# Firms' Qualifications and Subcontracting in Public Procurement: an Empirical Investigation[*]

Luigi Moretti

UNIVERSITY OF PADOVA

Paola Valbonesi

UNIVERSITY OF PADOVA

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## Abstract

Using a newly assembled dataset, we empirically investigate the effects of subcontracting on procurement auction prices in Italy. In this setting, the pre-qualifications required for firms aiming to bid on public contracts determine firms' different subcontracting formats. We find that fully qualified firms in a position to choose whether to subcontract generally offer lower prices than partially qualified firms, which must proceed with mandatory subcontracts. This result indicates that, in the public procurement supply-chain, firms' voluntary arrangements tend to improve, while imposed arrangements tend to worsen, market performance.

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Keywords: subcontracting, public procurement, regulation on entry (pre-qualification), supply chain strategy.

# 1 Introduction

Subcontracting usually involves "a reallocation of production requirements among firms" (Kamien and Li, 1990, p.1354), a process that is part of a firm's strategic production planning. Many theoretical contributions have addressed the determinants of subcontracting *vs* vertical integration and, more generally, of firms' boundaries based on transaction costs (Williamson, 1985), property rights (Grossman and Hart, 1986) and the knowledge-based view of the firm (Kogut and Zander, 1992 and 1996). Empirical research has provided several case studies that have documented how and when firms adopt subcontracting to efficiently organize production in different economic sectors.[1]

These theoretical and empirical contributions are all based on the firm's *voluntary* choice of internal/external sourcing. In public procurement, however, firms are often constrained by many rules that limit their decision making. What decisions should firms be allowed to make in production planning to execute a public contract efficiently? The answer to this question should impinge on policy makers' design of public procurement procedures: indeed, rigid rules might limit/constrain firms' decisions regarding the supply chain and thus affect the efficiency of procurement transactions and overall social welfare.

Typically, the regulatory burden related to the decision to subcontract in the execution of public contracts can be explained by two main factors. First, public resources conveyed through these procurement contracts are often specifically intended to be affirmative action to indirectly enhance the participation of disadvantaged business enterprises (DBEs) through subcontracting schemes. Second, highly regulated procedures are set to address the governance of quality in procurement transactions, to prevent favoritism, collusion, corruption and/or poor-performance.

Concerning the first factor, empirical evidence of the effect of rules requiring the par-

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[1]A seminal empirical survey on firms' vertical arrangements *vs.* spot market transaction and long term contracts in different sectors has been proposed by Joskow (1988); more recently, Lafontaine and Slade (2007) have provided a thoughtful empirical survey on backward and forward vertical integration. Several case studies specifically investigate outsourcing in different sectors; see, among others, Novak and Stern (2008) and Macher (2006) on the automobile and semiconductor industries, respectively. Finally, for a discussion on core competencies and activities that are better performed externally, see Quinn and Hilmer (1994).

ticipation of DBEs as subcontractors on procurement costs is by no means conclusive.[2] Marion (2009), exploiting a modification of the law that eliminated such a preferential treatment policy, finds that the average price of procured items fell by 5.6% in California Department of Transportation contracts after this affirmative action was abandoned. De Silva et al. (2012), empirically investigating the effect of a subcontracting goal program in Texas, compare projects in which prime contractors were obliged to outsource a portion of contracts to DBEs and projects in which they were not and find little differences between the projects in the level of submitted bids.[3]

Concerning the second factor, relevant examples are provided by frameworks for supplier qualification screening, which typically aims to verify that the supplier is indeed able to comply with all the contract specifications with a reasonable degree of certainty. These procedures determine firms' entry into the public procurement market and, according to the adopted rules, can directly affect suppliers' make-or-subcontract choice in performing a contract. Although supplier qualification screening, which often involves the verification of a firm's financial status, references, and product and surge capacity is commonly used in many countries, it is surprising that so little has been written about the effects of such qualification screening on procurement costs.[4] To the best of our knowledge, no empirical work has investigated how rules regarding firm qualification screening affect the effectiveness of subcontracting in public contracts, in terms of both contract price and performance quality.[5] This dearth of research is surprising considering that public procurement accounts for approximately 15% of the GDP in developed countries. Thus, given the size of the market, it is necessary to have a clear understanding of which rules are best

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[2]DBE programs are also implemented as bid preference schemes or set-aside auctions for such business (Marion, 2007; Krasnokutskaya and Seim, 2011; Athey et al., 2013).

[3]As suggested by De Silva et al. (2012), these contrasting results can be driven by the very different environments the two studies focused on.

[4]Experimental and theoretical studies comparing costly ex-ante or ex-post qualification screening in procurement have been recently provided by Wan et al., (2012) and Wan and Beil (2009).

[5]Conversely, a conspicuous number of empirical contributions have investigated which auction format should be addressed by procurement regulation to promote lower awarding prices and better contractual performances. See, among others, Bajari et al. (2009), Decarolis (2013), Bucciol et al. (2013), Lewis and Bajari (2011), Olivares et al. (2012).

to foster contractors' ability to make efficient supply-chain decisions.[6]

This paper aims to help fill this research gap. We empirically investigate the Italian regulation concerning qualification screening for public works, a regulation determining two different positions regarding firms' make-or-subcontract decisions. Similar to regulations in other national procurement settings,[7] this Italian regulation on public works requires i) that suppliers undergo a preliminary qualification screening before they enter the public contract market, and ii) that every task in public contracts be completed by qualified suppliers. Specifically, these requirements affect a firm's make-or-subcontract decision in the following two ways:

- *If the firm is not qualified to complete all the tasks involved in a given contract*, its production strategy has to take into account a "mandatory subcontracting" agreement with another firm that is qualified to do so.

- *If the firm is fully qualified for all the tasks involved in a given contract*, its production strategy may, or may not, involve subcontracting for part of the work to a similarly qualified firm; in this case, the firm holds an "optional subcontracting" position.

Thus, qualified firms bid for each tendered public contract, knowing in advance whether they are in a position to opt for subcontracting or whether they are required to do so once they win the contract. Our aim is to test whether these subcontracting positions are likely to affect a firm's bid and thus to determine different procurement costs. We also control for the effects of optional and mandatory subcontracting on ex-post contract performance, i.e. the probability of time and cost overrun.

**The data.** We have assembled an original database containing information on Italian public procurement contracts awarded by means of open tenders and on the characteristics

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[6]The recent "Green Paper on the modernization of EU public procurement policy" (2011) indicates that subcontracting is a relevant tool to encourage the participation of small and medium enterprises (SMEs) in public procurement contracts, whereby SMEs are considered to be of crucial importance for stimulating job creation, economic growth and innovation. However, no recommendations for best practices are provided.

