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PRE- AND POST-AWARD OUTSOURCING: TEMPORARY PARTNERSHIP VERSUS SUBCONTRACTING IN PUBLIC PROCUREMENT

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Pre- and post-award outsourcing: Temporary partnership versus subcontracting in public procurement[1]

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Abstract

This paper studies the impact of qualification rules for entry into public procurement auctions on firm bids and contract execution, contributing to the debate about which regulations foster the efficient participation of small and medium enterprises (SMEs). Using rich and detailed microdata on all public work contracts awarded by the regional government of Valle d'Aosta from 2000 to 2008, we investigate the differences between pre-award outsourcing by temporary partnerships (TPs) and post-award outsourcing by firms in optional or mandatory subcontracting. We find that both outsourcing status and firm size affect bids and the probability of time and cost overruns. TPs bid lower prices than mandatory and large optional firms and perform well in contract execution, similar to small optional firms. Mandatory firms are more likely to exceed expected cost and are no better in timely delivery. The evidence holds when we disentangle horizontal and vertical subcontracting. Our results highlight the TPs' advantage of freedom in choosing economic size and technical boundaries before entering the auction. (165 words)

Keywords: Public procurement, Regulation on entry, Vertical and horizontal subcontracting/outsourcing, SMEs, Temporary consortium, Supply chain.

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1. Introduction

Public procurement accounts for a significant part of taxpayers' money—about 29% of government expenditures and 12% of GDP in developed countries (OECD 2016)—and governments are expected to carry out public procurement efficiently in order to safeguard public interest. As such, public procurement is not only an important leverage for gaining monetary value in purchasing services, goods, and furniture, but also drives resources towards innovation and sustainability (e.g., programs for procuring innovative and/or green solutions and programs aimed at increasing disadvantaged and small businesses' participation in procurement).[4]

When it comes to its implementation, however, public procurement turns out to be a very complex process, consisting typically of at least two main phases—the contract's awarding and the contract's execution. These two stages are usually managed separately, but they are tightly interrelated since the supplier that wins the contract by bidding the best price according to the auction's rules should then deliver the contracted tasks and quality in the execution stage. In this process, whether and when suppliers outsource part of the contract's execution is crucial because it directly impacts the efficiency of the supply chain in production and, in turn, the procurer's costs. Differently from private procurement, in public procurement, the supplier's make-or-buy is affected by regulations that constrain decision-making in allocating resources to perform the public contract tasks. Indeed, in public procurement, firms typically have to comply with qualifications and rules in order to enter the tender. Such qualifications are implemented with the aim of reducing the risk of default in contract execution by screening and selecting potential

[4] Tirole and Saussier (2015) contributed to the recent debate on the use of public procurement for policy goals by highlighting that pursuing innovation or social/environmental goals could lead to inefficient outcomes given that public procurement should be driven by efficiency in costs and optimal quality in performance.

suppliers with the appropriate characteristics, such as available technology, size of the firm, experience, and financial status, as well as to prevent favoritism/corruption by keeping public officers accountable for the allocation of public funds.[5]

The goal of this paper is to study the impact of qualification rules on a firm's outsourcing status and, in turn, to empirically investigate how this affects public procurement costs and performance in the execution of the work. We do this by drawing on regulations about firms' qualification for entry in Italian procurement auctions for public works and an original and detailed dataset referring to it. Specifically, this dataset contains all public work contracts awarded by the regional government of Valle d'Aosta from 2000 to 2008, the bids of all participants in each awarding auction, information about each firm's ability to perform the tasks (the so-called work categories) included in the auctioned contract, and information about the winning firm's performance.

According to Italian regulations for public procurement, all the tasks in each auctioned contract have to be executed by technically and economically qualified firms. Hence, for each tendered contract, any required qualifications determine whether the firm can enter the auction and, in turn, whether it has the option or a mandate to subcontract or outsource any part of the work. That is, once the contract has been awarded, a fully qualified firm has the option to proceed with post-award outsourcing, while a partially qualified firm must proceed for post-award outsourcing. We define "optional subcontracting" the former and "mandatory subcontracting" the latter. Contextually, partially qualified firms have an alternative way to enter the auction. Given the tasks and the economic requirements of each contract, they can set up a temporary partnership (TP) with other firms that hold the complementary required

[5] As highlighted by Spagnolo (2012), these regulations are absent in private procurement, where the supplier can take advantage of reputational forces, relational contracts, and implicit incentives in designing outsourcing.

qualifications before participating in the tender. Notice that the key difference between TPs and firms with post-award mandatory or optional subcontracting status is that the latter choose their partners and subcontract right before entering the tender. Not surprisingly, the TP alternative is usually adopted by small- and medium-sized firms aiming to participate in tenders for high value or complex (such as those with many work categories) contracts.

Our empirical analysis investigates the differences, if any, for each auctioned contract in the bids (i.e., procurement prices) submitted by firms in the form of TPs, meaning pre-award outsourcing, and bids submitted by firms that proceed with mandatory or optional subcontracting in the form of post-award outsourcing. Moreover, focusing on the winning firms, who are the contractors executing the public procurement work, we investigate performance in terms of the probability of time and cost overruns in a contract's delivery. With the aim of gauging the differences in terms of the scale of a firm's activities, we compare bids and performance by TPs and by firms in a position of optional subcontracting by size. Finally, in order to explore potential differences between horizontal and vertical subcontracting, we also disentangle firms' bids and delivery performance by contract complexity, specifically by separating contracts with a single work category from those with more than one work category.

Our results show that bidding rebates by TPs are higher (i.e. prices are lower) than rebates by firms with a mandatory or optional subcontracting status. When we account for the size of firms in optional subcontracting, we find that TPs' rebates are significantly higher than large firms, but close to those from medium and small firms. Then, disentangling firms' rebates by the complexity of the contract, we find that rebates from TPs are significantly higher than large optional subcontracting firms in both horizontal (one work category) and vertical (more than one work categories) subcontracting.

Turning to the performance of winning firms in contract execution, our empirical analysis shows that TPs are less likely to exceed execution costs than firms in a position of mandatory subcontracting or medium-sized firms with optional subcontracting status. Firms with mandatory subcontracting were the worst performers in this analysis. Moreover, the probability of cost overruns is always significantly lower when TPs perform complex contracts with more than one work category. When we look at the ability to deliver the contract on time, TPs do significantly better than both medium- and small-sized firms with optional subcontracting and do not differ from firms with mandatory subcontracting. Results hold when we consider complex contracts that imply vertical subcontracting. All these results suggest that, on average, TPs not only succeed in planning and executing the contracted work at efficient costs as compared to firms using post-award mandatory subcontracting, but also manage to comply with the contract's timely execution, showing a similar or lower probability of delay than the other firms in this investigation.

Our findings contribute to inform the debate on the costs arising from regulatory constraints on the suppliers' choice of the organizational form when participating in the public procurement process. Specifically, our focus on TPs is motivated by the recent policy debate about how to foster entry by small and medium enterprises (SMEs) in procurement auctions.[6] We mainly contribute by providing evidence that TPs operate more efficiently than firms in a position to proceed with mandatory subcontracting or large firms in the position of pursuing optional subcontracting. As for the policy implication of our results, it follows that regulations on entry qualifications that support TPs should be encouraged in order to provide SMEs with a viable alternative for entering the public procurement bidding process.

[6] On the EU debate about SME's participation in public procurement, see *SMEs' access to public procurement markets and aggregation of demand in the EU* (2015), downloadable from: http://ec.europa.eu/DocsRoom/documents/15459/attachments/1/translations/

The rest of the paper is organized as follows. Section 2 discusses the existing literature and presents our research questions. Section 3 describes the institutional features of the Italian public procurement setting referenced in our dataset. Section 4 presents the dataset and preliminary descriptive evidence. Section 5 illustrates our empirical strategy and presents the econometric results. Finally, Section 6 concludes with policy implications.

2. Background and research questions

Since the seminal paper by Ronald Coase (1937) on firm boundaries, many theoretical contributions have addressed the determinants of contract outsourcing as being based on transaction costs (Williamson 1971, 1985), property rights (Grossman and Hart 1986), and the knowledge base of the firm (Kogut and Zander 1992, 1996). Holmstrom and Roberts (1998) highlighted how the interest on firms' boundaries has progressively moved from their role in coordination problems to their weight in rising incentives (e.g., hold-up issues). Empirical research has documented how and when firms adopt outsourcing to efficiently organize production in different economic sectors (Novak and Stern 2008; Macher 2006; Quinn and Hilmer 1994). Joskow (1988) proposed a seminal empirical survey of firms' vertical arrangements versus spot market transactions and long-term contracts in different sectors. More recently, Lafontaine and Slade (2007) have provided a thoughtful review of the empirical literature on backward/forward vertical integration, and Gibbons and Roberts (2013) provide an updated contribution to relevant issues within a firm's organization.

