variables used for regressions in part 1 and 2 are:

- **The number of bids**. In mature markets, as the one our data refer to, bidding suppliers are likely to know each other. The number of bids can therefore be used as a proxy of the ex-ante expected participation to the tender. In general, this variable can be an important determinant explaining bidding behavior. Standard theory suggests that in a setting of independent private value model, the bid increases with participation (in procurement, the bid decreases with participation).

- **Scoring rule.** This is a binary variable, 1 for independent and 0 for interdependent scoring rules, respectively. Our conjecture is that independent scoring rules should stimulate competition on the economic side, since the incremental score the supplier gets for any price reduction is known ex-ante. Predictability of the score may provide suppliers with incentives to bid more aggressively on price. Interdependent scoring, instead, induce suppliers to make conjectures about other competitors' bid. In average scoring rules, suppliers try to estimate the average price (respect. the lowest price) in order to bid as close as possible to that level. This "game of expectations" – as already mentioned – pushes prices up and makes price distribution more concentrated.
- **Experience**. Measured by the number of previously won contracts for any bid *i* at any given time *t*. We expect more experienced suppliers to better know the procurement environment and thus *ceteris paribus* to offer proposals that better fit the various needs of the buyer. Expert suppliers are expected to be more informed about the real needs of the buyer and how to put this knowledge into a comprehensive technical offer. This should yield higher technical scores with respect to less (or non-) experienced suppliers.
- **Committees.** This is a binary variable, equal to 1 for insiders committees and 0 for mixed committees (insiders + outsiders). This is a control variable capturing the fraction of technical score variability due to a different evaluation approach of the two types of committee.
- **Bids and score.** We use technical score as a proxy of the ex-ante quality. Rebates, financial scores and the price/reserve price ratio are alternative measures of economic effort.

The number of explanatory variables is kept low. Such parsimony is used to focus more on the variables that are more likely to explain the dependent variable, and more importantly, to avoid loosing degrees of freedom given that we do not rely on a very large number of observations.

Testing for price/quality trade-off

Technical score regression

In this section we investigate the main aspects affecting bidding on quality, controlling for the variables indicated above. In particular, *we investigate whether quality is explained by price*, controlling for the type of scoring rule, the number of bidders, the type of committee and the bidders' experience. The type of scoring rule represents one key element of the tender design. Expected participation and experience are important factors potentially affecting bidding behavior.

We measure quality with the technical score the suppliers are assigned by the committee at the end of the evaluation process of all proposals. Quality we consider is of the *ex-ante* type, i.e., what the suppliers *commit* to provide in terms of organization, quality standards and technological solutions.

The equation we estimate is the following:

$$Tech\_Score_i = const + \beta_1 Financial\_Score_i\ [Rebate_i;\ Bid\_Price/Res\_Price_i]$$
$$+ \beta_2 \sum_t Winning_{it} + \beta_3 N\_Bids_i + \beta_4 Scoring\_Rule_i + \beta_5 Committee\_dummy_i + \varepsilon_i \qquad (5.1)$$

Does price explains ex-ante quality? We performed 5 regressions with alternative measures of the price bid: financial score, rebate and relative price (price bid/reserve price). All the regressions suggest that price explains quality, all the coefficients being statistically significant. However, the relationship between ex-ante quality and economical aspects is *positive*: higher quality is associated to lower prices and vice versa. The sign in this relation seems to contradict the hypothesis of a "price-quality trade-off" in submitted bids. Nevertheless, this could be not so surprising, because of some arguments already mentioned above. In particular, we can make the following considerations.

Opportunism. Since a considerable part of quality is non-contractible and hence hard/costly to monitor ex-post, suppliers may offer outstanding technical proposals (yielding high technical scores) that will not be aligned to the ex-post effective level of quality. If suppliers realize that monitoring such contracts is hard/very costly, the ex-post implemented quality is likely to be lower than the level promised in the

TABLE 5
Technical Proposals Regression[20]

