ADAPTATION COSTS IN PUBLIC WORKS PROCUREMENT IN ITALY*

Calogero Guccio, Giacomo Pignataro and Ilde Rizzo*

ABSTRACT. It is widely agreed that rules governing public procurement of goods and services should be designed to ensure competition among suppliers, so as to achieve value for money. However in the public works sector, "… the good being procured is usually complex and hard to be exactly specified *ex ante*, … [and] alterations to the original project might be needed after the contract is awarded. This may result in considerable discrepancies between the lowest winning bid and the actual costs that are incurred by the buyer" [Bajari, Houghton and Tadelis, 2006]. The paper is aimed at offering an empirical test of the existence of a differential impact of procurement procedures on renegotation, and of its costs. Using a detailed data set on Italian public works contracts, we run an empirical analysis of the differential impact of procurement procedures on the final cost, controlling for several factors such as complexity of the work, the execution mode, the market characteristics and other environmental factors to try to assess whether, and under which conditions, competition is the best strategy to adopt in public works procurement.

INTRODUCTION

Procurement objectives can be stated saying that governments should aim at obtaining "*value for money*", including the quality dimension in the concept of value. The possibility of fulfilling this objective depends

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* *Calogero Guccio, Ph.D., Senior Lecturer, Giacomo Pignataro, Ph.D., Professor, and Ilde Rizzo, Ph.D., Professor, are on the Faculty of Law's Department of Economics and Quantitative Methods, University of Catania. Calogero Guccio's Research interests are in health economics, public economic, and applied econometrics. Giacomo Pignataro's teaching and research interests are in health economics, regulation and cultural economics. Ilde Rizzo's research interests are in cultural economics, public policy and health economics.*

on the selection of the private contractor, the specification of the contract, and the enforcement of the contract. The economic issues involved in procurement are very well known and are mainly related to asymmetric information, both in the form of adverse selection (i.e. the problem of choosing the best private contractor) and of moral hazard (i.e. the problem of preventing opportunistic behaviour in the implementation of the contract). In public procurement policies a crucial role is generally played by the set of procurement rules on the selection of the contractor. It is generally believed that if these rules are designed so as to ensure competition, the above problems should be overcome. Competition, however, is not always enough to ensure the achievement of public procurement objectives. The nature of the goods and services being procured may, in fact, reduce the effectiveness of its role. In another paper [Guccio, Pignataro and Rizzo, 2006], we have already tested how market differentiation may reduce the positive impact of competitive tendering procedures, in the procurement of medical devices. In this paper, we consider the case of public works.

A relevant feature of procurement in the building sector is the fact that "… the good being procured is usually complex and hard to be exactly specified *ex ante*, … [and] alterations to the original project might be needed after the contract is awarded. This may result in considerable discrepancies between the lowest winning bid and the actual costs that are incurred by the buyer" [Bajari, Houghton and Tadelis, 2006].

Within the existing normative constraints, the incompleteness of contracts, characterizing complex public works, may give room to opportunistic behaviour of the winning bidder, resulting in a pressure to revise the original contract, with the consequence that the final cost may be higher than the cost originally agreed upon. This paper is related to the growing empirical literature on the impact of contractual incompleteness on the extent of changes, occurring after the contract is agreed on, and on the subsequent adaptation costs, within the building sector [Crocker and Reynolds (1993), Bajari and Tadelis (2001), Corts and Singh (2004), Chakravarty and MacLeod (2004), Bajari, McMillan and Tadelis (2003), Bajari, Houghton and Tadelis (2006)].

The specific focus of this paper, however, is on the impact of procurement procedures on the final cost of the public works, to test if the procedures for the selection of the contractor have an impact on the

implementation of public works. Our hypothesis is that the more competitive is the selection procedure, the stronger the incentive for the firm, which has been awarded the contract, to pursue contractual renegotiation. We test our hypothesis using a unique panel data set of public works in Italy and we find some support it.

The paper develops as follows. In section 2, a short economic analysis of the rules on public works in Italy is provided. In the third section the theoretical motivations underlying the relation between procurement procedures and the incentive to renegotiate the contract is examined. In section 4 we will run an empirical analysis of the differential impact of procurement procedures on the final cost of the public works contracts and will offer some comments on the policy implications of the results. Few concluding remarks will be offered in section 5.

ITALIAN PUBLIC PROCUREMENT RULES

The national procurement system, during the last fifteen years has been subject to continuous changes. The reform of public works procurement was introduced by the law 11/2/94, n. 109, the so-called *legge Merloni,* "to improve the efficiency, the effectiveness, the transparency and the quality of public works" (art.1) and since then many changes to this law have been introduced; recently, new rules have been devised and a law was passed (*Codice dei contratti pubblici di lavori, servizi, forniture*) which transposes into the Italian legislation the EU Directive n. 2004/18/CE of the European Parliament and of the Council on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.[1]

No attempt is made here of analysing the Italian legislation and only few key general features will be recalled. Italian procurement rules are quite strict in specifying how decisions should be taken (for instance, "award to the lowest bidder,") or what process has to be followed in making a decision (for instance, "do not accept late proposals", "evaluate proposals only based on the evaluation criteria in the solicitation"). The law tries to reduce bureaucratic discretion as much as possible.[2] On these grounds, preference is given to competition[3]: procurements should be widely advertised and evaluated strictly on the criteria announced in advance. Sealed bids are used to prevent collusion among the

participants and to ensure transparency. In other words, competition is promoted as much as possible, as a tool to select the most convenient bidder.[4] As far as the specification of the contract is concerned, cost plus contract are not allowed to prevent opportunistic behaviour of private contractors.