[7]Qualifications are needed to enter the market for public contracts in many EU countries, the USA and Japan; however, the design of these systems and the criteria adopted differ somewhat. For a few detailed examples, see the OECD (2007).

of the bidding firms. Specifically, for each tendered contract, we have collected information regarding the tasks to be completed (i.e., the "categories of work" corresponding to the qualifications required), the identity of the bidding firm and the qualifications of the bidding firm. Thus, by matching the qualifications that are required to execute a contract with each bidder's qualifications, we are able to identify the bids that are offered by partially-qualified firms (i.e., firms that will have to engage in mandatory subcontracting if they win the auction) and those that are offered by fully-qualified firms (i.e., firms that may choose to complete the works by themselves or to subcontract a part of them).

**Our results.** Adopting a reduced form approach and checking for auction-/contract-related characteristics and firms' characteristics and fixed effects, we have found that bidding firms in a position to choose whether to subcontract part of the work (i.e., optional subcontracting) offer lower prices than those obliged to subcontract part of the work (i.e., mandatory subcontracting). This effect is still significant when we focus on the sub-sample of bids that are offered by winning firms that *actually* did engage in subcontracting.

These findings indicate that the production efficiency deriving from subcontracting is higher when, for the firm concerned, it is an option and not an obligation to perform activities externally.[8] In other words, mandatory subcontracting, an induced practice arising from regulation that restricts a firm's supply-chain, tends to increase procurement performance costs. We find that these results are explained by the interplay of the following factors. If a firm can choose to subcontract, it will do so only if subcontracting is profitable. In this case, subcontracting also implies that firms outsource part of the work to "similar and known" firms, and this entails lower search costs as well as a greater information symmetry concerning the execution costs. Moreover, being able to choose whether to outsource some of the work and having greater information symmetry together generate stronger bargaining power in optional than in mandatory subcontracting transactions.

**Related Literature.** This paper provides two main contributions. First, it contributes

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[8]In a competitive stochastic investment game, Van Mieghem (1999) investigates firms' choice of subcontracting as an option value and find that the choice of subcontracting improves firms' financial performance and investment coordination under a high degree of uncertainty.

to the recent empirical literature on subcontracting in public procurement that has investigated which rules and/or factors lead to both cost efficiency and quality in outsourced contract execution. As already discussed, De Silva et al. (2012) and Marion (2009) focus on procurement costs by programs supporting subcontracting in favor of specific groups of firms. Miller (2013) considers the impact of the complexity and incompleteness of construction contracts on subcontracting *vs* in-house arrangements. Gil and Marion (2013) examine the effect of past and future relationships between contractors and subcontractors in enforcing informal agreements and their effects on firms' bid and entry decisions in California highway procurement. Marion (2012) estimates the effect of horizontal subcontracting on bidding strategies in auctions conducted by the California Department of Transportation and, highlights the factors that lead to horizontal subcontracting. As an original contribution to this literature, we add an empirical analysis of procurement performance in a setting in which rules from supplier qualification screening affect firms' subcontracting positions and thus the available alternatives regarding make-or-subcontract decisions.

Second, our paper contributes to the extensive economics literature on firm boundaries, originating from Williamson's (1971) influential work on transaction costs. In this respect, we specifically offer an empirical test for the effect of horizontal and vertical sourcing on firms' bidding for public works contracts.[9] Indeed, in our setting, optional subcontracting corresponds to the "horizontal" subcontracting defined in the Spiegel (1993) as an agreement between rival firms, "each of which is capable of producing and marketing its product independently", and mandatory subcontracting corresponds to a form of unavoidable "vertical" agreement between firms with complementary capabilities/assets with the aim of obtaining an output (Webster et al., 1997). Comparing bids by firms in optional or mandatory subcontracting positions, we find that optional subcontracting promotes productive efficiency. Note that our results are consistent with Lafontaine and Slade's (2008) findings from an empirical survey on vertical restraints. These authors conclude that when

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[9]Theoretical contributions on horizontal subcontracting have been provided by Kamien et al. (1989), Gale et al. (2000) and Spiegel (1993).

manufactures choose to impose vertical restraints, their impact on market performance is positive by implication and that if vertical restraints are prohibited, the impact is negative. Our empirical findings on subcontracting and Lafontaine and Slade's findings on vertical restraint both highlight, on the one hand, that firms' voluntary arrangements tend to improve market performance and, on the other hand, that imposed arrangements, either to prohibit or mandate relationships, tend to worsen market performance.

The third contribution of this paper consists in providing empirical evidence regarding the cost arising from procurement rules that limits the discretion of the agents' (both the supplier and the contracting authority, henceforth CA) in procurement transactions. There is a lively debate about the optimal regulation in public contracts through the use of more rigid or more flexible rules affecting the procurement transactions' outcome. Spagnolo (2012), highlighted that this debate directly refers to the inclusion of reputation forces and arises from two opposite positions: in Europe, regulation has constrained the use of past performance information to select contractors, while in the US, the establishment of databases on the evaluation of companies' past performance in public contracts and the sharing of this information have been encouraged. Specifically referring to frameworks for supplier qualification screening, this paper adds an empirical test on the cost of a planning constraint (i.e., mandatory subcontracting) in the firms' strategy regarding the contract's execution. Future research is needed to assess the cost of flexible and rigid rules in procurement and to appropriately design a balanced mechanism.

**The structure of the paper.** The remainder of this paper is organized as follows. Section 2 describes the institutional features of public procurement auctions and subcontracting in Italy. Section 3 gives detailed information about the datasets on which we have based our investigations. Section 4 presents the econometric model, empirical results and robustness tests considering all the firms' bidding price reductions. Section 5 illustrates the results of our estimations focusing on the rebates offered by the winning bidders, i.e., the firms that won and fulfilled the contracts. Section 6 presents our findings on measures of ex-post performance. Conclusive comments are given in Section 7.

# 2 Regulation on entry in the Italian procurement for public works

In this section, we briefly review the current regulation on the supply and demand sides of the Italian market for public procurement works, focusing on those rules that directly affect firms' subcontracting position.

**The supply side.** According to Italian law on public procurement, firms must pre-qualify to bid in auctions for public work contracts worth more than 150,000 euros.[10] The Italian system for qualifying firms is operated by a third party (i.e., 37 private companies, called Societa' Organismi di Attestazione - SOA) that is accredited and monitored by the authority in charge of regulating the national market for public works, supplies and services ("Autorita' di Vigilanza sui Contratti Pubblici di Servizi, Lavori e Forniture" - AVCP). The firms' qualifications are provided once established "general" and "technical" requirements have been ascertained by one SOA. The general requirements concern the firms' financial standing and criminal records (e.g., anti-Mafia); these are the same for any firm wishing to participate in an auction for the procurement of a public work. The technical requirements have to do with the specific skills that are needed to perform certain work and are usually assessed based on firms' documented expertise and observable items. Specifically, in Italian public works, 46 "categories of work" have been defined over which firms can accordingly obtain qualifications, which, once obtained, remain valid for 3 or 5 years and then must be renewed.