Table 5 – Technical proposals Regression[20]					
		OLS			
Tech_Score$_i$	*I.*	*II.*	*III.*	*IV.*	*V.*
Financial_Score$_i$	*0.156*** (3.24)	-	-	-	-
Rebate$_i$	-	*0.389*** (3.72)	*0.364*** (3.47)	*0.244*** (2.44)	-
Bid_Price/Res_Price$_i$	-	-	-	-	*-38.91*** (-3.72)*
$\sum_t$ *Winning*$_{it}$	*3.07*** (6.55)*	*3.414*** (7.15)*	*3.55*** (7.44)*	*3.01*** (6.23)*	*3.414*** (7.15)*
N_Bids$_i$	*-1.41*** (-2.86)*	*-0.854** (-1.97)*	-	*-1.266*** (-2.91)*	*-0.854** (-1.97)*
Scoring_Rule$_i$	*-5.12** (-2.00)*	*-9.625*** (-3.49)*	*-11.11*** (-4.14)*	-	*-9.625*** (-3.49)*
Committee_dummy	*-8.964*** (-3.76)*	*-2.676 (-1.03)*	*-2.857 (-1.09)*	*-1.739 (-0.65)*	*-2.676 (-1.03)*
Constant term	*67.202*** (16.27)*	*61.092*** (12.62)*	*56.252*** (13.34)*	*63.158*** (12.60)*	*100.00*** (12.08)*
Adj. R^2	*0.33*	*0.35*	*0.33*	*0.29*	*0.35*
F-test	*14.09*	*15.06*	*17.46*	*14.51*	*15.06*
N. Obs.	*132*	*132*	*132*	*132*	*132*
*t-Statistic shown in parentheses; significant levels at *0.10, **0.05, ***0.01.*					

upfront. Accordingly, the submitted price can be kept lower. In other words, low prices would not be for the ex-ante (or "nominal") quality promised, rather for the ex-post lower and effective quality.[21] A similar effect is considered in theory by Kim (1998), who build up a procurement model where the buyer wishes to acquire a high-quality project by the use of a sealed-bid tendering. Non-contractible quality of projects implies transaction costs for contract enforcement and difficulties to ensure that the project is of the desired high quality. In this framework the author points out that if the buyer commits himself to a firm fixed price contract,[22] the contractor may provide low quality in order to cut down on production costs.

Optimism. Another hypothesis is that complexity of contracts may induce (risk neutral) suppliers to systematically underestimate supply costs, or, alternatively, to be too optimistic about the difficulties of implementing the project.

Both opportunism and optimism may arise because of contract complexity.[23] Opportunism may arises for the difficulties for the buyer in monitoring/enforcing contracts; optimism may result from the difficulties for the suppliers to estimate costs, if suppliers risk neutral.

The role of other variables

1) Estimates suggest that *independent scoring* (linear and parabolic) reduce technical score increases (the sign of coefficients is always negative as reported in Table 5). Independent rules allow each supplier to determine his financial score unloosed from his competitors' behaviour. This provides him with a clear incentive to improve the price offer. It is worth noting, on the contrary, that interdependent rules (lowest bid and average scoring) introduce uncertainty also on the price side. Scores become unpredictable because of the simultaneous presence of discretional evaluation of technical proposals and interdependent price scoring. In this context, incentives for the suppliers to shift effort from quality towards price improvements are expected to be weaker since the shift can pay for only with a *known* "rate of return" in terms of financial score.[24]

2) The variable $\sum_t Winning_{it}$ summarizes the number of past contracts awarded to each bidding supplier. Experience/learning is what the supplier has learnt during the contract execution period. Learning can be important in complex procurement like the ones we are considering. Experience improves the supplier's understanding of what are today (and could be in the future) the technological evolutions and developments most fitting buyer's needs, of the technological evolutions and developments most fitting the buyer's need, both today and in the future, as well as the most important/critical activities among the ones indicated in the contract. In other words, the contractor learns to make a "custom tailored suite" and how to exploit this (private) information in subsequent procurement tenders.

Any single observation, i.e., any single pair of price-quality bid, is associated to a measure of experience given by the number of contracts previously awarded to the supplier. Technical scores appear to be

positively and significantly correlated with this variable. Covariates statistical significance is robust to alternative regressions specifications, with estimated coefficients maintaining stability. Winning one additional contract allows the supplier to improve the technical score by roughly 3.1-3.6 points, about 6% of technical score.

3) The *number of bids submitted* has a negative impact on the technical score (although the coefficient has a weak statistical significance) suggesting that the larger the number of bidders the lower the "promised" quality. A possible explanation is that more participation shifts the players' efforts towards price-competition rather than technical-competition. Again, the expectation that quality improvements may not be appropriately rewarded (or will do less than price improvements) may induce suppliers to shift effort from quality to price when expecting higher participation.