Indeed, the «philosophy» underlying the above mentioned procurement rules does not always seem in line with the economic reality of procurement (though the recent changes occurred in the Italian legislation would seem to introduce some slight hints in this direction, with effects which cannot be assessed yet). However, emphasis is mainly placed on competition as a tool to ensure the selection of the best contractor on the assumption that it will also provide the minimization of the costs for the contracting authority.[5] However, procurement rules aimed at ensuring competition might not be effective in producing the expected final outcome. As Kelman (1990) stresses, the use of sealed bids, i.e. purchasing with anonymous sellers, is in contrast with any purchasing practice in the industrial sector since it makes difficult to establish any relationship between the purchaser and the seller. It follows that customers and suppliers cannot enjoy the value deriving from long term, continuing relationships such as those characterising private sector industrial purchasing[6], though the undesirable lock-in effect should be not undervalued. Potentially relevant incentives for good performance, such as a promise to award future contracts, are ruled out. These shortcomings might be especially relevant when centralized procurement procedures are used.

A peculiar feature of the Italian procurement is given by the existence of an independent Authority (Autorità di Vigilanza sui contratti pubblici di lavori, servizi e forniture) established in 1999 for the legal supervision of public works and engineering services and nowadays operating in all the areas of procurement.[7] The role of the Authority is to diffuse and supervise the proper implementation of the effective regulation by the public authorities and the contractors as well as to collect data on the procurement sector.

As far as public works are concerned, it is useful to point out that such a complex array of norms is designed to regulate a market of relevant size: in 2006,[8] in Italy, the demand of public works amounted to about 30,721 millions of euros.[9] The Italian public works market is

fragmented both in terms of the tender size and the number of purchasing authorities.[10]

The above mentioned regulation does not seem effective, however, in ensuring the functioning of the market, i.e. the capability of fulfilling on time the public need underlying the demand for public works. In fact, Table 1 shows that, in the period 2000 – 2005, 101.589 works above 150.000 euros have been awarded and that only 27.529, mainly of small size, were completed.

Moreover, among those which were concluded two relevant features can be noted, i.e. marked differences with respect to the expected contractual costs and the length of the contract. These differences can be considered indicators to measure the performance of public contracts as well as the difficulty of arranging complete contracts in this sector.

TABLE 1
Public works awarded and concluded in period 2000-2005 – public works over 150.000 euro (value at current prices)

Years	Public works awarded			Public works completed				
	Numbers	Total amount	Average amount	Numbers	*% on public works awarded*	Total amount	*% on amount of the public works awarded*	Average amount
2000	15.829	13.873.644.772	876.470,07	7.183	*45,38*	3.911.398.346	*28,19*	544.535,48
2001	18.550	14.296.974.296	770.726,38	7.734	*41,69*	3.833.104.563	*26,81*	495.617,35
2002	19.822	16.472.364.018	831.014,23	6.426	*32,42*	2.763.242.596	*16,78*	430.009,74
2003	18.709	16.982.584.300	907.722,72	4.355	*23,28*	1.644.129.437	*9,68*	377.526,85
2004	16.899	18.676.634.271	1.105.191,68	1.686	*9,98*	546.182.378	*2,92*	323.951,59
2005	11.780	14.348.833.775	1.218.067,38	145	*1,23*	37.274.626	*0,26*	257.066,39
Total	**101.589**	**94.651.035.432**	**931.705,55**	**27.529**	***27,10***	**12.735.331.946**	***13,46***	**462.615,13**

Source: Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture (2007).

INCOMPLETE CONTRACTS, PROCUREMENT PROCEDURES AND ADAPTATION COSTS IN THE CONSTRUCTION SECTOR

The issue of contractual incompleteness has been extensively investigated in the contract theory. The explanations provided for its existence seem all relevant in the case of public works. They are mainly related to the inability and the cost of accounting for all possible contingencies in contracts. Agents are not able to describe all the possible contingencies that could affect the public work realization.

Moreover, some contract contingencies, such as those based on the enterprise's level of exerted effort, cannot be verified by third parties. In such cases, writing a clause that includes effort level is useless, because such a clause cannot be enforced. Other contingencies cannot be even foreseen. Writing a contract contingent on all verifiable and foreseeable contingencies may, then, be too costly. Thus parties have to decide which contingencies they want to include.[11] A rational agent would be able to identify all the possible options relevant for decision making and establish a well-defined order among them. Even though a good theory of bounded rationality does not exist, and most models that deal with it have been criticized for being *ad hoc*, the truth is that in complex contexts, agents often make mistakes and need a learning period to approach an optimal solution. Of course, the learning period creates intermediate suboptimal results that must be remedied over time. Thus renegotiation and adaptation can be seen as a way of correcting past mistakes.