**The demand side.** A large part of the Italian public procurement market consists of contracts that are typically awarded by local CAs (i.e., municipalities, provinces, regions).[11] In awarding a contract, the CA should specify all the tasks (i.e., the categories of work) that are involved in the project and distinguish the *main* category from the *secondary* categories of work included in the project. For example, consider a contract for the building of a road in a new residential area. The fulfilment of this contract contains three tasks:

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[10]See: Italian Law No. 163/2006.

[11]According to the 2013 AVCP Annual Report, approximately 63% of contracts in 2011, with a value of 1,160 million euros were awarded by local governments.

$t_A$ (road works), $t_B$ (water works), and $t_C$ (sewage works). Accordingly, in the calls for tenders, the CA will present the task $t_A$ as the *main* category of work and the remaining two ($t_B$ and $t_C$) as *secondary* categories of work. This distinction is relevant, as participation in tenders is restricted to firms that are qualified for the *main* work category.[12] Alternatively, firms that are not qualified for the *main* work category can participate in the auction as part of temporary consortia (called "Associazioni Temporanee d'Impresa" - ATI): these consortia are created *ad hoc* to bid for a given contract and involve at least one firm that is fully qualified for the main task.[13]

For the *secondary* categories of work involved in a public contract up for tender, the bidding firm may either be qualified or not. If firm is qualified, the firm winning the contract can choose either to complete all the work on its own or to subcontract parts of the work to other similarly qualified suppliers (i.e., firms with similar qualifications, giving rise to optional subcontracting). On the other hand, if a firm is not qualified for one (or more) secondary categories, it can still bid for the contract, but it will have to subcontract the work for which it lacks qualification to qualified firms (i.e., mandatory subcontracting).[14] Considering optional and mandatory subcontracting in terms of firms' integration, the former can be considered a horizontal outsourcing because it occurs between two similarly qualified firms, whereas, the latter corresponds to required vertical outsourcing because it occurs between two firms with complementary capabilities.

**The Auction format.** In Italian procurement for public works, the most widely adopted awarding format is based on an average bid auction (ABA) in which the winner is deter-

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[12]The supplier can also subcontract part of the *main* category of work but cannot subcontract more than 30% category's value. Note that this is a not widely adopted practice and - according to our definition - it corresponds to optional subcontracting, as the bidder should be qualified for the *main* task to enter into the auction.

[13]We can reasonably assume that consortia bidding for tendered contracts are qualified to perform all the categories of work involved in a project, as each consortium is established *ad hoc* for a tendered contract. Note that, in our dataset, bidding behavior is not (statistically) different between consortia and firms in an optional subcontracting position; this evidence holds even when auction and firm characteristics are controlled for.

[14]As a remote alternative, the firm can lease the qualification for a task for which it lacks qualifications from a qualified firm that is not bidding for the contract. This is a rarely used practice because it entails a very expensive agreement (called "avvalimento").

mined as follows. Given the distribution of all bids received for an auction, a first average (A1) is computed by averaging all the bids except those located in the first and last deciles; then, a second average (A2) is computed by averaging all the bids above A1 (again excluding those bids located in the last decile). The winning bid is the one immediately below A2 (see Figure 1 in Appendix B for an illustration).[15]

The essential theoretical prediction of a general ABA format - where all the bids are considered and the one closest to the average wins - is that all bidders have an incentive to submit identical bids, leading to a potential continuum of Nash equilibria in which all the firms submit the same bid at a price that is high enough to ensure profitability for all bidders. Empirical and theoretical research on ABA indicated that prices should be higher than those with a first-price format and that the random selection of a winner could diminish performance(see Albano et al., 2006, and Decarolis 2013). Recent experimental research comparing ABA and first-price auctions indicates that bids in both formats are "strongly influenced by cost signal" and that the "there is no statistically significant difference in bidding behaviour" between the two formats (Chang, et al. 2013, p.13 and p.11, respectively). This experimental evidence on bidding behaviour, coupled with the ABA rule which awards the contract to the - somehow defined - average bid, seems to support the CAs' repeated adoption of ABA to award public works in many countries as a reasonable mechanism to adequately compensate suppliers, and avoid supplier default.

**Summary.** The aim of the Italian system for firms' qualification screening is to restrict participation in auctions to firms that are capable of executing the *main* category of work in a contract with a reasonable degree of certainty (i.e., firms that are qualified to perform such work). For the *secondary* categories of work involved as a tendered project, firms may or may not be fully qualified. In the latter case, firms are obliged to subcontract the work to qualified firms, as all aspects of the project involved must be handled by firms

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[15]In the awarding phase, bidding firms observe a "reserve price" that is computed by the CA using formulas and typically overestimate contractual costs, thus resulting in ineffective binding. Note that if there are fewer than ten bidders the lowest and highest bids are not considered to compute the first average (A1); while if there are fewer less than five bidders, the project is awarded to the firm that has offered the highest rebate. In our sample of 269 auctions, only one auction has fewer than five bidders, and nine have fewer than ten bidders.

that are qualified to do so.

A noteworthy direct consequence of this regulation of the public procurement market is that when a contract is tendered - as the categories for which bidding firms should be qualified are thus announced - the potential position of each bidder concerning any subcontracting is well defined. This means that each firm bidding for the public contract is aware that, if it wins, it may outsource some of the tasks for which it is fully qualified if it wishes, or it will be obliged to subcontract certain tasks for which it is not qualified. Thus, the regulation on bidders' qualifications for public contracts allows firms to assess their own production strategy at the bidding stage: this permits us to observe the two subcontracting formats and, accordingly, the firms' bids. For the sake of our analysis, it is important to bear in mind that, within the framework we have investigated, the same bidder may be in a position to consider optional subcontracting for some auctioned contracts, but be mandated to subcontract for others.

# 3    Data

Different sources of data were used to assemble our original dataset for the purposes of the present analysis. Detailed information on each open tendered public contract has been taken from a hitherto unexploited dataset, consisting of transcripts of competitive auctions conducted from 2000 to 2008 by the Regional Government of Valle d'Aosta.[16] Each transcript contains information on the auction ID, the number of bidders, the bidders' names, and their bids. The auction ID enabled us to access other details of the tendered contracts from a national dataset managed by the AVCP, containing all the contracts with a reserve price higher than 150,000 euros. This dataset includes information on the contract awarding procedure, the reserve price of the contract, and the categories of work involved.