Scoring rule and expected participation appear to interact, and to operate in the same direction. In point sub 1) we have seen how independent scoring rules encourage competitors to shift effort toward price. Here we have found that higher participation *in general* encourages them to shift effort toward price competition.

4) Despite statistical significance is achieved only when using the financial score as covariate, the composition of committees seem to affect technical scores in the expected direction. Internal commissions are associated to a lower average technical score. Insiders tend to discriminate quality proposals more than outsiders, providing support for the results of the analysis of technical score distributions presented in section 6.

The determinants of price bids

Symmetrically to the previous regressions, we test whether price bids are explained by quality, controlling for other variables. We also control for the contract value (reserve price) since this may effect more directly price bids, in particular the magnitude of rebates. We measure price bid with the % of rebate. Price bid regression is also performed as a "check" for results obtained in technical regressions.

The estimated equation is:

$$Rebate_i\,[Financial\_Score_i] = const + \beta_1\, Tech\_Score_i + \\ + \beta_2\, Scoring\_Rule_i + \beta_3 \sum_t Winning_{it} + \beta_4\, N\_Bids_i + \beta_5\, Reserve\_Price_i + \varepsilon_i \qquad (5.2)$$

TABLE 6
Financial Proposals Regression

	Tech_ Score$_i$	*Scoring_ Rule$_i$*	*$\sum_t$ Winning$_{it}$*	*N_Bids$_i$*	*Reserve_ Price$_i$*	*Constant term*	*Adj. R^2*	*F-test*	*N. Obs*
Rebate$_i$.$^{OLS(E)}$	*0.33****	*15.78****	*-2.025****	*1.05***	*7.30e-08*	*-4.55*	*0.42*	*19.97*	*132*
	(4.50)	*(7.49)*	*(-4.35)*	*(2.22)*	*(1.02)*	*(-0.73)*			
Rebate$_i$.$^{WLS(1)}$	*0.076*	*21.10****	*-0.45*	*1.481***	*3.28e-07**	*-1.59*	*0.53*	*31.04*	*132*
	(1.46)	*(9.78)*	*(-0.69)*	*(2.34)*	*(1.86)*	*(-0.21)*			

*t-Statistic shown in parentheses; significant levels at *0.10, **0.05, ***0.01.*

(E) Heteroscedastic affliction; (1) weight: Reserve_Price;

As expected, price and quality are still positively correlated. Estimated coefficients also show that: i) experience reduces rebates, i.e., increases prices; ii) higher expected participation lowers the price (increases rebate); iii) the reserve price seems to play no role in the regression. Notice that independent scoring rules induce/yield to lower prices (higher rebate). This suggests again that simplicity of the rule and predictability of the score make suppliers' life easier when bidding on price and induce them to bid more aggressively. Independent scoring affects financial proposals by decreasing submitted relative prices (increasing rebates) by 16%-21% on average.

THE DETERMINANTS OF PRICE/QUALITY RATIO

In this section we look at bidding behaviour under a different perspective. We investigate the main elements driving the submitted quality/price ratios. We identify the main determinants of price/quality

index incorporated in submitted bids and we attempt to estimate the direction of the effect of each determinant on the index.

The index may be considered a measure of the *elasticity* of the price with respect to quality. The *price/quality index* is as follows:[25]

$$R^{p}/_{Q_i} = \frac{Bid\ \mathrm{Pr}ice_i \,/\, \mathrm{Re}serve\ \mathrm{Pr}ice_c}{Tech.Score_i \,/\, MaxTech.Score_c}$$

The index displays the following properties.