All these theoretical and empirical contributions assume the firm's voluntary choice of internal or external sourcing in different timings and formats. Our paper differs from the above literature on outsourcing in that it specifically focuses on public procurement contracts, where firms are constrained by many rules and procedures that, on the one hand, limit their decision-

making and on the other, affect the efficiency and cost of the public–private transaction and overall social welfare.

The motivation to regulate procurement procedures based on a firm's qualifications and entry to the auction is twofold (OECD 2007). On the one hand, public authorities have to maintain fairness in procurement transactions in order to prevent favoritism and corruption; on the other, they have to minimize poor performance in the execution of these contracts financed by public resources.[7] In particular, frameworks for firms' qualification screening are adopted all over the world to implement the verification of a firm's financial status, references, technical/product/process, and surge capacity, but the literature examining the costs and benefits of "rules versus discretion" in public procurement and the consequences on bidding behavior and contract performance is still scarce.

Moretti and Valbonesi (2015), using a newly assembled dataset on qualification rules for public procurement auctions in Italy, found that firms in a position to choose whether to subcontract part of the work (optional subcontracting) offer significantly lower prices to execute the contract than firms obliged to subcontract part of the work (mandatory subcontracting). Their results highlight the direct effect of the regulatory burden on procurement costs, showing on the one hand that firms' voluntary arrangements tend to improve market performance, while on the other that any imposed arrangements that either prohibit or mandate relationships tend to worsen it. Their findings are consistent with evidence reported in Lafontaine and Slade's (2008) survey on vertical restraints, concluding that when manufacturers choose to impose vertical restraints,

[7] Such regulatory burdens could be even higher when these procurement contracts are specifically intended to be the core of affirmative action policies that indirectly enhance the participation of disadvantaged business enterprises (DBEs). See also Marion (2007, 2009) and Krasnokutskaya and Seim, (2011), De Silva et al. (2012), and Athey, Coey, and Levin (2013) for other examples of these policies.

their impact on market performance is positive by implication, whereas the impact is negative if vertical restraints are prohibited.

In this paper, exploiting the same dataset on Italian public procurement investigated by Moretti and Valbonesi (2015), we address a different question, focusing on TPs and testing the differences between firms that proceed to pre- and post-award outsourcing. According to the Italian qualification system, all tasks of the awarded contracts should be completed by qualified firms. Such a qualification system defines the categories of work that on the one hand could be part of awarded public contracts and on the other hand represent the object of firms' certification by a third party (see Section 3 on institutional settings). As a result, for each auctioned contract, a firm would enter the tender as one of the following:

i) *Fully qualified firm* – A firm in a position to complete the contracted work by itself that, if it wins the auction, can freely decide whether or not to outsource part of the work (i.e., a firm in an ex-post position of optional subcontracting);

ii) *Partially qualified firm* – A firm that, after bidding in the auction, is mandated to outsource if it wins the contract (i.e., a firm in an ex-post position of mandatory subcontracting);

iii) *TP* – Two or more partially qualified firms that set up an *ex-ante* binding agreement in order to obtain full economic and technical qualification to bid for and execute the awarded contract. [8]

Box 1 below classifies the above organizational forms according to the firm's status and the timing of any outsourcing. Considering the bid as a proxy for the firm's expected costs to

[8] In Moretti and Valbonesi (2015), TPs were included in the analysis as fully qualified firms (firms in an ex-post position of optional subcontracting) because TPs manage to enter the auction and bid having covered all the qualifications required to executing the contract. The pre-award and post-award dimension of outsourcing was thus not examined.

execute the tendered contract, our purpose is to empirically investigate differences, if any, in such expected costs for firms adopting different outsourcing formats in the execution of awarded public contracts.

– Box 1 about here –

Furthermore, in this paper, we investigate the performance of TPs in the execution of public procurement as measured by time and cost overruns in delivering the contracted project. We thus compare the probability of a TP's overruns with those incurred by firms in a position of either optional or mandatory subcontracting. In the literature on procurement auctions, cost and time overruns have attracted much attention and different explanations. Considering a setting where bidders can renege on their bids and contractual terms and where production costs are identical for all bidders but uncertain at the bidding stage, Spulber (1990) shows that such overruns will originate as a result of an adverse selection of the successful bidder. Ganuza (2007), focusing on large contracts, highlights that overruns belong to the procurer's attempts to minimize the information left up to the suppliers, in particular when the procurer underinvests in the initial project design and renegotiates both the price and the project specifications with the winning bidder. Lewis and Bajari (2011) empirically estimated the negative externalities for commuters (such as congestion effects) generated by a contractors' slow completion times in the case of a California highway procurement contract, and they highlighted the effects of these defaults on social welfare in terms of direct and indirect costs for taxpayers. Specifically referring to Italian public procurement, time and cost overruns in the execution of contracts have been empirically investigated along different directions by a number of papers.[9]

[9] By using different dataset extensions and periods in which Italian regulators allowed the adoption of both average bid auctions and first price auctions, Decarolis (2014) empirically finds that cost overruns are lower in the former auction format than in the latter. Bucciol, Chillemi, and Palazzi (2014) confirm this result but only when the entry in the former auction is restricted by the procurer. Moretti and Valbonesi (2015) refer overruns to optional and

To the best of our knowledge, this paper is the first to investigate cost and time overruns in public procurement performance with a focus on TPs and mandatory subcontracting. Indeed, cost and time overruns depend partly on the firm's ability to plan and bid wisely and partly on the firm's ability to minimize the risk of hold-ups whenever it chooses, or has to rely on, subcontractors for some contractual tasks. Within the TP, the participating firms delivering different parts of the public works chose to form the partnership before entering the procurement process and have then planned the production, estimated the costs, and accordingly, offered the rebate. The TP is thus a contractual agreement by which firms pre-commit to collaborate, and in this vein, it can be argued that the risk of hold-ups by partners in a TP (instead of subcontractors) should be lower.

Finally, we investigate the pre-award and post-award firm's outsourcing status as it relates to the number of work categories in each tendered contract, a good proxy for contract complexity. This last analysis allows us to investigate horizontal outsourcing that occurs in one work category contracts, where delegation of tasks is between or among similarly qualified firms, and vertical outsourcing adopted in more than one work category contracts, where delegation of tasks is spread out among differently qualified firms.

Our paper contributes to three strands of economic literature. First, we add to the extensive economic literature on firm boundaries and vertical restraints with new empirical results for the limited evidence on TPs. In this field, it has been highlighted that make-or-buy decisions can be driven by cost structures (Spiegel 1993; Shy and Stenbacka 2003; Kamien and Li 1990; Van Mieghem 1999; Marechal and Morand 2003), technology spillover (Van Long

mandatory subcontracting. Coviello, Moretti, Spagnolo, and Valbonesi investigate time overruns as contractors' opportunistic behavior under weak local courts' enforcement of contractual rules (2016). Coviello and Mariniello (2014) address the effects of tender publicity on renegotiations and overruns. Decarolis and Palumbo (2015) study overruns as they are related to the project's design stage.

2005), learning by doing (Chen 2006), hold-ups (Rey and Tirole 2007; Miller 2014), and strategic motives (Arya et al. 2008). In our setting, we find that outsourcing through TPs, where liabilities are distributed ex-ante among the consortium's participants, and thereby, hold-up issues are reduced, can effectively increase efficiency in the procurement production chain as compared to ex-post subcontracting.

Second, our paper contributes to the empirical literature assessing entry and subcontracting in public procurement. Branzoli and Decarolis (2016) show how different auctions format (e.g., average bid auctions vs. first price auctions) can differently affect the number of participants in the tender and their subcontracting behavior. In a setting where participants to a public work auction should provide, along with the bid, information about which tasks will be outsourced and to whom (the identity of subcontractors), Gil and Marion (2013) empirically show how the stock of past subcontractors affect a firm's bidding behavior. Moretti and Valbonesi (2015) highlight that limiting the discretion of firms in terms of their supply chain choices leads to higher costs for public procurement. Our paper differs from the previous ones in providing evidence that widening the scope for pre-award outsourcing by participants in the auction, like TPs, leads to higher efficiency through lower public contract prices and better performance in terms of cost overruns than when implementing ex-post mandatory rules to subcontract.