Information on the suppliers' qualifications was extracted from another national AVCP dataset known as the "Casellario SOA", a sort of national register collecting - for each

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[16]Valle d'Aosta is a small mountainous region (3,263 sq. km, 951 MSL) with a population of 129,000 on Italy's north-western borders with France and Switzerland.

firm - the qualification status for each work category.

In summary, for each tendered contract, we have information on the qualifications that are required to complete the tasks involved in the contracts and all the actual qualifications held by each bidding firm. Matching these data enabled us to disentangle the bids of firms in an optional subcontracting position, which would have the choice to subcontract, from the bids of firms obliged to proceed with a mandatory subcontract for part of a project.

## 3.1 Descriptive statistics

Our dataset consists of public contracts that were awarded by the Regional Government of Valle d'Aosta (the CA) by means of open tenders,[17] where firms participate by offering a price consisting of a percentage reduction - a rebate - on the reserve price set by the CA. Once the CA has acquired the bidders' qualifications regarding legal, fiscal, economic, financial and technical requirements, the contract is awarded according to the ABA. In the setting we investigated, this auction format was used for 89.2% of the auctions in our sample. For the other 10.8% of the auctions in the sample, a similar average-price mechanism was combined with a type of lottery for the winning bid.[18]

Our dataset covered 269 auctions for public contracts, for which a total of 13,331 prices were offered by bidders, consisting of 892 firms and 1,777 temporary consortia.[19] The average reserve price was approximately 1.1 million euros (ranging from 156 thousand to 5.3 million euros). In terms of tasks, see Table 1 where further summary statistics are also

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[17]According to EU directives, public procurement in Italy can take place through four types of awarding procedures: open, restricted, negotiated, and competitive dialogue. In our study, we consider only those cases involving open tenders ("pubblico incanto"). Participants in restricted and negotiated tenders are invited by the CA, and including such cases in our analysis might bias our results because the CA could invite firms with particular features and qualifications. We have no data concerning contracts awarded using competitive dialogue procedures.

[18]This format works as follows: Given the threshold A2 computed as above, a random number (R) is extracted from the set of the nine equidistant numbers between the lowest bid above the first decile and the bid just below A2. Averaging R with A2, the winning threshold W is obtained, and the winning bid is the bid immediately above W (see Figure 1 in Appendix B). As shown in Galavotti et al. (2013), the mean rebate is lower in the ABA format combined with a type of lottery than in the other ABA format; however, the bidding behavior is similar in both formats.

[19]Note that the total number of original bids for these 269 auctions was approximately 10% higher. However, for this share of bids, we do not have information on bidders' qualifications, so these bids were not considered in our final sample of 13,331 bids.

included, these contracts refer mainly to road works (37.2%), river and hydraulic works (29.7%), and buildings (14.9%).

**Table 1: Descriptive statistics: characteristics of auctioned contracts**

| Bid-level data | | | | | |
|---|---|---|---|---|---|
| Variable | Obs. | Mean | St.Dev. | Min | Max |
| Bid (Rebate, in %) | 13331 | 17.210 | 4.831 | 0.001 | 43 |
| Reserve price (euros) | 269 | 1103786 | 865298.5 | 155526.3 | 5267860 |
| No. of participants | 269 | 55.450 | 31.845 | 3 | 155 |
| Expected duration (days) | 269 | 311 | 168.179 | 79 | 1440 |
| Average price | 269 | 0.892 | 0.311 | 0 | 1 |
| Average price + lottery | 269 | 0.108 | 0.311 | 0 | 1 |
| Road works | 269 | 0.372 | 0.484 | 0 | 1 |
| River and hydraulic works | 269 | 0.297 | 0.458 | 0 | 1 |
| Building | 269 | 0.149 | 0.356 | 0 | 1 |

See Appendix A for the definitions of the variables.

As shown in Table 2, 73.8% of the bids in our sample were offered by firms that had all the qualifications required and that could thus opt to horizontally subcontract part of the work if they wished, while 12.9% of the bids were offered by firms that were not qualified for some of the secondary categories of work and that would consequently be obliged to subcontract such work to other qualified firms. Finally, approximately 13.3% of the bids were offered by consortia.

We also observe that the firms' subcontracting status often varied depending on the tasks included in a given contract and the firm's qualifications. In our sample, approximately 74.7% of the bids were offered by firms that took part in both auctions in which subcontracting would be optional and auctions in which subcontracting would be mandatory for the firm. Approximately 23.9% of the bids were offered by firms (including consortia) that always had an optional subcontracting status, and approximately 1.4% of bids were by firms that were always committed to adopting the mandatory subcontracting.

The descriptive statistics for our sample give us a clear idea of the local dimensions of the market for public procurement works in Valle d'Aosta (see Table 2). Approximately 35.3% of the participants in the auctions (corresponding to 32.4% of the bids) were firms located

in the region, and 22.6% (27.6% of the bids) came from the larger neighboring Piedmont region. The remaining 42.1% of firms (40.0% of the bids) came from other parts of Italy. The average distance between the bidder's location (i.e., the closest capital city) and the CA location (i.e., the city of Aosta) was approximately 310 kilometers (with a standard deviation of 399 kilometers). In terms of the price offered, local firms (those from Valle d'Aosta) slightly but nonetheless significantly differed from outsiders: the former offered an average discount of 17.0%, which was slightly lower than the mean discount of 17.3% made by the latter. Similarly, the backlog of local firms (i.e., the number of ongoing public procurement projects each firm has at the time of bidding) was lower for local firms (1.1 projects) than for other firms (2.8).[20]

### Table 2: Descriptive statistics: bidders' characteristics

|  | Percentage |
|---|---|
| Local bidders (% of bids) | 32.368 |
| Bidders' size (% of bids): |  |
| small | 11.800 |
| medium | 52.862 |
| large and co-operatives | 22.009 |
| Consortia (% of bids = % of bidders) | 13.330 |
| Subcontracting status (% of bids): |  |
| Mandatory | 12.865 |
| Optional (excluding consortia) | 73.805 |
| Subcontracting status (% of bids): |  |
| Always mandatory firms | 1.403 |
| Sometime optional and sometime mandatory firms | 74.721 |
| Always optional firms (excluding consortia) | 10.547 |

See Appendix A for definitions of the variables.

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[20]The firm backlog is defined as the number of pending projects (also considering also public procurement works tendered in the other Italian regions) the firm has at the date of bidding. The distance is defined as the number of kilometers between the capital city of the supplier's province and the city of Aosta. Because we do not have data on the size of the firms, we use the type of business entity as a proxy. See Appendix A for detailed definitions of the variables.