When some of the contingencies not included in the contract occur, renegotiation is needed; in the case of public works, this may generate a relevant adaptation cost (i.e. the additional cost above the value of the winning bid, incurred by contracting works authorities) with relevant consequences for the final cost. Table 2 gives an idea of the empirical relevance of such a phenomenon in Italy: the table offers the figures of the normalized adaptation cost of public works.[12] The renegotiation of the contract can also increase the length of the contract and generate a relevant adaptation time.[13] The table shows the frequency of occurrence of positive normalized adaptation costs and time and its distribution according to their size.

TABLE 2
Distribution of Public Works for Classes of Normalized Adaptation Cost and Time

Adaptation class (%)	*Normalized adaptation cost*		*Normalized adaptation time*	
	No.	***%***	***No.***	***%***
≤ 0	4.516	*29,35%*	3.632	*23,60%*
>0<5	4.836	*31,43%*	282	*1,83%*
≥ 5 <10	2.204	*14,32%*	411	*2,67%*
≥ 10 <20	2.366	*15,38%*	1.112	*7,23%*
≥ 20	1.465	*9,52%*	9.950	*64,66%*
Total	**15.387**	***100,00%***	**15.387**	***100,00%***

Source: Relazione al Parlamento per l'anno 2005 dell'Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

As far as Italian public works in 2005 are concerned, then, renegotiations of the original contract, implying positive adaptation costs, occurred in almost two thirds of the works executed in that year. For about a quarter of all works, adaptation costs were higher than 10% of the original cost. The results in terms of adaptation time are even more striking: about two thirds of all works involved an adaptation time higher than 20% of the completion time agreed upon in the contract.

Italian data, therefore, reveal that renegotiation is a relevant feature of the public works sector, with relevant economic consequences. However, the nature and, above all, the size of the adaptation costs do not necessarily reflect just the additional cost for the firm to carry out revisions of the original project, which are implemented to adjust the work to unforeseen circumstances. They can be also the outcome of the opportunistic behaviour of the contractor, which can exploit its bargaining power with respect to the contracting authority, in the event of a revision of the original contract and of the consequent renegotiation of the price, since the latter may find it costly to delay a new agreement or even to breach the contract. The extent of the opportunistic behaviour and the attempt to achieve a "generous" renegotiation may be related to the characteristics of the winning bid, more precisely to the fact that a relatively low bid, originated, for instance, by the effort to win the auction, may find a "compensation" in the event of a renegotiation. In

turn, the value of the winning bid is, of course, affected by the procedure used to award the works. As we said before, the existing rules in Italy, as well as in other countries, tend to favour the use of open tendering procedures, with the consequence that a large portion of bidders are selected through competitive auctions. However, if bidders have anticipated the possibility of renegotiation – given the existing normative constraints to renegotiation- and their potential bargaining power at the implementation stage, they could find convenient to underbid, at the auction stage, so as to increase the probability of winning the auction, since the expectation of renegotiation will reduce the loss associated to this strategy.

Data about Italian public works carried out between 2000 and 2005 seem to give a confirmation of the potential existence of this phenomenon, which will be explored with a proper empirical analysis in the following section. Table 3 shows some statistics of the normalized adaptation costs for different classes of values and for different classes of the ratio of the value of the winning bid to the estimated total value of the contracting authority. [14]

TABLE 3
Summary Statistics of the Normalized Adaptation Cost for Classes of Works Values and for Classes of the Ratio of the Winning Bid to the Estimated Total Value

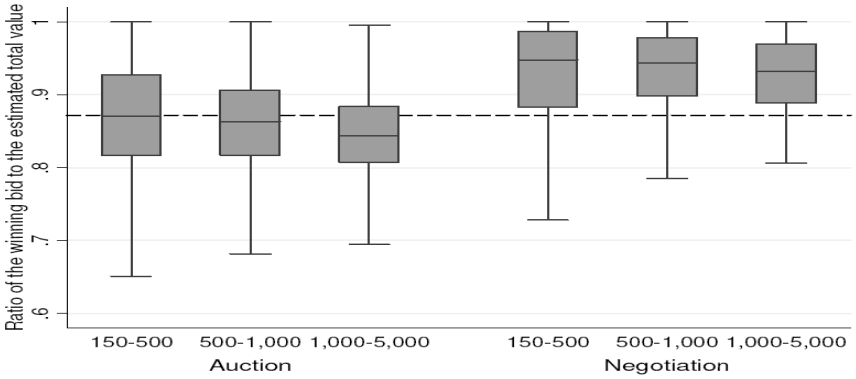
Class of works value		***Class of the ratio of the winning bid to the estimated total value***				
		Between 1.00 to 0.98	*Between 0.98 to 0.95*	*Between 0.95 to 0.90*	*0.90 or less*	*All obs.*
Between 150.000 to 500.000 €	Means	0.048	0.049	0.063	0.110	0.086
	St. Dev.	*0.119*	*0.102*	*0.101*	*0.159*	*0.141*
	Number of obs.	*901*	*910*	*1,695*	*4,464*	*7,970*
Between 500.000 to 1.000.000 €	Means	0.061	0.074	0.087	0.116	0.104
	St. Dev.	*0.091*	*0.105*	*0.123*	*0.141*	*0.133*
	Number of obs.	*74*	*127*	*253*	*903*	*1,357*
Between 1.000.000 to 5.000.000 €	Means	0.114	0.065	0.093	0.130	0.121
	St. Dev.	*0.225*	*0.058*	*0.122*	*0.153*	*0.150*
	Number of obs.	*27*	*32*	*75*	*427*	*561*
All obs.	Means	0.051	0.052	0.067	0.112	0.091
	St. Dev.	*0.121*	*0.102*	*0.105*	*0.156*	*0.141*
	Number of obs.	*1,002*	*1,069*	*2,023*	*5,794*	*9,888*