Third, the economic literature explores mechanisms and procedures to support SME participation in public procurement and, more generally, to implement the so-called affirmative policies for disadvantaged businesses. Loader (2013) and Flynn and Davis (2015) provide empirical evidence that i) contract size is commonly regarded as the main impediment to SME involvement in public procurement and ii) regulations that promote contracting authorities'

actions to minimize the issue by, for example, dividing contracts into lots and/or encouraging consortium bidding, are not often implemented. Marion (2007) empirically evaluates the effect of bid preferences in California public procurement auctions for highway construction contracts, where small businesses receive a 5% bid preference in their offers.[10] He found that procurement costs are 3.8% higher on auctions using preferences.[11] Our paper contributes to this literature on SME participation in procurement for public works by providing empirical results on prices and performance by TPs, an organizational option typically adopted, when allowed, by SMEs to enter procurement auctions and match the required technical and economic value of the awarded contracts. In this regard, to the best of our knowledge, we are the first to compare *ceteris paribus* TPs and ex-post traditional subcontracts as well as controlling in our analysis for horizontal versus vertical features in outsourcing contractual tasks.

3. Institutional setting

In this section, we describe the regulations on the supply and demand side of the Italian public procurement market in more detail.

The supply side. The aim of the Italian public procurement system of firm qualifications is to restrict participation in the call for bids to those firms with the technical, economic, and

[10] On affirmative actions toward minority owned firms and SME employment, see also Marion (2009a, 2009b) and Farlie and Marion (2012), respectively.

[11] The higher procurement costs in preference auctions is explained by the reduced participation of lower-cost large firms (see Marion 2009). Krasnokutskaya and Seim (2006), also using data from Caltrans highway auctions to estimate a structural model and investigate bidder participation in bid preference auctions, find that bid preferences increase the probability of small firms winning; however, their simulations do not suggest a significant effect on procurement costs. On the other hand, Corns and Schotter (1999) suggest, with an experimental investigation, that bid preferences for disadvantaged agents could lower the equilibrium in the winning bid if it forces non disadvantaged agents to bid more aggressively. Athey, Coey, and Levin (2013), studying the US Forest Service timber sale program, highlight that bid preferences for SMEs could be a more effective means than set-aside in auctions.

other capacities to efficiently execute on all aspects of the awarded project. In the period our data refer to, the Italian qualification system was operated by 37 private companies called SOA (Società Organismo di Attestazione, i.e. Certification Offices), accredited and monitored by AVCP (Autorità per la Vigilanza dei Contratti Pubblici, i.e. Italian Authority for Public Contracts),[12] the national authority in charge of regulating and monitoring the national market for public works, supplies, and services. The qualifications for a firm refer to i) general requirements for the firm's financial standing and criminal records (e.g., anti-Mafia) and ii) technical and economic requirements for the specific skills needed to perform certain works and which are usually assessed based on the firm's documented expertise, economic size, and other observable factors such as number of employees, capital invested in technological assets, etc.[13] Qualifying for each category and size (i.e., value) of work is costly for the firm, with different fees for different categories and sizes of work, and the qualification remains valid for three or five years, after which it must be renewed. Firms must be qualified to bid in these auctions, and all the contract's parts should be executed by qualified firms. Information on a firm's qualification status and tasks for each awarded contract enables us to classify suppliers into three outsourcing positions (TPs, mandatory subcontracting, and optional subcontracting) and to run our empirical analyses on their bidding and performance comparisons while also taking into account firm size and contract complexity.

The demand side. When awarding a public works contract, the contracting authority (CA) specifies all the tasks (e.g., the work categories and their economic value) involved in the project and indicates the main category as well as any secondary category(ies) of work to be

[12] AVCP has formed part of the Italian National Anti-Corruption Authority (ANAC) since August 2014. Regulations on a firm's qualifications and regulations for the awarding of public contracts have not changed.
[13] Specifically, 46 categories of work have been defined in Italian public works for which firms can obtain the necessary qualifications along with an assessment about the allowed contracts' economic value.

executed in the contract's completion. For example, consider a contract for the building of a road in a new residential area. The fulfillment of this contract requires three tasks: t_A (road works), t_B (water works), t_C (sewage works). Accordingly, in the requests for tenders, let's assume that the CA will present task t_A as the main work category and the remaining two tasks (t_B and t_C) as secondary work categories. Such a distinction is relevant since participation in tenders is restricted to firms qualified for the main work category. The bidding firm may or may not be qualified for the secondary work categories involved in a public contract up for tender. In particular, we can have several different cases. If the bidding firm is fully qualified when it wins the contract, it can choose to either complete all the works itself or to horizontally subcontract parts of the work to other similarly qualified firms (such as rival firms with comparable qualifications), thus giving rise to optional subcontracting. If the winning firm is not qualified for one or more secondary categories, it has to declare that it will vertically subcontract the work for which it lacks qualifications to other qualified firms, and if it wins, it is required to subcontract (mandatory subcontracting). Alternatively, if a firm lacks the qualifications and/or the required economic value, it can enter the auction by setting up a TP.[14] These partnerships are established ad hoc to bid for a given contract, involve firms that pool their qualifications together to address the main and secondary categories required to execute the awarded contract and break up after the auction or after the contract is executed, in case they win.

As soon as the CA announces in the call for bid procedure the qualification categories to enter the auction and their size, the potential position of each bidder concerning any outsourcing or subcontracting becomes clear, and each firm is ex-ante aware (i.e., before bidding) of its qualification status. Therefore, each firm willing to participate in that auction can ex-ante verify whether it is fully qualified to bid—a status which permits them to proceed with optional

[14] In Italy, the name for this organization of firms bidding jointly is Associazione Temporanea d'Impresa, ATI.

subcontracting—and, if not, can alternatively choose whether to organize a TP or proceed for mandatory subcontracting.[15]

After the CA has verified the bidders' legal, fiscal, economic, financial, and technical requirements, the winner is then identified according to the rules governing the competitive auction, and the contract is finally awarded. The procurement setting investigated here adopts either average bid auctions (ABA) or average bid auctions with lottery (ABA with lottery).[16] As shown by Galavotti, Moretti, and Valbonesi (2014) the mean rebate is lower in the ABA with lottery than in the simple ABA, but the bidding behavior is similar in both formats.[17]

4. Data and descriptive statistics

Our dataset collects public works worth more than EUR 150,000 awarded by the regional government of Valle d'Aosta in the period 2000–2008 by means of open tenders, where firms participated by offering a rebate (i.e., a percentage reduction on the reserve price set by the CA). Different from many other datasets on public procurement, where often only the winning bid is collected along with the name of the winner in each competitive tender, our dataset contains all the bids submitted and the winner in each auction, along with detailed information both on each auction and the participating firms. Specifically, for each firm, our dataset includes its name (identity), the rebate it offered in all auctions in which it participated, its size and location, its distance from the CA awarding the contract (the city of Aosta), the number of pending public

[15]Notably, each firm's full or partial qualification status is not granted forever but may change at any procurement auction, depending on the contractual tasks that have to be executed in each awarded contract.

[16] These mechanisms work as follows. Within the ABA framework, given the distribution of all bids received in the auction, a first average (A1) is computed by averaging all the bids except those located in the first and last deciles. A second average (A2) is then computed by averaging all of the bids above A1 (again, excluding those bids located in the last decile). The winning bid is the one immediately below A2. Within the ABA with lottery scheme, given A2 computed as above, a random integer R between 1 and 9 is extracted. The R-th number among the nine equidistant numbers between the bid just above the first decile and the bid just below A2 is averaged, with A2 defining the winning threshold. The winning bid is the one immediately above this threshold.

[17] For further investigation of these auction formats, see Albano et al. (2006) and Decarolis (2009).

procurement projects at the time of bidding (the backlog), the work categories for which it qualifies, and accordingly, its optional or mandatory outsourcing position in each auction, meaning whether the firm has the option or must rely on outsourcing. However, for fully qualified firms that have the option to subcontract, we have no information as to whether they did so, while for TPs, we have no information on the identity of all the individual firms that form the TP because each TP forms and dissolves at every single auction. Therefore, TPs enter the dataset with a separate identification number that differs in every auction.