# 4 Analysis of the bidding offers

## 4.1 Testable hypothesis and model specification

In this section, we consider the bids offered by all the participating firms in the 269 average bid auctions for public procurement contracts. We investigate bids as a *proxy* for the value attributed by the firm to the project, i.e., what the firm expects the completion of the work to cost plus a mark-up. We refer our approach to the recent experimental findings by Chang et al. (2013), who comparing a first-price (i.e., "low bids") with "average bid" methods find that bidding behavior is identical in the two formats and is strongly influenced by cost signals. Accordingly, in this study, we simply assume that the bid is a *proxy* for each firm's expected costs of completing the tendered contract.[21]

Mandatory and optional subcontracting in this procurement setting can be considered a planning constraint and a planning alternative, respectively, in the firms' strategy regarding the contract's execution, with consequently different effects on the expected costs and, therefore, on the firms' bids. Our testable hypothesis is that there may be a significant difference between firms that are obliged to subcontract and those that are in a position to decide whether to complete the contracted work alone or to outsource part of the work.

**Table 3: Correlation: Subcontracting format and bidding rebates**

|            | Average rebate | Average rebate (excluding consortia) |
|------------|----------------|--------------------------------------|
| Optional   | 17.348         | 17.339                               |
| Mandatory  | 16.272         | 16.272                               |
| Difference | 1.076***       | 1.067***                             |

See Appendix A for definitions of the variables.
Inference: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

A simple two-group mean-comparison test (Table 3) shows that the average rebates offered by firms obliged to subcontract are significantly lower (i.e., corresponding to higher prices to be paid by the CA) than those offered by firms with the option to subcontract; the picture does not change after we exclude consortia from the sample.

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[21]Note that Bajari et al. (2011) empirically investigate highway procurement in the state of California and show that adaptation costs are an important determinant of firms' bids in public procurement, accounting for 8-14% of the winning bids.

These results may be due to various factors associated with the characteristics of the firms concerned, e.g. their production capacity, financial position, productivity, location and associated logistic costs, as well as the type of auction, the dimensions of the project, and the categories of work involved. For instance, firms that are qualified for more categories of work might be more likely to be fully qualified because they are larger and/or more efficient. To check for the influence of these factors and to examine the differences in the price offered by bidders in the two subcontracting positions, we estimate the following model specification for bidding rebates:

$$Rebate_{ij} = \alpha + \beta Optional_{ij} + \gamma Q_j + \theta X_i + \lambda Z_{ij} + \epsilon_{ij}. \tag{1}$$

where $Optional$ is a dummy variable with a value of 1 when firm $i$ is fully qualified to handle project $j$'s tasks (i.e., in an optional subcontracting position) and a value of 0 if it is partially qualified (i.e., in a mandatory subcontracting position). $Q_j$ is a set of variables to control for the nature of the project and auction (i.e., proxies for the characteristics of the project, such as the dimension or complexity of the project and the type of work involved; proxies for the characteristics of the auction, such as the format of auction and the level of competitive pressure; and year dummy variables to adjust for temporal shocks that might have affected both the time-related trends of the firm's bidding behavior and the contracts chosen by the CA). $X_i$ represents a set of features of firm characteristics (i.e., proxies for firm size and the distance between the firm location and the CA). $Z_{ij}$ controls for firms' capacity constraints, which is proxied with a measure of firm's backlog when it bids for each project; $\epsilon_{ij}$ is the error component.

To reduce omitted variable problems, in some specifications, we also include firm fixed effects to adjust for firm-specific characteristics (e.g., size, productivity, financial position, and location): this enables us to focus on the within-firm variation in optional or mandatory subcontracting status and to better capture the effect of changes therein. These firm-specific characteristics could also vary over time, so in different specifications of the model, we also include firm-year fixed effects to focus on the within-firm-year variation in the subcontracting positions.

## 4.2   Estimation results

Our primary coefficient of interest is $\beta$, which indicates whether a firm's subcontracting status affects its bidding offer. This coefficient reflects the difference between the rebate offered by firms that can choose to subcontract and that offered by those obliged to subcontract. To address potential heteroscedasticity issues, we use ordinary least squares (OLS) estimates with robust standard errors clustered at the firm level to enable correlations among within-firm observations.

Our results are presented in Table 4, columns 1-3, and show that the coefficient for the *Optional* variable always has a positive sign and is statistically significant. Thus, all else remaining equal, firms that are fully qualified to complete a project - and, thus, that may or may not subcontract part of the work as they wish - offer significantly greater rebates (i.e., corresponding to lower prices) than firms that would be obliged to subcontract part of the work to other qualified firms. In particular, fully qualified firms offer approximately 2-3% larger discounts than partially qualified firms.

These findings show that a bidding firm's production efficiency increases (i.e., via lower production costs) when its subcontracting position is flexible and would enable the firm to subcontract part of the project to similar firms; this is not the case when firms are required to subcontract part of the work to a complementary firm.

We interpret our findings as resulting from the following considerations. If a firm can choose to subcontract, it will do so only if subcontracting is profitable.[22] Optional subcontracting implies that firms outsource a part of the work to "similar and known" firms; thus, optional subcontracting is associated with lower search costs as well as a greater information symmetry concerning the execution costs than any form of required subcontracting to firms with "different and complementary" qualifications. Moreover, being able to choose whether to subcontract part of the work and having greater information symmetry combine to give a firm stronger bargaining power in optional than in mandatory

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[22]Quinn and Hilmer (1994) present an extended discussion on firms' relative risks/costs and benefits from outsourcing in different industrial sectors.

subcontracting.

### Table 4: Estimation results: bidding offers

| Dependent variable: | Bidding Rebate | | |
|---|---|---|---|
| Mean outcome: | 17.210 | 17.151 | 17.530 |
| | OLS | | |
| | 1 | 2 | 3 |
| Optional | 0.224** | 0.316*** | 0.403*** |
| | (0.099) | (0.100) | (0.109) |
| log(Reserve price) | 0.104 | 0.143* | 0.122 |
| | (0.065) | (0.076) | (0.088) |
| log(Expected duration) | -0.097 | -0.093 | -0.235* |
| | (0.084) | (0.094) | (0.128) |
| log(no. Participants) | 1.242*** | 1.340*** | 1.234*** |
| | (0.137) | (0.153) | (0.199) |
| log(1+backlog) | -0.065 | 0.035 | -0.225 |
| | (0.063) | (0.085) | (0.213) |
| log(distance) | 0.007 | | |
| | (0.029) | | |
| Category of work dummy | YES | YES | YES |
| Type of auction dummy | YES | YES | YES |
| Firm size dummy | YES | NO | NO |
| Firm fixed-effects | NO | YES | NO |
| Firm-year fixed-effects | NO | NO | YES |
| Year dummy | YES | YES | NO |
| Observations | 13,331 | 9,961 | 6,280 |
| R-squared | 0.520 | 0.562 | 0.575 |

Note: See Appendix A for definition of variables.
Robust standard errors clustered at firm-level in parentheses.
Inference: *** p<0.01, ** p<0.05, * p<0.1.