1. $\mathrm{Re}serve\ \mathrm{Pr}ice_c \geq Bid\ \mathrm{Pr}ice_i$;
2. $Tech.Score_i \leq MaxTech.Score_c$.
3. $0 \leq \left(Bid\ \mathrm{Pr}ice_i \,/\, \mathrm{Re}serve\ \mathrm{Pr}ice_c \right) \leq 1,$

and

4. $0 \leq \left(Tech.Score_i \,/\, MaxTech.Score_c \right) \leq 1.$

where subscripts "c" and "i" identify contracts and bidders, respectively. As a consequence, it will also be

5. $R^{p}/_{Q_i} \in [0; +\infty].$

The price/quality ratio improves when the index decreases. When the price declines Price bid/Reserve price declines (the rebate increases). This in turn lowers the index, i.e., improves the price/quality index. At the same time, as the technical score increases the denominator also increases; this pushes the ratio down, again improving the price/quality index. Therefore, higher quality and lower prices are associated to $R^{p}/_{Q_i}$ closer to 0.[26] With the following equation we estimate the effect of a set of explanatory variables:

$$R^{p}\!/_{Q_i} = const + \beta_1 Scoring\_Rule_i + \beta_2 N\_Bids_i + \beta_3 \sum_t Winning_{it} + \\ + \beta_4 \mathrm{Re}serve\_\mathrm{Pr}ice_i + \varepsilon_i$$

(6.1)

TABLE 7
Price/Quality Index Regression

	I.	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*
	Rp/Q_i *OLS (E)*	Rp/Q_i *WLS (1)*	*Num_* Rp/Q_i *OLS*	*Num_* Rp/Q_i *WLS (1)*	*Den_* Rp/Q_i *OLS*	*Den_* Rp/Q_i *WLS (1)*	*Den_* Rp/Q_i *WLS (2)*
Scoring_Rule$_i$	*-0.267*** (-3.77)*	*-0.331*** (-3.30)*	*-0.148*** (-6.56)*	*-0.21*** (-9.66)*	*-0.031 (-1.24)*	*-0.026 (-0.71)*	*-0.027 (-1.03)*
N_Bids$_i$	*-0.015 (-0.96)*	*-0.033 (-1.12)*	*-0.011** (-2.10)*	*-0.015** (-2.34)*	*0.0004 (0.08)*	*0.001 (0.11)*	*-0.003 (-0.46)*
$\sum_t Winning_{it}$	*-0.036*** (-2.63)*	*-0.086*** (-3.03)*	*0.010** (2.31)*	*0.001 (0.16)*	*0.031*** (6.21)*	*0.046*** (4.40)*	*0.031*** (6.30)*
Reserve_Price$_i$	*-5.81e-09** (-2.44)*	*-1.04e-08 (-1.27)*	*-1.29e-09* (-1.70)*	*-3.35e-09* (-1.89)*	*1.69e-09** (1.98)*	*8.93e-10 (0.30)*	*1.51e-09** (2.08)*
Constant term	*1.50*** (10.11)*	*1.84*** (5. 65)*	*0.8498*** (18.00)*	*0.97*** (13.81)*	*0.60*** (11.21)*	*0.57*** (4.77)*	*0.62*** (12.80)*
Adj. R^2	*0.19*	*0.24*	*0.33*	*0.53*	*0.26*	*0.13*	*0.26*
F-test	*8.50*	*11.59*	*17.28*	*37.93*	*12.29*	*5.93*	*12.77*
N. Obs.	*132*	*132*	*132*	*132*	*132*	*132*	*132*

*t-Statistic shown in parentheses; significant levels at *0.10, **0.05, ***0.01.*
(E) Heteroscedastic affliction; (1) weight: Reserve_Price; (2) weight: N_Bids

The first two columns report the results of standard estimation with OLS and WLS. Weighted Least Squares regression is used to treat heteroscedasticity.[27] The other columns instead report the estimation

considering either the numerator or the denominator, again controlling for heteroscedasticity.

Estimates indicate that both scoring rule and past experience play an important role in explaining the price/quality ratios. Negative correlations implies overall improvements in the price/quality index. Scoring rules and experience clearly go towards this direction, confirming some effects showed in previous regressions. Independent scoring positively impacts the price/quality ratio achieved by the buyer: about 26%-33% of improvement in the index is associated with the use of independent scoring rules instead of interdependent scoring rules. However, the largest impact occurs on the economic side of competition (the numerator of the index captures the effect on price side). This is shown by regressions 3 and 4.

Table 7 reports regressions 5-7 that capture the impact on quality side of competition (denominator of the index). Experience is also relevant. One additional contract awarded improves the price/quality index of 3.6%-8.6%. Decomposing the estimation, bidder experience has still the strongest impact on quality as found in the previous regressions (5 to 7). Reserve price variable here is used as a control variable, in order to account for the variability of the contract value. In the second column the reserve price is used as instrument to control for heteroscedasticity.