For each auction, we have information on the reserve price (i.e., the price over which each participating firm has to bid a rebate) and on the contractual duration of the public work, as both are defined by the CA; the auction's format (ABA or ABA with lottery); and on the tasks to be covered within the tendered project (category of work). In addition, we have some information on the contract's execution, such as the final cost of the project and whether the winning firm completed the project on time, which allows us to observe whether the firm had any defaults under the contract in the form of cost and/or time overruns.[18]

Crucially, we know the qualifications required for the completion of each contract and all the qualifications held by the bidding firms. This information enables us to identify, auction by auction, whether each bidding firm was fully or partially qualified, meaning whether a firm winning an auction had the option to subcontract ex-post (optional subcontracting) or was required to outsource part of the work ex-post (mandatory subcontracting).

Finally, by disentangling projects that include one work category from projects with more than one work category, we distinguish contracts where subcontracting can only be horizontal from contracts where outsourcing will typically be vertical. This feature helps us with the

[18] Following Moretti and Valbonesi (2015), we define time overruns as the probability of completing the project after the expected (contracted) deadline and cost overruns as the probability that the final cost of the project is greater than the winning bid.

identification of differences between TPs and other organizational forms in the econometric analysis. For example, when focusing on horizontal subcontracting, we can investigate SMEs that enter procurement auctions for public works by setting up TPs to overcome the contract's economic capacity requirement (the economic size).

Our dataset consists of 269 auctions awarding public contracts for road work (37.2%), river and hydraulic work (29.7%), and buildings (14.9%) awarded by the regional government of Valle d'Aosta. Eight hundred ninety-two firms and 1,777 TPs participated in these auctions. The total number of bids offered was 13,331.

– Table 1 about here – Summary statistics: Full sample

Table 1 shows that the average reserve price is about EUR 1.18 million (with a minimum of EUR 155,000 and a maximum about EUR 5.25 million) and the average expected duration of completion is 322 days. The market is essentially a local one, with the average distance between the bidder's location and the CA location being about 310 kilometers and a standard deviation of about 399 kilometers. The average number of firms and TPs participating in the auctions was 49. On average, each firm in the sample participated in about 13 auctions (but by definition, TPs participate only in one auction). In our sample, 13.3% of the bids were offered by firms organized as TPs, 73.8% were offered by firms in an optional subcontracting position, and 12.9% were offered by firms in a mandatory subcontracting position. Moreover, 13.6% of the bids were offered by small firms in either an optional or mandatory subcontracting position, 61% by medium-sized firms, and 25.4% from large companies. Considering firm performance in executing the contract, we note that the probabilities of cost and time overruns were quite high

(0.850 and 0.919, respectively).[19] Finally, 83% of the open tenders are in the form of ABAs and 17% in the form of ABAs with lottery.

Table 2 reports the descriptive statistics by the firms' outsourcing positions.

– Table 2 about here – Summary statistics by form of organization (sub-samples)

We observe that, on average, TPs offer larger rebates (i.e., lower prices) than firms in both the mandatory and the optional subcontracting positions. TPs also appear to bid lower prices than large and small fully qualified firms. Finally, TPs record a slightly higher probability to incur cost and time overruns than optional firms, while with respect to firms in a mandatory subcontracting position, TPs seem to deliver later, but at a lower cost.

– Table 3 about here – Mean comparisons

In Table 3, we test the significance of mean differences for rebates and probability of winning. In Panel A, we find that average rebates by TPs are significantly higher than those by firms in mandatory subcontracting positions and similar to rebates by firms in an optional subcontracting position. However, when we break down optional firms by size, we find that TPs' rebates are higher than both large and small optional firms', but lower than rebates by medium-sized firms.

In Panel B of Table 3, we compare the mean probabilities of being successfully awarded a contract by outsourcing status and by firm size. For each outsourcing position (TPs, optional subcontracting, and mandatory subcontracting) and size category, we compute the mean

[19] These high percentages in overruns are consistent with other empirical investigations on Italian procurement for public works. See, for example, Moretti and Valbonesi (2015), Guccio et al. (2012), Decarolis and Palumbo (2015), Decarolis (2009), and Coviello et al. (2016).

probability as the ratio between the number of contracts awarded (i.e., the winning outcomes) and the total number of bids by firms in that position or size category. Our findings show that TPs have a significantly higher probability of being awarded a contract than large and medium-sized optional firms, but not with respect to either small-sized optional firms or firms in a mandatory subcontracting status. Results from this table suggest that not only do TPs tend to bid aggressively but that they are also quite successful when they do so. To confirm the descriptive evidence, in the next section, we turn to multivariate regression analysis.

5. Empirical models and results

In the previous sections, we have described how the qualification system for entry into public procurement auctions affects a firm's outsourcing status. Now we empirically investigate how the firm's outsourcing status affects its bids (i.e., rebates offered in the auction) and the winning firm's performance in contract execution (e.g., the probability of time and cost overruns in delivering the public works). Moreover, we extend the analysis by relating firms' bids and performance to firm size and contract complexity. Note that contract complexity is measured here by the number of work categories in the project, allowing us to add a focus on the differences between horizontal and vertical subcontracting.

5.1 The firms' bidding behavior and outsourcing status: A close-up on TPs

Our empirical model of firm bidding investigates the differences in the rebates offered by TPs and by firms that proceed with ex-post outsourcing in the form of either mandatory subcontracting or optional subcontracting. Fully qualified firms that optionally subcontract are further disentangled by size. The results are in Table 4.

We assume that the firm's bid is a proxy for its expected costs to complete the tendered contract. We estimate the following specification of the rebate of firm *i* in each auction for project *j* in year *t*:

$$Rebate_{ijt} = \alpha + \beta\, TP_{ijt} + \varphi\, OF_{ijt} + \gamma\, Q_{jt} + \theta X_{it} + \delta Z_{ijt} + \lambda_t + \varepsilon_{ijt} \quad (1)$$

where TP is a binary variable that takes value 1 when the bidder *i* in the auction for project *j* in year *t* is a TP and 0 otherwise. *OF* is a set of dummies that covers for the other *n-1* organizational forms that we control for when we want to compare the bidding rebates of TP vis-à-vis the n*th* organizational form. For example, if we aim to test the difference between the TPs' and the mandatory firms' rebates, *OF* will be a dummy equal to 1 when the bidder is a fully qualified firm that can optionally decide ex-post whether to subcontract (optional), as in column 2 of Table 4. Correspondingly, when we move on to test the difference with respect to optional firms, *OF* will be a dummy equal to 1 when the bidder is a partially qualified firm that has to proceed to mandatory subcontracting, as in column 3. Finally, when we explore the size-related issues, *OF* will be a set of dummies that covers sub-samples by size (small, medium, large), as in columns 4–6.

Q_{jt} is a set of variables that controls for the characteristics of the project and the nature of the auction. This includes the size of the project as measured by the reserve price, its length in terms of expected duration, the toughness of competition (i.e., the number of participants in each auction), the tasks to be executed (i.e., a set of dummies to control for 16 categories of work), the type of auction (whether ABA or ABA with lottery), and a dummy indicating whether the auctioned contract is a project that implies only one work category or more than one work category.

X_{it} is a set of variables that measures the characteristics of the bidder, such as its size (as measured by a set of dummies for small, medium, and large-sized firms) and the distance between its location and the CA's location.

Z_{ijt} controls for the bidder's capacity constraints as measured by the firm's backlog when it bids for the project *j*. In addition, we include a dummy denoting the winning firm in the auction and, λ_t, the year dummies, since the auctions were held from 2000 to 2008. ε_{ijt} is the error component.

Because we don't know the identity of the firms in each TP and TPs form and participate in each auction with a different identification code and composition (and split after the auction or after the contract's execution in the case of a winning bid), we cannot estimate a regression model with firm fixed effects since we do not have continuous (or repeated) observations for TPs. For identification, however, we rely on several firm- and auction-specific control variables and, in Appendix Table A1, we also report estimates with auction fixed effects.

Robust standard errors are clustered by firm to account for the fact that bidders may contemporarily participate in more than one auction, and their bids may be influenced by the current status of their business (e.g., backlog, distance). In addition, we control whether the results hold when we cluster the standard errors by auction to account for possible correlation of firms' bids across auctions.

In Table 4, our variable of interest is the β coefficient on TP, which indicates whether bids by TPs significantly differ from those by firms having the status of optional or mandatory subcontracting.