Source: our elaboration on data provided by Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

Table 3 seems to show that the adaptation cost tends to increase when the ratio of the winning bid to the estimated total value decreases and this seems to support the above considerations about the firm's strategic behaviour of renegotiation.

Should this hypothesis be confirmed by the empirical analysis carried out in the next section, it would have interesting policy implications when one considers that the ratio of the value of the winning bid to the estimated total value of the contracting authority can be correlated to the procedure used to select the contractor (see Figure 1).

FIGURE 1
Box-Plot of the Ratio of the Winning Bid to the Estimated Total Value, for Classes of Work Value and for Tendering Procedure



In Table 4, we show some summary statistics for the normalized adaptation cost, computed for different classes of works value and for the two broad classes of procedures, auction and negotiation. In general, and almost for all the classes of works value, the normalized adaptation costs are higher for works that have been auctioned with respect to the ones that have been negotiated.

TABLE 4
Summary Statistics of Normalized Adaptation Cost for Class of Works Value and for Tendering Procedure

Class of amount	Procedure	Number of obs.	Mean	St. dev.	Max	Min
Between 150.000 to 500.000 €	Auction	6,289	0.089	0.144	1.804	0,000
	Negotiation	1,681	0.075	0.131	1.229	0,000
	All	*7,970*	*0.086*	*0.141*	*1.804*	*0,000*
Between 500.000 to 1.000.000 €	Auction	1,197	0.106	0.136	1.215	0,000
	Negotiation	160	0.088	0.113	0.627	0,000
	All	*1,357*	*0.104*	*0.133*	*1.215*	*0,000*
Between 1.000.000 to 5.000.000 €	Auction	507	0.121	0.146	1.093	0,000
	Negotiation	54	0.123	0.187	0.969	0,000
	All	*561*	*0.121*	*0.151*	*1.093*	*0,000*
All observation	**Auction**	**7,993**	**0.094**	**0,143**	**1-804**	**0,000**
	Negotiation	**1,895**	**0.077**	**0,131**	**1.229**	**0,000**
	All	***9,888***	***0.091***	***0.141***	***1.804***	***0,000***

Source: our elaboration on data provided by Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

EMPIRICAL ANALYSIS

Data Employed

The data used in the following analysis are those collected by *Osservatorio per i lavori Pubblici"* of the "*Autorità di Vigilanza sui contratti pubblici di lavori, servizi e forniture"*. The observation unit is given by the single public work and very detailed information are available on the various steps of the procedure – project, selection of the contractor, realization and conclusion of the work.[15] The sample refers to 9,888 public works, whose costs range from 150,000 euros to 5 million euros, awarded in the period 2000-2004 and completed by 2005.[16] Table 5 provides summary statistics for the number of contracts awarded per year, the total amount, the mean value of contracts.

Tables 6 and 7, respectively show the composition of the sample in terms of the sectors covered and of the type of contracting authorities, grouped in five categories, according to their different governance structure.

TABLE 5
Distribution and Summary Statistics of Contracts for Year of Award – Public Works above 150,000 Euros (Value at Current Prices)

Year	Number of obs.	Total Amount	Mean	St. Dev.	Maximum amount	Minimum amount
2000	2.344	1.083.325.523,00	462.169,59	508.013,50	4.482.703,00	150.024,00
2001	3.117	1.246.033.883,00	399.754,21	417.028,79	4.815.961,00	150.047,00
2002	2.511	978.561.626,00	389.709,93	384.391,69	4.965.733,00	150.000,00
2003	1.485	524.318.865,00	353.076,68	314.363,19	4.340.000,00	150.000,00
2004	431	137.830.536,00	319.792,43	264.866,73	3.212.078,00	150.000,00
Total	**9.888**	**3.970.070.433,00**	**401.503,89**	**415.902,42**	**4.965.733,00**	**150.000,00**

Source: Our elaboration on data provided by Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

TABLE 6
Composition of the Sample for Sector – Public Works above 150.000 Euros Value at Current Prices)

Sector	Number of obs.	Total amount
Roads and highways	3.221,00	1.189.073.222
Railways	63,00	33.235.714
Other transport infrastructures	153,00	87.869.082
Works of protection of the environment, of defence of the soil, water resources.	1.313,00	535.337.234
Urbanization works	738,00	301.676.359
Infrastructures of the energy sector	57,00	24.408.624
Telecommunications and data processing technologies	36,00	10.940.267
Infrastructures for the agriculture and the fishing sector	73,00	31.166.499
Infrastructures for industrial activities, commerce and handicrafts sector	150,00	83.121.308
Social and school building	1.248,00	513.926.814
House building	275,00	142.660.487
Cultural Heritage	456,00	166.292.991
Infrastructures for sport, show and tourism	453,00	169.660.266
Building for health care sector	355,00	150.022.778
Other public building	1.125,00	445.501.630
Other transport infrastructures	172,00	85.177.158
Total	**9.888,00**	**3.970.070.433**