EVALUATING COMMITTEES

Evaluation of quality proposals may vary significantly, depending on how deeply people involved in the evaluation process know the procurement context and the various details of the contract. Insiders, i.e. Consip employees, know the context much better than any outsider expert. Filling this information gap can be very costly and time consuming for outsiders. Outsiders in the committee were introduced by law to increase transparency in the awarding/evaluation procedures. However, such a transparency may came at some cost. Lack of familiarity with the specific procurement context may have limited the ability of committees to appropriately distinguish among quality proposals with respect to insiders (which results in a lower dispersion in technical scores), and in general to over-reward quality (which results in higher actual technical scores). This might signal the fear of outsiders for potential appeals of suppliers. On their part, day-to-day direct work on

projects put insiders in a ideal position to fully understand the procurement tender context and to better evaluate quality proposals. This also enables insiders to better defend their choices in case of dispute with suppliers. These conjectures find some support in the data. Table 8 summarizes some simple statistics on technical score distinguishing between insiders (committee = 1) and mixed (insiders + outsiders) committee (committee = 0). Two things are worth noting:

a. The variability of technical scores with all-insider committees is greater than with mixed committees. Mean variance is 0.083 vs. 0.058, i.e., 43% greater than in mixed committees. Mean standard deviation is 0.136 vs. 0.11, 23% greater than in mixed committees. Dispersion of technical scores is clearly higher with insider committees. Regression analysis reported in table 8.2 shows that such differences are statistically significant.

b. Mixed committees are also more generous in rewarding quality with respect to insiders. Mean technical score is 68.63 and 62.55, respectively, 10% higher with mixed commissions. The maximum score is 96.82 of outsiders and 93.33 from insiders.

TABLE 8.1
Summary Statistic on Committee

Statistics	*Committee = 0*	*Committee = 1*
Mean of Technical Score St. Deviation	*0.11*	*0.136*
Mean of Technical Score Variance	*0.058*	*0.083*
Observations (by group)	*79*	*56*
Mean of Technical Score	*68.63*	*62.55*
St. Deviation (by group)	*13.88*	*15.15*
Minimum	*29.17*	*32.29*
Maximum	*96.82*	*93.33*

TABLE 8.2
Evaluation Committees Regression[28]

	OLS			
	St.Dev_ TechScore$_t$	*St.Dev_ TechScore$_t$*[29]	*Var_ TechScore*	*Var_ TechScore$_t$*
St.Dev_FinScore$_t$	*0.242*** (2.72)	*0.278**** (4.10)	-	-
Var_ FinScore$_t$	-	-	*0.112** (1.91)	*0.115*** (2.33)
N_Bids$_t$	*0.008*** (2.14)	*0.01**** (5.43)	*0.006* (1.50)	*0.006**** (3.80)
Committee$_t$	*0.032** (1.89)	*0.036*** (2.34)	*0.03* (1.60)	*0.030** (1.84)
Constant term	*0.021* (0.63)	-	*0.003* (0.10)	-
Adj. R^2	*0.31*	*0.92*	*0.15*	*0.77*
F-test	*3.85*	*78.53*	*2.14*	*23.18*
N. Obs.	*20*	*20*	*20*	*20*

*t-Statistic shown in parentheses; significant levels at *0.10, **0.05, ***0.01.*

CONCLUSIONS AND POLICY INDICATIONS

In this paper we explored the determinants of suppliers' bidding behaviour, using a unique dataset of contracts for IT services that Consip awarded on behalf of the Italian Ministry of Economy and Finance.

One key finding is that the nature of the scoring rule and past experience appear to be among the most important determinants of submitted price/quality ratios. Experience plays a primary role in bidding, positively affecting the level of ex-ante quality and in general price/quality ratios. A deep knowledge of the procurement environment can significantly increase the contractor's probability to award future contracts.

Independent scoring rules facilitate bidding and encourage suppliers to be more aggressive on the economic side. This suggests that interdependent scoring rule are only an obstacle to bidding in already complex procurement environments. The result has some connections with Lundberg (2005) who suggest how bidding strategies are

complicated when the buyer's trade-off between price and quality is not announced to bidders.