– Table 4 about here –

In column 1, we find that TPs' rebates are significantly higher, meaning the bid price is, on average, lower than the rebates offered by both optional and mandatory subcontracting firms, which are the default in this specification. Turning to the control variables, we find that the number of participants and the dummy variables indicating the winning firm and the auctions with only one work category enter significantly in all columns. The positive coefficient on the number of participants suggests that the tougher the competition in the bidding process, the higher the bidding rebate and the lower the final price, with a benefit for the public buyer. The positive coefficient on the only one work category dummy suggests that competition for projects that are relatively less complex to execute and may be easier to monitor, is probably tougher, thus leading firms to bid lower prices.

In column 2, we focus on the comparison between TPs and partially qualified firms that have to proceed to mandatory subcontracting once they win the contract. We find that TPs' bidding rebates are significantly higher. In contrast, the insignificant coefficient on fully qualified firms that optionally subcontract indicates that their rebates do not differ from those by partially qualified firms subject to mandatory subcontracting.[20] When we turn to column 3, we find that TPs' bidding rebates are significantly larger than those of optional firms (i.e., the default after controlling for mandatory subcontracting), thus suggesting that ex-ante outsourcing leads to lower prices. This result—suggesting a potential higher efficiency or planning capacity of TPs with respect to fully qualified firms—is somewhat unexpected, thus leading us to further investigate the differences between TPs and optional firms. We do so by disentangling their bids by firm size in columns 4–6. The new estimates reveal that the above result was driven by the lower rebates of large optional firms since the TPs' coefficient is significant only in column 4,

[20] Notice that in the paper by Moretti and Valbonesi (2014), such coefficient is significant. The difference with the present paper is explained by the fact that here, focusing precisely on TPs, we consider optional subcontracting firms as not including TPs.

where the default is the large optional category, and insignificant in the remaining two columns, where we directly compare TPs' bids with those of medium and small optional firms, thus suggesting that TPs' bids do not differ from theirs. Moreover, looking at the coefficients of optional firms of different sizes, we note that small firms bid significantly higher rebates than both large and medium optional firms (see columns 4 and 5) and firms in a status of mandatory subcontracting (column 6), while mandatory firms' rebates do not significantly differ from the others (medium or large optional firms and TPs).

Overall, our findings show that along with the outsourcing status, firm size matters for the outcome of the bidding process, suggesting that TPs are able to choose the optimal size for entry and match the size of the auctioned contracts similarly to small fully qualified firms and more efficiently than large optional firms and firms subject to mandatory subcontracting.[21] Considering the firm's bid as a proxy for self-estimated costs in executing the contract, these results suggest that TPs, which choose their partners, boundaries, and size in advance, have a better ex-ante planning ability than large and mandatory subcontracting firms that outsource parts of the contract ex-post.

5.2 Cost and time overruns in contract execution

In this section, we investigate the performance of firms winning the auction, disentangling by outsourcing status and firm size. Time and cost overruns in contract execution are the typical measures of defaults in procurement contract performance. They are defined, respectively, as the extra time on the contractual duration and the extra cost on the winning bid. Both time and cost overruns usually lead to a costly renegotiation of the contract, which in some ways could waste the advantages from the competitive tender.

[21] Results with the alternative clustering by auction are very similar and available on request.

We estimate probit regressions of the probability that the project's final cost for the winning firm is greater than the winning bid and of the probability of completing the project after the expected (contracted) deadline, respectively. The estimating sample consists only of the winning firms, and the specification is the following:

$$Prob[ExtraCost/Delay=1]_{ijt} = \alpha + \beta\, TP_{ijt} + \varphi\, OF_{ijt} + \gamma\, Q_{jt} + \theta X_{it} + \delta Z_{ijt} + \varepsilon_{ijt} \quad (2)$$

where all the variables are defined as in Section 5.1. Before turning to the results in Table 5, we calculate the correlation between the probability of time and cost overruns in the sample of winning firms considering that delayed delivery may lead to penalties with potential higher costs. However, we find that the correlation is as low as 0.01.

– Table 5 about here –

In Table 5, the β coefficient on TPs is negative in all columns, thus suggesting that the probability of TPs completing the contract with cost overruns is always lower than firms in a different outsourcing status, but the coefficient is statistically significant only in columns 2 and 5, that is, with respect to firms in a position of mandatory subcontracting and optional firms of medium size. Turning to the probability of cost overruns of other outsourcing forms, we note that large and small optional firms are similar to TPs in their ability to conform to the expected costs, while mandatory firms are the most likely to default (see the results in columns 4 and 6).

When we look at the estimation of the probability of time overruns in Table 6, we find that TPs report mixed results. On the one hand, the β coefficients on the TP dummy are insignificant in columns 1–3, suggesting that the probability to delay the completion of the contract is similar across all organizational forms. On the other hand, breaking up optional firms

by size, TPs appear significantly less likely to incur time overruns than both medium and small fully qualified optional firms (columns 5 and 6). Focusing on large firms, the results also tell us that large optional firms are definitely less likely to deliver late than any other form except TPs. Apparently, large optional firms, which appear less aggressive in the bidding stage according to Table 4, appear more efficient in the execution stage, as they are less likely than other firms to incur a default in either time or cost (see Table 5).

– Table 6 about here –

The result that TPs are significantly less likely to exceed the project's expected cost than firms in the position of mandatory subcontracting (with a similar probability to deliver on time) indicates that voluntary ex-ante agreements among firms lead to a lower probability of default than a forced ex-post subcontracting relationship. This evidence seems to suggest that precommitment by firms in the consortium is affected by a lower risk of hold-up as compared to ex-post subcontracting relationships in the mandatory status. Moreover, with respect to small firms in an optional position to subcontract, TPs do not differ in the lower probability of exceeding costs but are more efficient in timely delivery.

5.3 A focus on vertical and horizontal outsourcing

In this section, we re-estimate the above models after partitioning the dataset into two sub-samples of auctioned contracts, namely one including contracts with only one work category and the other including contracts with more than one work category. This analysis enables us to distinguish horizontal (i.e., one category) from vertical (i.e., more than one category) subcontracting and to evaluate the bidding and performance differences between firms in the pre- and post-award outsourcing status in a homogeneous environment (i.e., in a ceteris paribus

condition). Indeed, if the project includes only one work category, all firms entering the bidding stage must be qualified for that category, and both ex-ante TPs and ex-post optional subcontracting firms will outsource to similarly qualified firms, namely, they will subcontract horizontally. In the case of one work category contracts, TPs are set up only to comply with economic and size-related requirements[22] (not technical ones), and mandatory firms are not present (see the entry qualification rules in Section 3). In this analysis, we therefore compare TPs and optional firms that horizontally outsource.

In contrast, projects with more than one work category imply that partially qualified firms will outsource parts of the contract to firms with different qualifications, thus vertically subcontracting. In this case, partially qualified firms engaging in TPs will comply with such technical requirements ex-ante (i.e., before bidding in the auction) while partially qualified mandatory firms will outsource the work categories for which they are not qualified by vertically subcontracting to other firms ex-post (i.e., after bidding and winning the auction). This approach allows us another ceteris paribus identification of the differences between TPs and both mandatory and optional firms within vertical relationships (more than one work category).

Table 7 reports the estimates of the bidding rebates model, while Tables 8 and 9 present the probit estimates for the probability of cost and time overruns, respectively.

– Table 7 about here –

In Table 7, column 1, we find that the bidding rebates by TPs and optional firms in auctions for projects with only one work category do not significantly differ. This is an important

[22] Notice that for SMEs that wish to bid for one work category contracts, setting up a TP may be the only way to enter the auction procedure and bid to win contracts of large economic value. In other words, by setting up a TP, small firms can reach the economic value required for the qualification included in the awarded contract.

result that states the ability of likely small firms to overcome an economic, size-related constraint by setting up a TP and bidding like fully qualified firms. Even more so, when we disentangle by size, we find that TPs bid more aggressively than large optional firms (column 2) and similarly to small and medium optional firms.

Looking at control variables, we note that the larger the size of the project, as measured by the contract value, meaning reserve price, the lower the rebate, and the longer the contractual execution period, the higher the rebate. Contract value is usually understood in the procurement literature as a proxy for project complexity. In this perspective, the negative relationship between contract size and rebates is consistent since large value contracts will also be more difficult and/or complex to execute. On the other hand, the contractual time to execute the awarded project is usually perceived as a constraint for the firm. Ceteris paribus, the longer the contractual execution time, the higher the firm's flexibility to simultaneously allocate its capacity over different projects and the larger the rebate offered.[23]

When we turn to more complex projects that imply more than one work category, we find that TPs, on average, tend to bid significantly higher rebates than all the other firms. However, looking further, we find that this result is driven by the significantly higher rebates that TPs bid than optional firms (column 7), specifically, large optional firms (column 8). The comparison with firms in a position of mandatory subcontracting reveals that TPs' rebates do not statistically differ.