Source: our elaboration on data provided by Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

TABLE 7
Composition of the Sample for Purchasing Authorities – Public Works above 150.000 Euros (Value at Current Prices)

Purchasing authorities	Number of obs.	Mean	St. Dev.	Maximum amount	Minimum amount
Central government	545.0	364,155.8	429,264.0	4,441,529.0	150,135.0
Local government	6,987.0	376,435.2	359,715.0	4,777,537.0	150,000.0
Public agencies with special budget autonomy	1,216.0	509,189.5	569,304.8	4,815,961.0	150,000.0
Public ownership companies	606.0	321,276.5	285,910.9	3,436,940.0	150,082.0
Private concessionaires	534.0	613,454.2	636,289.0	4,965,733.0	150,024.0
Total	**545.0**	**364,155.8**	**429,264.0**	**4,441,529.0**	**150,135.0**

Source: our elaboration on data provided by Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

Empirical Estimation

The empirical analysis developed in this section aims at testing the hypothesis that renegotiation and adaptation costs may depend on the behaviour of the winning bidder during the awarding procedure, since as he lowers his bid to increase the chance of being awarded the work, he will have a stronger incentive to exploit any opportunity to renegotiate the contract and to ask for larger increases of the original compensation. This behaviour, in turn, may be related to the different tendering procedures, insofar as they may give a different incentive to reduce the bid. As it was pointed out before, the indicator which seems suitable to measure the extent of contractual revisions is the ratio of the adaptation costs to the value of the winning bid (***NAC***) and it will be used as dependent variable.

As far as independent variables are concerned, we will use two alternative classes of models. In a first class of models, we check whether underbidding and its intensity affects the extent of renegotiation and its adaptation costs, as a result of the exploitation of contractual incompleteness by the firm. The variable used to capture underbidding is the ratio of the value of the winning bid to the estimated total value of the contracting authority (***R_WBID_ETV***). Since the degree of underbidding heavily depends on the competitiveness of the award procedure, which in turn is related to the type of procurement procedure,

we will directly test its effect on the dependent variable, using a dummy variable (***OPEN***).

Other variables, which can affect the final cost and, therefore, cause a difference with respect to the original cost are: the *complexity of the work*, the *execution mode*, the *market characteristics* and other *environmental factors*.

As far as the *complexity* is concerned, our hypothesis is that contractual incompleteness is increasing in the degree of complexity and, therefore, contracts implementation becomes more uncertain and the final cost is more likely to be higher than the value of the winning bid. As proxies for complexity we use the expected time of completion of the work (***ED***); the estimated total value of the work by the contracting authority (***ETV***); and the composition index of the work (calculated on the different sub-categories involved in the work, weighed for their relative amount - ***WCI***). [17]

As for the *execution mode*, the factors which potentially affect the final cost are: the presence of subcontractors in the execution of the work (***SUB***); the actual completion time with respect to the expected one (***EX_T***); the existence of legal disputes between the firm and the purchasing authority (***DIS***); the contractual content of the firm's commitment – whether the firm intervenes in the design of the project (***PROJ***). Our hypothesis is that the variables ***SUB, EX_T*** and ***DIS*** tend to increase the final cost. The effects of the variable ***PROJ*** need some further comments because they are not unambiguous: on one hand, the lack of an executive project and therefore, the possibility for the firm to intervene on the project could allow for the adoption of technical solutions consistent with its productive capacities and know-how and, therefore, could reduce the pressure on the renegotiation and adaptation cost during the implementation. On the other hand, however, the separation of the activities of project and implementation introduces a conflict of interests between the engineer/architect and the firm implementing the work and, therefore, may limit the firm's opportunistic behaviour. However, on the grounds of the hypothesis of firm's strategic behaviour we would expect that the latter effect prevails and, that ***PROJ*** is positively correlated with the adaptation costs.

The *market characteristics* play a role in connection with the relevance of reputation for the firm. Reputation is likely to reduce the convenience of strategic behaviour, aimed at the contract revision, when

there is a probability to obtain other contracts in the future. *Ceteris paribus*, the relevance of such a variable depends on the *market competition level* and on the *market share* of the firm. To measure market competition we employ the number of potential bidders (i.e. the number of firms qualified for the public work category -e.g. roads, railways, etc.- and value at national level – ***P_BID***). The expected sign of this variable is positive: the higher the competition, the lower the probability of being awarded a contract in the future and, therefore, the lower the future value of reputation and the more convenient the contract renegotiation strategy. It is also important, however, to evaluate the position of the winning bidder within the market. We have, therefore, estimated the market leadership as the number of contracts awarded to each firm by the contracting authorities, included in the data set in the period under consideration (***LEAD***). In a market in which tendering is effective in selecting the best bidder and assuming that quality is homogeneous across firms for the works of the same category and size, the market leadership could be considered as cost leadership. In this case, the greater the market leadership, the higher the probability of being awarded contracts in the future and, therefore, the greater the value of reputation and the lower the occurrence and extent of contract revision. Finally, we consider as a proxy for the value of the long-term relationship between the firm and the purchasing authority, the number of contracts awarded to each firm by the same purchasing authority (***INT***). The expected sign for this variable is negative, since the interaction is likely to prevent opportunistic behaviour and, therefore, the greater the interaction the lower the contractual revision and adaptation costs.