These considerations are based on several studies on the effect of parties' information asymmetry and bargaining power on the outsourcing choice. For the effects of information asymmetry, Lewis and Sappington (1991), in a standard procurement model, assume that firms are better able to monitor effort in internal tasks rather than in outsourced tasks. Because the subcontractor may have a lower cost technology, the authors argue that the decision to outsource belongs involves a trade-off between lower production costs

and higher monitoring costs; thus, the supplier opts to use subcontractors when the efficiency gains from lower production costs are greater than the loss of control resulting from the higher monitoring costs of outsourcing. In our setting, monitoring costs are lower for optional subcontracting than for mandatory subcontracting, as work with optional subcontracting is delegated to similarly qualified firms.[23]

For the effects of bargaining power, Grossman and Helpman (2002) investigate how the distribution of bargaining power between the subcontractor and the supplier affects the viability of outsourcing. Their model shows that a generic task - as opposed to a specific one - enhances outside options, which improves the task producer's bargaining power. Similarly, in our setting, a firm that can choose whether to delegate part of the work (i.e., optional subcontracting) is endowed with an outside option that enhances its bargaining power in outsourcing; this outside option is not present in the case of mandatory subcontracting.

Our results are also consistent with the study of Lafontaine and Slade (2008) regarding firm boundaries and the effects of rules. In that setting, the authors find that voluntary arrangements among firms have a positive impact on market performance (i.e., lowering both firm costs and consumer prices), while government-mandated arrangements systematically have a negative impact on market performance.

For other firm characteristics, the model specification in column 1 of Table 4 includes dummy variables for firm size, the distance between firms' location and the CA, and a measure of firms' backlog. The model in column 2 includes dummy variables for firm-related fixed effects, which enables us to control firm characteristics that do not vary over time; moreover, the model in column 3 includes dummy variables for firm-year fixed effects, which aim to capture a firm's characteristics (e.g., its size, financial position and productivity) in any given year. The use of fixed effects in the model also allows us to exclude consortia and firms that - always or never - had all the necessary qualifications

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[23]Riordan and Sappington (1987) provide a two-stage production model in which costs are observable only by the producing party: the information asymmetry between parties and the correlation between first- and second-stage costs determine the principal's optimal choice in the organization of the task production.

from our sample and thus to concentrate on only the bidding firms that were fully qualified for some auctions and partially qualified for others. Concentrating on such firms is important for two reasons: first, to avoid any biases in our estimates that might have stemmed from the inclusion of consortia in our sample (with the corresponding assumptions regarding whether these consortia had all the necessary qualifications); and, second and more importantly to support our inference that the overall results are not influenced by those firms that always or never had all the required qualifications, thus allowing us to exploit the within firm (or within firm-year) variation in subcontracting status.

Our estimates of the other control variables in the model specifications are comparable to the results obtained in previous empirical studies on the awarding of public procurement contracts. It is hardly surprising that rebates are positively influenced by the size of a project and the number of participants, and negatively influenced by the expected duration of the work (the size and duration measures are both calculated by the CAs' engineers and are known to firms before they place their bids).[24]

## 4.3   Robustness checks

A first concern regarding our estimates has to do with the influence of extreme bids. In fact, it may be that outlying bids drive the estimation of the coefficient for our *Optional* variable of interest. We address this concern by using a robust regression approach (IRLS, iteratively reweighted least squares) that iteratively assigns a lower weight to outlying observations. As shown in Table 5, column 1, the estimated coefficient indicates that a firm's optional subcontracting status is positive and statistically significant, thus confirming the previous estimates.

A further concern is related to the likelihood that the estimated difference in offered bids

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[24]In the US, Bajari et al. (2009) show, based on a dataset of contracts awarded in the building construction industry in Northern California from 1995 to 2001 by private authorities, that having more firms competing in an auction reduces bidding prices. Similarly, based on a sample of Italian public procurement auctions, Bucciol et al. (2013) find that a larger number of bidders increases the amount of the winning bidder's rebate. Our results confirm the positive (although weakly significant) relationship of the reserve price on the rebates offered, as also reported by Coviello and Gagliarducci (2010) and Decarolis (2009). Note that, in our estimates, the results for the controls for backlog and distance between the bidder and the CA are not statistically significant.

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between firms in mandatory subcontracting positions and firms in optional subcontracting positions is driven by very different distributions of rebates across auctions. In fact, the number of participants and their bids vary across auctions, resulting in a different distribution of rebates for each auction. Even if we control for several characteristics of the auction in the model specification, we might not fully capture the different distributions of bids for each auction.

The average price mechanism adopted to award the public procurement contracts investigated in this study enables us to identify different areas in the distribution of the bidding firms' rebates. In particular, we distinguish the area around the winning rebate as follows (see Figure 1 in Appendix B): the winning offer in each auction is between the mean rebate (A1) and the rebate corresponding to the 90th percentile of the distribution ("area A"). We focus on this area of the auction-specific distribution of the rebates, and we check whether the previously estimated difference holds. We perform this check because one might suspect that the previous results are driven by the fact that bidders subject to mandatory subcontracting tend to offer particularly small rebates, i.e., those on the left-hand side of the distribution. If this were true, subcontracting status might not be the only difference between the two types of bidders; there might be other differences related to their productivity and technology. Moreover, firms bidding in a mandatory subcontracting position would not be competitive enough to win the auction, and they might take part in auctions for collusive purposes, i.e., to favor a given bidder (or group of bidders).

Therefore, we concentrate our analysis on "area A". Then, after ensuring that the subcontracting position is not a significant determinant of the bidders' likelihood of offering a bid in "area A" of each auction distribution,[25] we nonetheless find that the difference in the rebates offered between firms in the two different subcontracting positions persist and are statistically significant (Table 5, column 2).

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[25]Note that firms in both optional and mandatory subcontracting positions do not have a different and statistically significant probability of bidding in "area A". Furthermore, in terms of distance from the winning bid, firms in both optional and mandatory subcontracting positions offer, on average, rebates lower than the winning rebate (-0.812 and -0.617 percentage points, respectively).