In Table 8, we test differences in the probability of cost overruns in horizontal and vertical subcontracting. We find that the results for the one work category in column 1 suggest that there are no differences between TPs and optional firms in this type of default, regardless of

[23] For a theoretical and empirical analysis on contracted time to execute procurement contract, flexibility, and option value, see D'Alpaos et al. (2013).

size.[24] In contrast, in contracts with more than one work category, hence in vertical subcontracting, TPs appear to always be less likely to exceed the expected costs. Conversely, results in columns 3–5 suggest that firms in a status of mandatory subcontracting are significantly more likely to incur cost overruns than both TPs and optional firms.

– Table 8 about here –

Finally, we look at time overruns in Table 9. Our results in column 1 show that within projects that imply horizontal subcontracting, TPs tend to deliver significantly later than firms in a status of optional outsourcing, regardless of the size. When we turn to contracts with more than one work category (i.e., vertical outsourcing), the results confirm the previous evidence in Table 6, whereby TPs are similar to both mandatory firms and large optional firms in probability of delivering late and less likely than small and medium-sized optional firms to exceed the expected project's duration. Finally, large optional firms appear to be the most efficient in terms of timely delivery, significantly outperforming both small and medium fully qualified optional and mandatory firms.

– Table 9 about here –

Overall, if we combine the evidence for cost and time overruns to evaluate the differences between TPs and firms in a status of mandatory outsourcing (i.e., ex-ante and ex-post subcontracting within vertical relationships), we note that TPs appear to comply with the contractual terms better than firms that have to mandatorily outsource ex-post. The latter, indeed,

[24] Due to multicollinearity problems in the probabilistic model, the only way to estimate this specification was to leave the dummy for TPs as the default and estimate the differences with firms in the optional regime separated by size.

appear to do worse in terms of cost overruns and no better in terms of timely execution. Finally, large optional firms appear quicker to execute the contracted works, but their costs also rise faster.

6. Conclusion

We empirically investigate an Italian dataset on public procurement auctions with the aim of identifying the effects of different types of outsourcing implemented by firms to comply with the auction entry qualification systems. Such a system allows contracting authorities to award public contracts through tenders in which the contractor has to be qualified for a precise description of work category(ies) that is advertised therein. Thus, if firms are fully qualified for such advertised work category(ies), they can enter the auctions and bid individually; if firms are partially qualified they can choose to either i) bid and opt for post-award subcontracting or ii) set up pre-award outsourcing in the form of TPs with other firms and bid accordingly.

We empirically find that TPs offer lower prices than those offered by firms that ex-post proceed with mandatory or optional subcontracting. When we run a comparison after disentangling fully qualified firms by size, we find that TPs bid significantly higher rebates than large optional firms, but on a similar level to small and medium-sized firms. This suggests that i) firm size does matter in the expected cost of the procurement supply chain and ii) TPs can derive positive efficiency effects from their discretion in deciding ex-ante on their size and boundaries for each auctioned contract.

Taking contract performance into consideration, we found that TPs execute contracts i) with a lower probability of cost overruns than firms in a position of mandatory subcontracting and ii) with a similar or lower probability of time overruns than firms in another subcontracting status.

When we disentangle the dataset by contract complexity to focus on horizontal and vertical relationships, the main results hold. Moreover, we also find that TPs have the lowest probability to exceed the expected costs within vertical subcontracting (contracts with more than one work category), and the lowest probability to overrun delivery time within horizontal outsourcing contracts.

Our empirical evidence highlights that TPs, being free to choose their boundaries for each awarded contract, enter the auction with an efficient economic and technical size and perform with a lower (or similar) probability of cost and time overruns as firms in a post-award outsourcing status. This evidence suggests that regulations for efficient and effective SME entry into public procurement auctions should provide incentives to encourage firms to coordinate in pre-award outsourcing, namely, TPs.

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TABLES

Box 1: Firm qualification status and timing of outsourcing

		Firm qualification status (for each awarded contract)	
Firm timing of outsourcing		Fully qualified	Partially qualified
	Ex-ante bidding in the auction	Ready to bid and perform the contract	TPs
	Ex-post bidding in the auction	Optional subcontracting	Mandatory subcontracting

Table 1 – Summary statistics: Full sample

	No. obs.	Mean	*Std. dev*	Min	Max
Rebates (%)	13331	17.210	*4.831*	0.00	43.00
Winning rebates (%)	13331	17.996	*4.360*	3.62	32.25
TP dummy	13331	0.133	*0.340*	0	1
Optional outsourcing dummy	13331	0.738	*0.440*	0	1
Mandatory outsourcing dummy	13331	0.129	*0.440*	0	1
Reserve price (euros)	13331	1,182,926	*833891*	155,526	5,267,860
Expected duration (days)	13331	322.575	*155.176*	79	1440
Distance (km)	13331	310.398	*398.783*	30	1762
No. of participants	13331	74.848	*31.842*	3	155
ABA	13331	0.831	*0.375*	0	1
ABA with lottery	13331	0.169	*0.375*	0	1
Firm size dummy: Large	13331	0.254	*0.435*	0	1
Firm size dummy: Medium	13331	0.610	*0.488*	0	1
Firm size dummy: Small	13331	0.136	*0.343*	0	1
One work category contract dummy	13331	0.559	*0.497*	0	1
Prob. of cost overrun (winners)	227	0.850	*0.358*	0	1
Prob. of time overrun (winners)	234	0.919	*0.274*	0	1

Table 2 – Summary statistics by outsourcing status (sub-samples) and size

	TPs			Optional			Mandatory		
	No. obs.	Mean	*Std. dev.*	No. obs.	Mean	*Std. dev.*	No. obs.	Mean	*Std. dev.*
Rebates	1777	17.396	*4.708*	9839	17.339	*4.847*	1715	16.272	*4.759*
Winning reb.	1777	18.139	*4.390*	9839	18.164	*4.838*	1715	16.889	*4.006*
Reserve price	1777	1,663,345	*993998*	9839	1,104,538	*764945.3*	1715	1,134,852	*865321*
Exp. duration	1777	377.454	*175.068*	9839	312.019	*143.152*	1715	326.266	*184.702*
Pr. cost over.	38	0.842	*0.370*	157	0.828	*0.379*	32	0.969	*0.177*
Pr. time over.	41	0.976	*0.156*	161	0.907	*0.292*	32	0.906	*0.296*
	Small-sized optional			Medium-sized optional			Large-sized optional		
	No. obs.	Mean	*Std. dev.*	No. obs.	Mean	*Std. dev.*	No. obs.	Mean	*Std. dev.*
Rebates	1193	17.051	*4.493*	6011	17.617	*4.833*	2635	16.836	*4.986*
Winning reb.	1193	17.763	*3.965*	6011	18.315	*4.448*	2635	18.000	*4.410*
Reserve price	1193	885,956	*612177*	6011	1,021,262	*694929*	2635	1,141,587	*726060*
Distance (km)	1193	288.223	*130.81*	6011	304.347	*139.862*	2635	340.296	*151.565*
Pr. cost over.	26	0.846	*0.368*	95	0.916	*0.279*	40	0.925	*0.267*
Pr. time over.	26	0.731	*0.452*	92	0.848	*0.361*	39	0.846	*0.366*

Table 3 – Mean differences by outsourcing status and firm size

	TPS	Mean difference	Other outsourcing forms
Panel A: *Mean rebates*			
TPs	17.396		
Mandatory		> ***	16.272
Optional		~	17.339
Large-sized optional (excl. TPs)		>***	16.836
Medium-sized optional (excl. TPs)		<*	17.617
Small-sized optional (excl. TPs)		>**	17.051
Panel B: *Mean probability of winning outcomes*			
TPs	0.0231		
Mandatory		~	0.0186
Optional		> **	0.0164
Large-sized optional (TPs excl.)		> *	0.0151
Medium-sized optional (TPs excl.)		> **	0.0158
Small-sized optional (TPs excl.)		~	0.0218

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 – TPs vs. other outsourcing forms: Analysis of bidding rebates (full sample)