Finally, we take into consideration *environmental factors.* Besides the variables listed before, other factors potentially able to affect the final cost of public works are: *geographical area* (***NORTH, CENTRE*** and ***SOUTH*** areas of the country) and the '*governance*' model of the contracting authority. The different models of '*governance*'[18] of contracting authorities may affect the final cost of the public works because of the different incentives to monitoring the implementation of the work. To grasp the relation between the *governance* and the *performance* of the contract, contracting authority have been grouped in the following categories: Central Government (State administrations even with autonomous organization- ***C_GOV***) Local Governments (regions, provinces, municipalities – ***L_GOV***); Institutions (Public

institutions, Health Authorities, etc.- ***INST***), Public ownership companies (ANAS, FS, Poste s.p.a. – ***P_ENT***) and Private Companies (e.g. Concessionaires – ***PRIV_COM***). Our hypothesis is that Central Government on one side and Private Companies on the other side are the 'polar' cases as far as incentives are concerned. Moving from the former extreme to the latter we would expect a lower difference of cost.[20]

Moreover, to capture the different incidence of corruption in the various areas we used as a proxy the associative crime incidence for 100,000 inhabitants at provincial level (***CORR***). Finally we control for the year of award and for the category of public work. The variables we will use are reported in Table 8 and summary statistics for these variables are reported in Table 9.

The dependent variable is the normalized adaptation cost (***NAC***) for project ***i*** in sector ***j*** and, therefore, the general models estimated are:

$$NAC_{it} = \beta_0 + \beta_1 TP_{ij} + \boldsymbol{CV}\,\boldsymbol{\beta} + \varepsilon_{it} \qquad [1]$$

where:

TP stands for tendering procedure (i.e. ***OPEN*** *vs* ***R_WBID_ETV***);
CV is a matrix of the other control variables; and
$\boldsymbol{\varepsilon}$ are disturbance terms.

In the estimate of [1] it is necessary to take into account that the dependent variable assumes a zero value, which represents the minimum variable value, several times.[21] A natural approach is to use a Tobit estimate.[22] We estimate [1] with Tobit GLS panel random effects. In the estimates we assumed robust standard errors.[23] The results from the regression described in [1], and its variants, are displayed in Table 10.

Discussion of Results

We believe that the results of the empirical analysis, carried out in the previous section, can suggest some comments. The competitiveness of the procurement procedure is associated to an increase of the adaptation cost, in the implementation stage. The result is robust since both variables used in the analysis (the dummy for open tendering procedures and the ratio between the winning bid and the estimated total value) are significant, with the expected sign. The interpretation of the result we provided in section 3 is that underbidding, whose extent varies with the competitive strength of the procurement procedure, is a way to

TABLE 8
Description of Variable Employed

Variable	Meaning
Dependent Variable	
NAC	Normalized adaptation cost
Independent Variable	
*Tendering procedure (**TP**)*	
OPEN	Dummy for open tendering procedures
R_WBID_ETV	Ratio between the winning bid and estimated total value
Work execution mode	
SUB	Dummy for subcontracting
PROJ	Dummy for the completion of the project by the firm
EX_T	Ratio between actual duration and estimated duration
DIS	Dummy for legal dispute
Complexity of the public work	
ETV	Estimated total value
WCI	Weighted public work composition index
ED	Estimate duration
Market factor	
INT	Past relationship between enterprise and contracting authority
P_BID	Number of firms qualified for the work category and value
LEAD	Number of contracts awarded by winning bidder in the estimate market
*Environmental factors (**OEV**)*	
C_GOV	Central Government
L_GOV	Sub-Central Governments
INST	Institutions
P_ENT	Public Enterprises
PRIV_COM	Private Companies
CORR	Associative crime incidence for 100.000 inhabitants at provincial level
NORTH	Dummy for north area of the country
CENTRE	Dummy for centre area of the country
SOUTH	Dummy for south area of the country
Other covariate	Year of award

TABLE 9
Summary statistics of variable employed

Variable	Number of obs.	Mean	St. Dev.	Minimum	Maximum
NAC	9,888	0.77	0.42	0.00	1.00
OPEN	9,888	0.81	0.39	0.00	1.00
R_WBID_ETV	9,888	0.87	0.09	0.43	1.00
SUB	9,888	0.78	0.42	0.00	1.00
PROJ	9,888	0.20	0.40	0.00	1.00
EX_T	9,888	1.77	1.91	0.01	128
DIS	9,888	0.02	0.14	0.00	1.00
ETV	9,888	401,503.90	415,923.50	150,000.00	4,965,733.00
WCI	9,888	1.20	0.34	1.00	4.00
ED	9,888	212.96	139.24	3.00	1,327.00
INT	9,888	2.42	3.38	1.00	60.00
P_BID	9,888	2,249.49	1,396.36	1.00	5,707.00
LEAD	9,888	17.88	37.91	1.00	436.00
C_GOV	9,888	0.06	0.23	0.00	1.00
L_GOV	9,888	0.71	0.46	0.00	1.00
INST	9,888	0.12	0.33	0.00	1.00
P_ENT	9,888	0.06	0.24	0.00	1.00
PRIV_COM	9,888	0.05	0.23	0.00	1.00
HARD_B	9,888	2.35	.89	1.00	5.00
CORR	9,888	5.75	2.97	1.27	18.35
NORTH	9,888	0.46	0.49	0.00	1.00
CENTRE	9,888	0.34	0.47	0.00	1.00
SOUTH	9,888	0.20	0.39	0.00	1.00
CORR	9,888	1.52	1.21	1.00	14.26