Another finding is the absence of a tension between price and quality in observed bids. Price and quality appear inversely related: higher quality is associated to lower prices. This apparent perverse effect could be explained on the ground of opportunism and optimism. Opportunism can arise when suppliers anticipate that buyer's performance monitoring may be costly, therefore delivered quality may be lower than the contractually agreed levels. Optimism may arise as a consequence of complexity of the supply, inducing risk neutral suppliers to underestimate provision costs. We suspect opportunism and optimism to be both relevant although we are not able to separate the effects. Contract complexity may be at the root of the two phenomena: the difficulty/cost for the buyer to write and enforce contracts with effective monitoring (under opportunism), and the difficulty for the suppliers to estimate costs (under optimism).

Finally, we find that the distribution of scores for technical proposals is significantly less dispersed when evaluation committees are composed of "outsiders" (mainly non-IT persons) rather than "insiders", suggesting that in the former case competition is shifted more towards price. Also, outsiders tend to be more generous than insiders. Risk aversion for appeals may explain this pattern.

Results suggest us to draw some policy indications.

1. Scoring rules. Using independent scoring rules in the place of interdependent, the buyer improves his price/quality ratio of about 30%. Improvements are mainly due to the simplicity of the rules and predictability of the scores. This strongly suggests to use independent scoring, such as a linear scoring rules.

2. Price and quality. There if no evidence of tension between price and quality in data. The difficulties for the buyer to correctly represent her preference into the tender design, as well as the difficulties for suppliers to trade-off their own price-quality bids (i.e., to design their iso-profit curve) may suggest to use other mechanisms to award these contracts – as negotiation/beauty contests – in acquisitions for similar services. This may allow sharing information among experienced and non-experienced suppliers, contributing to leveling the playfield [although this

strategy may come at the cost of experienced suppliers (mis- or) under-reporting their private information.

3. Committees. We have shown a potential trade-off between transparency and the effectiveness of bid evaluation process. Providing for all-insider committees might appear less transparent to the market, however, outsiders are not those who better know the contract details and the procurement environment. More than mixed (or all-outsiders), insiders committees may i) guarantee fair bid evaluation process ii) avoid the shift of competition towards price when quality is a relevant component of the supply.

NOTES

1. IT services are estimated to achieve 21% of European total ICT expenditure in 2007. In Italy, the IT market was €13,5 billions in 2006, with services absorbing 68%, and development, maintenance and consultancy services covering €2,41 billions (about 18%).
2. In Italy, for instance, since the early 90's a new architecture (SICOGE) enables the central Government to monitor local administrations' accounts by automated and standardized balance sheet information flows. The SICOGE (Sistema di Contabilità Generale) system has a double role. It informs the MEF about any single transaction of each local administrations and at the same time serves as workflow for expenditure authorization. Web-based information flows replaced paper and now allow the Government to save monitoring costs and to perform more rapid check on public transactions and accounts.
3. Open competition is a central principle for both European and U.S. public procurement legislations (EU Directive 2004/18 and the U.S. Federal Acquisition Regulation, 2005).
4. This is true when the scoring rules governing the price/quality tension have certain properties (e.g., linearity in the price dimension). Dini, Pacini and Valletti (2006) analyze in more detail the properties of linear and non-linear scoring rules.
5. Since 1997 Consip is mandated to select suppliers and manage contracts in the behalf of the MEF.

6. Things can be uneasy also for the buyer when designing the tender. Whether the organization set up and the solutions proposed by the suppliers fit the buyer's need can be difficult to evaluate ex-ante also for experts. And while one solution appears ex-ante more appropriate than others, it is in general quite complex to write in – and enforce with a contract what promised in the upfront by the supplier.

7. Function Points are a software metrics to quantify estimating software development. Function Point Analysis is considered a reliable method for measuring the size of computer software. In addition to measuring output, Function Point Analysis is useful in estimating projects, measuring productivity, and communicating functional requirements.

8. Rule on committees apply to Consip as well as to all public administrations.

9. In some circumstances the competitive tender is split in different lots. Each lot is a different contract and thus considered as separated competitive framework. See Grimm, Pacini, Spagnolo and Zanza (2006) for an in-depth discussion on lots division and competition in procurement.

10. We dropped (4 pairs of) abnormally low or incompletely submitted tenders.

11. Henceforth, we will use score(s) and points(s) interchangeably.

12. There are several types of average scoring rules. In general average scoring assigns the score proportionally to the distance between the actual bid and the average bid. In some rules, the supplier whose bid is closest to the average bids gets the maximum score, while all others get a lower score proportional to the distance: (your bid-average bid). Interdependent scoring rules are those in which the supplier's score depends on both her bid and (some) other suppliers' bid.