	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional
	1	2	3	4	5	6
TP	0.440**	0.497**	0.429**	0.453***	0.280	-0.288
	(0.176)	(0.198)	(0.176)	(0.175)	(0.311)	(0.403)
Mandatory subcontracting			-0.069	0.180	0.006	-0.561**
			(0.103)	(0.234)	(0.124)	(0.274)
Optional subcontracting		0.069				
		(0.103)				
Small-size optional				0.740**	0.567*	
				(0.367)	(0.309)	
Medium-size optional				0.173		-0.567*
				(0.259)		(0.309)
Large-size optional					-0.173	-0.740**
					(0.259)	(0.367)
Log (1+backlog)	-0.058	-0.060	-0.060	-0.059	-0.059	-0.059
	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)
Log (distance)	0.005	0.006	0.006	0.004	0.004	0.004
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
Log (reserve price)	0.119*	0.119*	0.119*	0.114*	0.114*	0.114*
	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)
Log (no. of participants)	1.227***	1.230***	1.230***	1.236***	1.236***	1.236***
	(0.137)	(0.137)	(0.137)	(0.137)	(0.137)	(0.137)
Log (expected duration)	-0.098	-0.100	-0.100	-0.096	-0.096	-0.096
	(0.083)	(0.084)	(0.084)	(0.084)	(0.084)	(0.084)
Winning firm dummy	0.722***	0.720***	0.720***	0.720***	0.720***	0.720***
	(0.167)	(0.167)	(0.167)	(0.167)	(0.167)	(0.167)
One work category contract	0.275***	0.256***	0.256***	0.251***	0.251***	0.251***
	(0.059)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)
Constant	4.042**	4.005**	4.073**	3.971*	4.145**	4.712**
	(2.023)	(2.022)	(2.029)	(2.043)	(1.995)	(2.010)
Dummies						
Firm size	Yes	Yes	Yes	Yes	Yes	Yes
Categories of work	Yes	Yes	Yes	Yes	Yes	Yes
Type of auction	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.521	0.521	0.521	0.521	0.521	0.521
No. of observations	13331	13331	13331	13331	13331	13331

Notes. OLS estimates on the full sample of firms participating in auctions. The dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 5 – TPs vs. other outsourcing forms: Probability of cost overrun in contract execution (winning firms)

	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional
	1	2	3	4	5	6
TP	-0.589	-1.501**	-0.424	-0.360	-4.378***	-0.111
	(0.452)	(0.646)	(0.465)	(0.471)	(0.714)	(0.640)
Mandatory subcontracting			1.077**	4.731***	0.713	4.980***
			(0.525)	(0.434)	(0.574)	(0.400)
Optional subcontracting		-1.077**				
		(0.525)				
Small-size optional				-0.249	-4.267***	
				(0.574)	(0.652)	
Medium-size optional				4.018***		4.267***
				(0.668)		(0.652)
Large-size optional					-4.018***	0.249
					(0.665)	(0.572)
Log (1+backlog)	-0.088	-0.088	-0.085	-0.085	-0.069	-0.069
	(0.164)	(0.164)	(0.167)	(0.167)	(0.169)	(0.169)
Log (distance)	-0.128	-0.128	-0.113	-0.113	-0.104	-0.104
	(0.084)	(0.084)	(0.083)	(0.083)	(0.083)	(0.083)
Log (reserve price)	0.330	0.330	0.372*	0.372*	0.377*	0.377*
	(0.223)	(0.223)	(0.214)	(0.214)	(0.214)	(0.214)
Log (no. of participants)	-0.332**	-0.332**	-0.375**	-0.375**	-0.368**	-0.368**
	(0.163)	(0.163)	(0.164)	(0.164)	(0.168)	(0.168)
Log (expected duration)	0.307	0.307	0.291	0.291	0.284	0.284
	(0.304)	(0.304)	(0.297)	(0.297)	(0.299)	(0.299)
One work category contract	0.018	0.018	0.270	0.270	0.278	0.278
	(0.222)	(0.222)	(0.243)	(0.243)	(0.245)	(0.245)
Dummies						
Firm size	Yes	Yes	Yes	Yes	Yes	Yes
Type of auction	Yes	Yes	Yes	Yes	Yes	Yes
Wald $\chi 2$ (p-value)	0.184	0.178	0.178	0.000	0.000	0.000
Pseudo R-squared	0.068	0.100	0.100	0.109	0.109	0.109
No. of observations	227	227	227	227	227	227

Notes. Probit analysis on the sub-sample of winning firms. The dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 6 – TPs vs. other outsourcing forms: Probability of time overrun in contract execution (winning firms)

	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional
	1	2	3	4	5	6
TP	0.890	0.662	0.934	1.001	-2.928***	-2.626**
	(0.604)	(0.646)	(0.620)	(0.628)	(0.758)	(1.030)
Mandatory subcontracting			0.272	4.008***	0.078	0.381
			(0.379)	(0.385)	(0.463)	(0.679)
Optional subcontracting		-0.272				
		(0.379)				
Small-size optional				3.627***	-0.303	
				(0.761)	(0.803)	
Medium-size optional				3.930***		0.303
				(0.572)		(0.803)
Large-size optional					-3.930***	-3.627***
					(0.572)	(0.761)
Log (1+backlog)	0.149	0.140	0.140	0.145	0.145	0.145
	(0.201)	(0.197)	(0.197)	(0.199)	(0.199)	(0.199)
Log (distance)	-0.061	-0.055	-0.055	-0.050	-0.050	-0.050
	(0.104)	(0.104)	(0.104)	(0.106)	(0.106)	(0.106)
Log (reserve price)	0.463	0.471	0.471	0.457	0.457	0.457
	(0.301)	(0.293)	(0.293)	(0.288)	(0.288)	(0.288)
Log (no. of participants)	-0.422	-0.431	-0.431	-0.434	-0.434	-0.434
	(0.271)	(0.266)	(0.266)	(0.271)	(0.271)	(0.271)
Log (expected duration)	-0.539	-0.531	-0.531	-0.506	-0.506	-0.506
	(0.418)	(0.410)	(0.410)	(0.416)	(0.416)	(0.416)
One work category contract	0.363	0.455	0.455	0.460	0.460	0.460
	(0.258)	(0.279)	(0.279)	(0.281)	(0.281)	(0.281)
Dummies						
Firm size	Yes	Yes	Yes	Yes	Yes	Yes
Type of auction	Yes	Yes	Yes	Yes	Yes	Yes
Wald $\chi 2$ (p-value)	0.004	0.006	0.006	0.000	0.000	0.000
Pseudo R-squared	0.128	0.132	0.132	0.138	0.138	0.138
No. of observations	234	234	234	234	234	234

Notes. Probit analysis on the sub-sample of winning firms. The dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 7 – TPs vs. other outsourcing forms: Bidding rebates by number of work categories in the contract

	Sample of contracts with one work category				Sample of contracts with more than one work category					
	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional
	1	2	3	4	5	6	7	8	9	10
TP	0.052	0.544**	-0.026	0.049	0.323*	0.157	0.403**	0.420**	-0.019	-0.124
	(0.176)	(0.234)	(0.176)	(0.232)	(0.198)	(0.212)	(0.196)	(0.193)	(0.133)	(0.168)
Mandatory							0.247**	0.600***	0.161	0.055
							(0.096)	(0.159)	(0.105)	(0.148)
Optional						-0.247**				
						(0.096)				
Small-size optional		0.494**	-0.076					0.544***	0.105	
		(0.230)	(0.174)					(0.193)	(0.143)	
Medium-size optional		0.570***		0.076				0.439***		-0.105
		(0.160)		(0.174)				(0.160)		(0.143)
Large-size optional			-0.570***	-0.494**					-0.439***	-0.544***
			(0.160)	(0.230)					(0.160)	(0.193)
Log (1+backlog)	-0.130*	-0.027	-0.027	-0.027	-0.078	-0.061	-0.061	-0.064	-0.064	-0.064
	(0.069)	(0.073)	(0.073)	(0.073)	(0.076)	(0.076)	(0.076)	(0.073)	(0.073)	(0.073)
Log (distance)	-0.034	-0.009	-0.009	-0.009	0.039	0.034	0.034	0.036	0.036	0.036
	(0.033)	(0.033)	(0.033)	(0.033)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Log (reserve price)	-0.515***	-0.468***	-0.468***	-0.468***	0.296***	0.286***	0.286***	0.278***	0.278***	0.278***
	(0.085)	(0.087)	(0.087)	(0.087)	(0.091)	(0.091)	(0.091)	(0.093)	(0.093)	(0.093)
Log (participants)	1.549***	1.560***	1.560***	1.560***	1.731***	1.729***	1.729***	1.728***	1.728***	1.728***
	(0.236)	(0.234)	(0.234)	(0.234)	(0.146)	(0.145)	(0.145)	(0.146)	(0.146)	(0.146)
Log (exp. dur.)	0.299**	0.287**	0.287**	0.287**	-0.429***	-0.407***	-0.407***	-0.403***	-0.403***	-0.403***
	(0.118)	(0.117)	(0.117)	(0.117)	(0.118)	(0.119)	(0.119)	(0.119)	(0.119)	(0.119)
Winning firm	0.661**	0.660**	0.660**	0.660**	0.825***	0.833***	0.833***	0.832***	0.832***	0.832***
	(0.272)	(0.271)	(0.271)	(0.271)	(0.204)	(0.205)	(0.205)	(0.206)	(0.206)	(0.206)
Dummies										
Firm size	No	No	No	No	Yes	Yes	Yes	No	No	No
Type of auction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Category of work	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Observations	7,450	7,450	7,450	7,450	5,881	5,881	5,881	5,881	5,881	5,881
R-squared	0.500	0.500	0.500	0.500	0.573	0.574	0.574	0.573	0.573	0.573