Source: our elaboration on data provided by Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture.

TABLE 10
Estimation results

Variable	Tobit estimate with GLS random effects	
*Tendering procedure (**TP**)*		
OPEN	0.020***	-
	(0.005)	-
R_WBID_ECE	-	-0.512***
	-	(0.022)
Work execution mode		
SUB	-0.005	-0.000
	(0.005)	(0.004)
PROJ	0.013***	0.010**
	(0.005)	(0.004)
EX_T	0.006***	0.006***
	(0.001)	(0.001)
DIS	0.035***	0.032***
	(0.012)	(0.012)
Complexity of the public work		
ETV	0.000*	0.000
	(0.000)	(0.000)
WCI	0.004	0.010*
	(0.005)	(0.005)
ED	0.000***	0.000***
	(0.000)	(0.000)
Market factor		
LEAD	0.000	0.000**
	(0.000)	(0.000)
INT	0.000	0.000
	(0.001)	(0.001)
P_BID	-0.000	0.000**
	(0.000)	(0.000)
*Environmental factors (**OEV**)*		
L_GOV	-0.007	-0.004
	(0.010)	(0.010)
INST	-0.024***	-0.023***
	(0.008)	(0.008)
P_ENT	-0.084***	-0.098***
	(0.011)	(0.011)
PRIV_COM	-0.029***	-0.029***
	(0.011)	(0.011)
CORR	0.004***	0.002***
	(0.001)	(0.001)
NORTH	-0.023***	-0.019***
	(0.005)	(0.005)
CENTRE	-0.035***	0.005
	(0.005)	(0.005)
Controlling for year	*yes*	*Yes*
Constant term	*yes*	*Yes*
Observations	*9,888*	*9,888*
Number of sector	*16*	*16*
Log pseudo-likelihood	*-987.01*	*-1,243.65*
Wald test	*χ2(22)= 571.94 ******	*χ2(22)= 1,059.26 ******

Notes: Bootstrap standard errors are reported in parentheses.
***, ** and * denote significance at 1, 5 and 10 per cent levels, respectively.

reinforce the chances of being awarded the work, in the expectation of a renegotiation that can compensate the reduction in the bid. This result does not imply any conclusive judgement on the overall efficiency of the different procurement procedures, since it is not possible to conclude which procedure produces the best outcome for the contracting authority, in terms of minimization of the total cost of construction. However, it makes clear that this outcome may not be completely guaranteed by the competitiveness of the award procedure, but it is also related to the monitoring in the works' implementation stage. Moreover, even if, in principle, there are rules, in the Italian law, that should prevent the opportunistic behaviour of firms, excluding the "too" low or "too" high bids, they seems to be not so much effective in terms of preventing renegotiations.[21]

As expected, higher levels of complexity of the works, as measured in terms of the different variables used in the analysis, increase adaptation costs, for the plausible reason that they are associated to a higher degree of contractual incompleteness, greater uncertainty in the implementation and, consequently, wider opportunities for renegotiation.

As for the variables representing some aspects related to the execution of the work, the longer the delay in the completion of the work, the higher the adaptation cost. The delay is, in fact, representative of problems connected with the implementation of the work. This effect is reinforced by the sign related to the variable representing the existence of legal disputes. The involvement of the firm in the project design seems to increase the adaptation cost offering some support to the hypothesis of the firm's opportunistic behaviour. The existence of sub contractors seems to have no significant effect on adaptation costs.

Market conditions do not play a significant role. The variables representing the number of potential bidders and the number of contracts awarded to the winning bidder are not always significant, and when they are so, the size of their effect is negligible.

As far as the environmental factors are concerned, it looks like that all the models of governance different from central (with exception of local governments) have a significant effect on adaptation costs, more precisely they tend to be associated to lower adaptation costs. Strangely enough, the effect is stronger for public enterprises than for private companies. This implies that the nature of this effect needs further investigation. Contracting authorities operating in areas where organized

crime is stronger tend to be associated to higher adaptation costs. Finally, adaptation costs are systematically different in the great geographical areas of the country: they tend to be higher in the South and lower in the Centre, even if this result is lower but more robust for the North.

CONCLUDING REMARKS

The focus of this paper is on the impact of procurement procedures on the final cost of the contract, with specific reference to the public works sector, to test if the procedures of firm selection have effects on the implementation of public works.