13. We computed a Locally Weighted Scatter Plot Smoothing with a bandwidth = 0.8.

14. Not rarely, however, smaller firms are delegated to perform lower added-value tasks, such as web sites maintenance, database management, etc.

15. The relation between winning and participation is well fitted by a polynomial graph of 2nd order which shows a more than proportional increase in winning with respect to the numbers of bids submitted.

16. See Che (1993) and Asker and Cantillon (2008-2006) for theoretical implications and properties of scoring auctions. See also Dini, Pacini and Valletti (2006) for an in-depth analysis on the design of scoring rules.

17. "The linear scoring rule is a very simple way to transform price bids into a score. This rule is described by […]": $\mathrm{Pr}\,iceScore = nn * \frac{(\mathrm{Re}\,serve\,\mathrm{Pr}\,ice - \mathrm{Pr}\,iceBid)}{(\mathrm{Re}\,serve\,\mathrm{Pr}\,ice - \mathrm{Pr}\,iceThreshold)}$, where the price threshold is a percentage of the reserve price that the procurer may want to introduce in order to stimulate competition on price." See Chapter 12, N. Dimitri, G. Piga, G. Spagnolo (2006), "*Handbook of Procurement"*, Cambridge University Press.

18. Data also show that price bids tend to be more concentrated (lower variance) under interdependent scoring rules than under independent scoring rules. This might be on first indication supporting the idea of Albano *et al.* (2007) who suggest that interdependent scoring rules facilitate coordination among bidders.

19. One issue of our data is that sometimes explanatory variable cannot be considered fully exogenous. Endogeneity may affect for instance the scoring rule or the reserve price. Often their setting at time *t* depends on the outcome of – or what the tender designer learnt about the tender at time *t-1*. Despite we look at data cross-sectionally, the issue is still present.

20. Tests indicate that the estimated model is not affected by multi-collinearity for independent variables. F-test indicate that all variables should be included in the regression. Goodness of estimation appears good: despite parsimony the model is able to explain up 30%-35% of total variance. Further testing rejects the hypothesis of non-normality in estimated residuals, therefore supporting the choice of a liner model for our data. These considerations hold also for the price regressions.

21. Unfortunately, our dataset does not allow us to control for the ex-post quality.

22. Instead of re-tendering in case of undesired outcome.

23. Complexity of auctioned contracts can make the estimation of the organizational efforts actually required (and thus their monetary cost) a very hard/puzzling task for the suppliers. This may affect their ability to appropriately trade-off price and quality. While it is easy to evaluate the trade-off between offering, say, 5 additional consultants and lowering the price in a well defined contract, things can be harder when the supplier does not know at the time of bidding if and how much intensively he will have to employ such consultants. Ex ante unspecified/unknown tasks that may be required by the buyer during the procurement relationship are a big source of uncertainty.

24. With independent scoring rules such a shift can indeed pay: rather than offering X additional consultants at a cost of say €250.000, to get an uncertain incremental technical score, the supplier can easily compute the increase in scores associated with lowering the price by the same amount.

25. Where the reserve price and the upper bound of technical scores are indexed for $c = 1 \ldots C$, the number of awarded contracts.

26. Notice that when the submitted price is equal to the reserve price (zero rebate) and the actual technical score equals the maximum, $R \,{}^{p}\!/\!_{Q_i} = 1$, however, this cannot be considered the worst price/quality ratio. In other words, the index is not defined for extreme values. This also occurs when technical score is zero and thus the index explodes to infinity although price approaches zero. However, we have not extreme cases in our dataset.

27. Tests identify the variable(s) source of the heteroscedasticity. We use these variables to weight observation when running WLS regressions. In the second and last column of Table 7, regressions are weighted for the reserve price and number of bid according to the results of the test.

28. Explanatory variables are indexed to $t = 1 \ldots 20$, where t is the contract number. In this field the observations available are only 20, such that the number of all treated contracts we analyze. In our estimations we use the dispersion measures of financial scores simply as a control variable. The number of bidders by lot (contract)

is useful in order to control for tender participation that may affect the expectation of each bidder on quality proposals from competitors, and so the actual distribution of technical proposals.