Notes. OLS estimates. The dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 8 – TPs vs. other outsourcing forms: Probability of cost overrun by number of work categories in the contract (winning firms)

	Contracts with one work category	Contracts with more than one work category			
	Optional vs. TPs	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional
	1	2	3	4	5
TP	-	-5.509***	-7.341***	-6.138***	-5.643***
	-	(1.035)	(1.427)	(1.424)	(1.299)
Mandatory subcontracting	-			1.204**	-4.036***
	-			(0.552)	(1.139)
Optional subcontracting	-		-1.204**		
	-		(0.552)		
Small-sized optional	0.005				-6.091***
	(0.653)				(1.149)
Medium-sized optional	-0.534				-5.105***
	(0.772)				(1.015)
Large-sized optional	-0.195				
	(0.716)				
Log (1+backlog)	-0.066	-0.161	-0.287	-0.287	-0.257
	(0.239)	(0.335)	(0.338)	(0.338)	(0.329)
Log (distance)	-0.115	-0.167	-0.144	-0.144	-0.135
	(0.122)	(0.133)	(0.128)	(0.128)	(0.128)
Log (reserve price)	0.473	0.202	0.295	0.295	0.380
	(0.320)	(0.308)	(0.295)	(0.295)	(0.303)
Log (no. of participants)	-0.286	-0.392**	-0.421**	-0.421**	-0.400**
	(0.328)	(0.186)	(0.188)	(0.188)	(0.189)
Log (expected duration)	0.365	0.328	0.182	0.182	0.046
	(0.423)	(0.428)	(0.394)	(0.394)	(0.419)
Dummies					
Firm size	No	Yes	Yes	Yes	No
Type of auction	Yes	Yes	Yes	Yes	Yes
Wald $\chi 2$ (p-value)	0.462	0.000	0.000	0.000	0.000
Pseudo R-squared	0.108	0.136	0.203	0.203	0.203
No. of observations	108	119	119	119	119

Notes. Probit analysis on the sub-sample of winning firms. The dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 9 – TPs vs. other outsourcing forms: Probability of time overrun by number of work categories in the contract (winning firms)

	Contracts with one work category	Contracts with more than one work category					
	Optional vs. TPs	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional
	1	2	3	4	5	6	7
TP	-	0.840	0.706	0.856	0.959	-3.007***	-2.972**
	-	(0.818)	(0.824)	(0.828)	(0.832)	(0.761)	(1.216)
Mandatory subcontracting	-			0.150	4.035***	0.069	0.105
	-			(0.386)	(0.519)	(0.495)	(0.885)
Optional subcontracting	-		-0.150				
	-		(0.386)				
Small-sized optional	-4.315***				3.931***	-0.036	
	(0.404)				(1.027)	(1.047)	
Medium-sized optional	-3.860***				3.966***		0.036
	(0.415)				(0.713)		(1.047)
Large-sized optional	-4.225***					-3.966***	-3.931***
	(0.648)					(0.713)	(1.027)
Log (1+backlog)	-0.066	0.434	0.418	0.418	0.410	0.410	0.410
	(0.285)	(0.317)	(0.303)	(0.303)	(0.292)	(0.292)	(0.292)
Log (distance)	0.032	-0.083	-0.079	-0.079	-0.081	-0.081	-0.081
	(0.147)	(0.136)	(0.135)	(0.135)	(0.138)	(0.138)	(0.138)
Log (reserve price)	1.071**	0.107	0.116	0.116	0.102	0.102	0.102
	(0.455)	(0.360)	(0.347)	(0.347)	(0.352)	(0.352)	(0.352)
Log (no. of participants)	-0.919*	-0.356	-0.358	-0.358	-0.385	-0.385	-0.385
	(0.493)	(0.272)	(0.267)	(0.267)	(0.269)	(0.269)	(0.269)
Log (expected duration)	-0.268	-0.692	-0.689	-0.689	-0.659	-0.659	-0.659
	(0.680)	(0.565)	(0.557)	(0.557)	(0.577)	(0.577)	(0.577)
Dummies							
Firm size	No	Yes	Yes	Yes	No	No	No
Type of auction	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald $\chi 2$ (p-value)	0.000	0.011	0.016	0.016	0.000	0.000	0.000
Pseudo R-squared	0.249	0.158	0.159	0.159	0.165	0.165	0.165
No. of observations	111	123	123	123	123	123	123

Notes. Probit analysis on the sub-sample of winning firms. The dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Appendix Table A1 – TPs vs. other outsourcing forms: Analysis of bidding rebates (With auction fixed effects)

	TPs vs. all	TPs vs. mandatory	TPs vs. optional	TPs vs. large optional	TPs vs. medium optional	TPs vs. small optional
	(1)	(2)	(3)	(4)	(6)	(7)
TP	0.281***	0.249*	0.287***	0.320***	0.002	-0.281
	(0.104)	(0.131)	(0.105)	(0.106)	(0.207)	(0.255)
Mandatory subcontracting			0.038	0.346*	0.028	-0.256
			(0.093)	(0.190)	(0.105)	(0.176)
Optional subcontracting		-0.038				
		(0.093)				
Small-size optional				0.601**	0.283	
				(0.245)	(0.192)	
Medium-size optional				0.318		-0.283
				(0.196)		(0.192)
Large-size optional					-0.318	-0.601**
					(0.196)	(0.245)
Log (1+backlog)	-0.009	-0.008	-0.008	-0.006	-0.006	-0.006
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
Log (distance)	0.007	0.007	0.007	0.006	0.006	0.006
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Log (reserve price)	1.483***	1.484***	1.484***	1.491***	1.491***	1.491***
	(0.515)	(0.514)	(0.514)	(0.513)	(0.513)	(0.513)
Log (no. of participants)	-0.321	-0.324	-0.324	-0.281	-0.281	-0.281
	(0.506)	(0.507)	(0.507)	(0.505)	(0.505)	(0.505)
Log (expected duration)	-2.008**	-2.010**	-2.010**	-2.064**	-2.064**	-2.064**
	(0.885)	(0.885)	(0.885)	(0.884)	(0.884)	(0.884)
Winning firm dummy	0.922***	0.923***	0.923***	0.923***	0.923***	0.923***
	(0.070)	(0.070)	(0.070)	(0.070)	(0.070)	(0.070)
One work category contract	1.074	1.086	1.086	1.074	1.074	1.074
	(0.677)	(0.678)	(0.678)	(0.676)	(0.676)	(0.676)
Constant	8.404**	8.443**	8.405**	8.305**	8.623**	8.906**
	(4.026)	(4.024)	(4.024)	(4.024)	(4.018)	(4.022)
Dummies						
Auction dummies	Yes	Yes	Yes	Yes	Yes	Yes
Firm size	Yes	Yes	Yes	Yes	Yes	Yes
Categories of work	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.704	0.704	0.704	0.704	0.704	0.704
Observations	13,331	13,331	13,331	13,331	13,331	13,331

Notes. OLS estimates with auction fixed effects on the full sample of firms participating in auctions. Dependent variable is the bidding rebate. Robust standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$