**Table 5: Robustness checks: bidding offers**

| Dependent variable: | Bidding Rebate | |
|---|---|---|
| Mean outcome: | 17.210 | 18.210 |
| | Robust reg. | OLS |
| Sample: | All bids | Bids [mean, 90th perc.] |
| | 1 | 2 |
| Optional | 0.149*** | 0.418*** |
| | (0.043) | (0.096) |
| Res.price; Exp.dur.; No.part.; Backlog | YES | YES |
| Category of work dummy | YES | YES |
| Type of auction dummy | YES | YES |
| Firm size; Distance | YES | NO |
| Firm fixed effects | NO | YES |
| Year dummy | YES | YES |
| Observations | 13,331 | 3,597 |
| R-squared | 0.874 | 0.751 |

Note: See Appendix A for the definitions of the variables.

Standard errors in parentheses. In column 2, robust standard errors are clustered at the firm-level.

Inference: *** p<0.01, ** p<0.05, * p<0.1.

# 5    Analysis of the winning offers

This section analyzes whether the more aggressive bids offered by firms that can choose whether to subcontract result from the expected potential advantage of outsourcing or the reluctance of such firms to use subcontractors. To ascertain whether firms' optional subcontracting status is associated with lower prices, we examine which winning firms that could opt for outsourcing *actually* used subcontractors to complete part of a project. With this aim, we now consider two samples: one consists of 220 winning bids drawn from the sample of auctions held by the Regional Government of Valle d'Aosta;[26] the other (which served to test the robustness of our estimates) includes a larger number of winning bids in 506 auctions held by several CAs in Valle d'Aosta between 2000 and 2009. For the latter sample of auctions, we only know the characteristics of the winning firms and their

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[26]This sample is extracted from the 269 auctions held by the Regional Government of Valle d'Aosta. For 49 of these auctions, we do not have full details regarding the number of subcontractors used and the value of the subcontracted work or we do not have information to determine the subcontracting position of the winning firm. See the upper panel in Table 6 for the summary statistics for this sample.

winning rebate, while we have no information on the bids of all the other participants in the auctions and their characteristics.[27] For each project, we obtain information from the AVCP dataset on the extent of subcontracting and the number (and ID) of subcontractors that were used by the winning firm (see the summary statistics in Table 6).

**Table 6: Descriptive statistics: winning offers and characteristics of contracts**

| Procurement projects issued by Valle d'Aosta Regional Government | | | | | |
|---|---|---|---|---|---|
| Variable | Obs. | Mean | St.Dev. | Min | Max |
| Winning rebate (%) | 220 | 17.222 | 4.260 | 3.620 | 31.990 |
| Sub | 220 | 0.850 | 0.358 | 0 | 1 |
| Optional | 220 | 0.882 | 0.324 | 0 | 1 |
| No. of subcontractors | 220 | 1.645 | 1.527 | 0 | 11 |
| Value of subcontracts (euros) | 220 | 244543.9 | 297106.3 | 0 | 1800620 |
| Bidder-Subcontractor | 220 | 0.409 | 0.403 | 0 | 1 |
| Reserve price (euros) | 220 | 1137356 | 894343.5 | 155526.3 | 5267860 |
| Number of participants | 220 | 57.005 | 32.604 | 3 | 155 |
| Expected duration (days) | 220 | 310.145 | 155.766 | 79 | 899 |
| Road works | 220 | 0.341 | 0.475 | 0 | 1 |
| River and hydraulic works | 220 | 0.327 | 0.470 | 0 | 1 |
| Buildings | 220 | 0.150 | 0.358 | 0 | 1 |
| Procurement projects issued within the borders of Valle d'Aosta by several CAs | | | | | |
| Variable | Obs. | Mean | St.Dev. | Min | Max |
| Winning rebate (%) | 506 | 16.202 | 4.770 | 1.900 | 36.639 |
| Sub | 506 | 0.775 | 0.418 | 0 | 1 |
| Optional | 506 | 0.765 | 0.425 | 0 | 1 |
| No. of subcontractors | 506 | 1.678 | 1.930 | 0 | 17 |
| Value of subcontracts (euros) | 506 | 208322.3 | 318420.4 | 0 | 3256000 |
| Reserve price (euros) | 506 | 965678.9 | 870070.9 | 151457.4 | 6180000 |
| Number of participants | 506 | 44.358 | 32.545 | 3 | 159 |
| Expected duration (days) | 506 | 305.583 | 177.779 | 59 | 1440 |
| Road works | 506 | 0.346 | 0.476 | 0 | 1 |
| Buildings | 506 | 0.204 | 0.403 | 0 | 1 |
| River and hydraulic works | 506 | 0.182 | 0.386 | 0 | 1 |

See Appendix A for definition of variables.

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[27]The summary statistics for this sample are presented in the lower panel in Table 6. In this sample, 59.49% of the projects were for the Regional Government, 33.60% were for municipalities, and the remainder were for other local public authorities, e.g., territorial associations for mountainous areas. Note that for the auctions appearing only in this sample, we are not able to detect whether the contractor is a consortium or to distinguish between ABA and ABA+lottery awarding mechanisms. Note also that the smaller set of winning offers for contracts awarded by the Regional Government is a sub-sample of this larger sample.

The descriptive statistics for the sample of winning rebates in the Regional Government's auctions indicate that approximately 85.0% of suppliers actually subcontracted at least part of the work and that approximately 88.2% of the firms were in an optional subcontracting. Note also that firms in mandatory and optional subcontracting positions outsource similar proportions of the projects' value (on average approximately 245 thousand euros, i.e. approximately 1/4 of an average size project). Winning firms that could opt to subcontract outsourced to a slightly smaller number of subcontractors (1.5) than firms that were required to outsource (2.4), and firms belonged to consortia (1.7).

## 5.1 Estimation results

To study the rebates offered by winning firms that actually engage in mandatory or optional subcontracting, we exclude the *Optional* variable from our benchmark model specification (i.e., from previous equation 1) and include the variable indicating the firm's actual use of subcontracting (*Sub*) and its interaction with the firm's subcontracting status (*Sub\*Optional*).

The results are presented in Table 7 columns 1 and 3, and show that the *Sub\*Optional* interaction term is positive and statistically significant, indicating that when firms engage in subcontracting, they offer larger rebates when they can choose to do so (optional) than when they are obliged to do so (mandatory). By contrast the effect of subcontracting *per se* (*Sub*) is negative and non statistically significant.[28]

These empirical findings are in line with Spiegel's (1993) theoretical results on horizontal subcontracting, which indicate that this form of outsourcing allows firms to improve their production efficiency and - for a large set of parameters - increases social welfare.