Our results suggest that competitive procurement procedures, such as auctions, are associated to an increase of the adaptation cost, in the implementation stage. The use of competitive procedures make not convenient for the firms to invest in reputation; highly competitive selection procedures induce the firms to underbid and, after having been awarded incomplete contracts, to pursue contractual renegotiation strategies, aimed at maximising their profits.

We believe that the major policy implication of the results of our analysis is that the "automatic" incentive mechanism of open tendering procedures, which, in theory, should allow for selecting the best bidders and, consequently, achieving an efficient realization of public works, in practice, does not necessarily ensure the desired outcome, as compared to negotiations. This shortcoming mainly depends on the contractual incompleteness characterizing the public works field; in fact, unlike in the case of market goods, the fulfilment of the contract crucially depends on the implementation stage. Notwithstanding the existing rules aimed at preventing the firm's opportunistic behaviour, ex post negotiation and adaptation costs are likely to occur at the implementation stage, and they can offset the gains arising, at the bidding stage, by the competitiveness of the awarding procedure. The incompleteness is likely to be more severe in presence of complex works and, therefore, it would suggest to evaluate carefully the choice of the procedure which is suitable for works with different degrees of complexity. Allowing for more discretion in the selection of contractors, and attributing a role to the reputation may counterbalance the "compensation" role that renegotiation can assume, as a way to recover the "losses" from underbidding in competitive

procedures. In this case, however, great attention should be paid to the design of proper incentive schemes for the contracting authority.

NOTES

* The authors wish to thank the *Autorità di Vigilanza sui contratti pubblici di lavori, servizi e forniture* for supplying the data used in the analysis. The usual disclaimer applies. Even if the paper is the result of the joint work of the authors, section 4 is attributable to Calogero Guccio.

1. Being Italy a member State of the European Union, its legislation on procurement needs to be designed according with the principles set up in the EU Directive.
2. As Kelman (2002) points out these features strongly characterized the USA procurement before the legislative reforms passed in 1994, 1995 and 1998.
3. Open and restricted procedures are the rule and negotiated procedures can be adopted only in well defined circumstances.
4. This is in line with the more traditional results of the economic literature on auctions. For an overview of this literature see Klemperer (1999).
5. Expected total costs do not necessarily decrease when the number of bidders increases: the administrative costs as well as the costs for the preparation of the bid should not be undervalued.
6. The advantages of such a kind of relationship have been stressed by Williamson (1985).
7. Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture, (2007).
8. Rizzo (2008) points out that the creation of an independent authority to supervise and regulate the procurement market is not widespread in other EU countries and offers a tentative political economy explanation.
9. The demand is not evenly distributed across the different geographical areas and the different sectors.
10. In 2006 there were 12.231 public works below 150.000 euros

(38.1% of the total) and, at the other extreme, 150 works above 15 millions of euros. 83% of works is below 1 million of euros (Autorità di vigilanza sui contratti pubblici di lavori, servizi e forniture, 2007).

11. In public procurement such a decision is usually constrained; for instance, the Italian legislation provides a precise list of unforeseeable contingencies which are admitted as causes of contractual revision.

12. Data are normalized data to take into account the heterogeneity of public works, using the ratio of the adaptation cost to the value of the winning bid. More formally, if B_h is the value of the winning bid for a public work *h*, FC_h is the final cost and AC_h is the adaptation cost of the same public work, thus $FC_h = B_h + AC_h$. We define normalized adaptation cost as $NAC_h = \frac{AC_h}{B_h}$, which is clearly independent of the economic dimension of a public work.

13. We can similarly define normalized adaptation time as $NAT_h = \frac{AT_h}{T_h}$ where T_h is the time contractually agreed for the completion of a public work *h* and AT_h is the adaptation time.

14. For the detail of the contract sample see next section.

15. Data concerning the bidders are incomplete and, therefore, it is not possible to analyze the behaviour of bidders in relation to the various award procedures of the contract (see Bajari *et al*, 2006).

16. The sample was selected on the basis of the completeness of the records included in the data base. To limit the heterogeneity, the public works above 5 millions euros were not included in the sample because of the longer time lag required to complete complex works. Moreover, public works with a final cost lower than the contract cost were not taken into account because of the lack of adequate information. The sample was, positively, verified with the ordinary statistical tests.

17. Public works are articulated in sub-categories, i.e. the different components of the overall work, which contribute, according with their relative relevance for the specific work, to the estimated total

value. It is plausible to assume that the more complex is a public work the higher is the number complexity of sub-categories involved in its implementation.

18. Different models of 'governance' refer to appointment methods, soft or hard budget constraints, incentives, etc.

19. The relations of causality between the difference of cost and the procurement procedure for each contracting authority need to be explored. A lower difference of cost for a category of contracting authority might not be determined necessarily by a more careful behaviour but a larger use of negotiated procedures (which reduce the risk of contractual revisions).

20. The range of the variable in the sample is between 0 and 1.8037.

21. To control for sample selection we also considered a Tobit II estimate [Amemiya, 1984] obtaining results comparable with reported in the table.

22. With bootstrap 50 interaction. For discussion see Cameron and Trivedi (2005)

23. A system for evaluating the bids based on the notion of standard cost might be more effective in preventing underbidding because it might reduce the asymmetrical information of the contracting authority .

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