29. Imposing the model with a zero-intercept should be reasonable. When number of valid bids is zero (no participant) there is no reason because dispersion of financial score is different from zero, the same is for dispersion in technical score.

REFERENCES

Albano, G. L., Bianchi, M., & Spagnolo, G. (2007). "Bid Average Methods in Procurement." In G. Piga and K. Thai (Eds.) *The Economics of Public Procurement*. Palgrave.

Asker, J., & Cantillon, E. (2008). "Properties of Scoring Auctions." (Forthcoming). *Rand Journal of Economics*.

Asker, J., & Cantillon, E. (2007). "Procurement when Price and Quality Matter." Mimeo.

Athey, S., & Haile, P. (2006). "Empirical Models of Auctions." Forthcoming in "R. Blundell, W. Newey, and T. Persson, (Eds.), *Advances in Economics and Econometrics, Theory and Applications*: *Ninth World Congress of the Econometric Society*. New York: Cambridge University Press.

Bajari, P., McMillan, R. & Tadelis, S. (Forthcoming). "Auctions vs. Negotiation in Procurement: An Empirical Analysis." *Journal of Law, Economics and Organization*.

Bajari, P., Houghton, S., & Tadelis, S. (2007). "Bidding for Incomplete Contracts: An Empirical Analysis of Adaptation Costs." Mimeo.

Bajari, P., & Tadelis, S. (2001). "Incentives Versus Transaction Costs: A Theory of Procurement Contracts." *Rand Journal of Economics, 32* (3): 287-307.

Branco, F. (1997). "The Design of Multidimensional Auctions." *Rand Journal of Economics, 28* (1): 63-81.

Che, Y. K. (1993). "Design Competition through Multidimensional Auctions." *Rand Journal of Economics, 28*: 668-680.

Crocker, K. J., & Reynolds Kenneth, K. J. (1993). "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement." *Rand Journal of Economics*, *24* (1): 126-146.

Dasgupta, S., & Spulber, D. (1989). "Managing Procurement Auctions." *Information Economics and Policy*, *4*: 5-29.

Davidson, R., & MacKinnon, J.G. (1993). "Estimation and Inference in Econometrics." New York, NY: Oxford University Press.

Dimitri, N., Dini, F., Pacini, R., & Valletti, T. (2006). "Scoring Rules." In N. Dimitri, G. Piga, and Spagnolo G. (Eds.), *Handbook of Procurement*. Cambridge University Press.

EC (2004). "On the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts." (2004, March 31), Directive 2004/18/EC of the European Parliament and of the Council.

General Services Administration, Department of Defense and National Aeronautics and Space Administration. (2005), U.S.A F.A.R..

Grimm, V., Pacini, R., Spagnolo, G., & Zanza, M. (2006). "Division Into Lots and Competition in Procurement." In N. Dimitri, G. Piga, and G. Spagnolo (Eds.), *Handbook of Procurement*. Cambridge University Press.

Guerre, E., Perrigne, I., & Quang, V. (2000). "Optimal Nonparametric Estimation of First-Price Auctions." *Econometrica*, *68* (3): 525-574.

Hong, H., & Shum, M. (2002). "Increasing Competition and the Winner's Curse: Evidence from Procurement." *The Review of Economic Studies*, *69* (4): 871-898.

Kim, H. I. (1998). "A Model of Selective Tendering: Does Bidding Competition Deter Opportunism by Contractors?" *Quarterly Review of Economics and Finance*, *4* (3): 907-925.

Lundberg, S. (2005). "Auction Formats and Award Rules in Swedish Procurement Auctions." CERUM Working Paper No. 79.

Paarsch, H. J. (1992). "Deciding between the Common and Private Value Paradigms in Empirical Models of Auctions." *Journal of Econometrics*, *51* (1): 191-215.

Porter, R. H., & Zona, J. D. (1993). "Detection of Bid Rigging in Procurement Auctions." *Journal of Political Economy*, *101* (3): 518-538.

Zhong, F. V. (2007). "Empirical Analyses of Online Procurement auctions: Business Value, Bidding Behavior, Learning and Incumbent Effect." Georgia Institute of Technology. [On-line]. Available at www. smartech.gatech.edu/. [Retrieved January 1, 2008]