Horizontal subcontracting corresponds to optional subcontracting in our setting, and firms engaging in optional subcontracting can indeed offer higher rebates than firms engaging in mandatory subcontracting (a form of vertical outosurcing). In particular, our estimates

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[28]The two different effects of optional *vs* mandatory subcontracting on the bids may be responsible for the lack of significance of the average effect of subcontracting *per se*. Coviello and Mariniello (2010), analyzing Italian procurement auctions without distinguishing between optional and mandatory subcontracting, also find that subcontracting *per se* is not significantly associated with rebates.

indicate that the option to subcontract induces firms to outsource only when doing so is profitable. This option to outsource, in turn, gives the firm a stronger bargaining position than the obligation to contract out part of the project. This conclusion is confirmed by the results in columns 2 and 4 of Table 7, where the auction samples are restricted to contracts in which at least part of the project was handled by subcontractors (i.e., the focus in these columns is limited to projects that involve subcontracting). The coefficient estimated for the *Optional* variable is again positive and statistically significant.[29]

In the model specifications estimated in Table 7, columns 2 and 4, we include two further variables - the number of subcontractors (*No. of subcontractors*) and the value of the sub-contracts (*Value of subcontracts*) - to investigate whether these variables affect the bids offered and influence the validity of our findings. The estimated coefficient of the variable *No. of subcontract* is positive and not statistically significant,[30], while the estimated co-efficient of the variable *Value of subcontracts* is positive and statistically significant (only in the sample of 506 winning rebates). This result indicates that, independent of their subcontracting status, firms benefit from outsourcing a larger amount of work.[31]

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[29]To deal with any outliers, we use robust regressions (IRLS, iteratively re-weighted least squares), which iteratively assign a lower weight to deviant observations. The average winning prices are generally distributed in the same way in the two samples; however, when the distribution of the winning price is compared with the distribution of all the prices offered for contracts with the Regional Government of Valle d'Aosta, the presence of outlying observations seem to have more weight in the distribution of the winning price.

[30]Differently from the setting investigated by Gil and Marion (2012), in the public procurement market of Valle D'Aosta we rarely observe repeated interactions between contractors and subcontractors (on average they interacted only 1.2 times in a decade). Note that the environment analyzed in Marion and Gil's paper is characterized by features that potentially gives rise to relational intertemporal incentives between contractors and subcontractors: there, the subcontractors do not have to be strictly qualified and should be indicated when the bid is made; and the contractors benefit from having larger degree of discretion in the outsourcing choice.

[31]Note that, in column 2 of Table 7, the coefficient for the *Bidder-subcontractor* variable (concerning the presence of at least one subcontractor who also took part as a bidder in the same auction) is not statistically significant. As recently studied by Marion (2013), when a supplier outsources part of the work to a subcontractor that has participated to the same auction (i.e., a rival in the auction) and when there is an ex-ante agreement between the two, maximizing the effort to win the auction may not be optimal for the subcontractor because the opportunity to work as a subcontractor may be more convenient. It is worth stressing here that in Italian public procurement, bidders should not commit - at the auction stage - to engagement in a subcontracting relationship with a particular firm. Indeed, bidders do not have to indicate the names of the subcontractors in their offers. This setting thus reduces the likelihood that firms will make ex-ante agreements, and thus, such agreements might not have any influence on the rivals' costs.

## Table 7: Estimation results: winning offers

| Dependent variable: | Winning rebate | | | |
|---|---|---|---|---|
| Mean outcome: | 17.222 | 17.183 | 16.202 | 16.126 |
| | Robust reg. | | | |
| CA: | Regional Government | | Other Public Admin. | |
| Sample: | Full | Only sub | Full | Only sub |
| | 1 | 2 | 3 | 4 |
| Sub | -0.408 | | -0.226 | |
| | (0.370) | | (0.328) | |
| Sub*Optional | 1.171*** | | 0.818*** | |
| | (0.298) | | (0.279) | |
| Optional | | 1.258*** | | 1.179*** |
| | | (0.301) | | (0.251) |
| log (Value of subcontracts) | | 0.190 | | 0.313** |
| | | (0.147) | | (0.135) |
| log (1+no. subcontracts) | | 0.088 | | 0.171 |
| | | (0.282) | | (0.284) |
| Bidder-subcontractor | | -0.234 | | |
| | | (0.207) | | |
| Res.price; Exp.dur.; No.part.; Backlog | YES | YES | YES | YES |
| Category of work dummy | YES | YES | YES | YES |
| Type of auction dummy | YES | YES | NO | NO |
| Type of CA dummy | NO | NO | YES | YES |
| Firm size; Distance | YES | YES | YES | YES |
| Year dummy | YES | YES | YES | YES |
| Observations | 220 | 187 | 506 | 392 |

Note: See Appendix A for the definitions of the variables.

Robust standard errors clustered at the firm-level are presented in parentheses.

Inference: *** p<0.01, ** p<0.05, * p<0.1.

# 6 Extensions

Thus far, our results indicate that the subcontracting status is strongly associated with the amount of rebate offered. We interpret this results to indicate that firms discount their outsourcing position in their bids. Considering procurement agencies' interest - which usually focuses also on other performance outcomes other than gathering competitive bids - it is worthwhile to examine whether the two subcontracting positions are associated with different ex-post performance. To empirically test whether a relationship between

subcontracting position and ex-post performance exists, we use data for the probability of time and cost overrun in the execution of a project. We define time overrun as the probability of completing the project after the expected (contracted) duration of the work and the cost overrun as the probability that the final cost of the project is greater than the winning price.

A priori, the effect of the subcontracting position on ex-post performance is unclear. In fact, on the one hand, one might expect that the more aggressive bidding behavior of optional subcontracting firms by offering higher rebates would result in worse ex-post performance as suppliers try to recover some mark-up during the executional phase of the project. On the other hand, mandatory subcontracting firms may not have sufficiently discounted their position of asymmetric information and lower bargaining power in their offer, so they may incur additional costs during the contract's execution.

In our data we observe a high probability of time and cost overrun. In fact, time overrun occurred in approximately 84% and cost overrun in approximately the 89% of the projects for the Regional Government of Valle d'Aosta, while time overrun occurred in approximately 91% and cost overrun in approximately the 86% of projects awarded by CAs in Valle d'Aosta region. To test the relationship between firm's subcontracting position and the probability of time and cost overrun, we used both samples of projects.

The results in Table 8, columns 1 to 4, indicate first that subcontracting does not have a significant (although the effect is positive) effect on the probability of time and cost overrun. Secondly, we find that when firms resort to subcontracting, their optional or mandatory subcontracting position does not significantly explain time or cost overrun in the execution of the project, even if firms in an optional subcontracting position seem to have a lower (but not statistically significant) probability of incurring in cost and time overrun. This result indicates that the different subcontracting positions are mainly discounted by the firms in the awarding phase rather than in the execution phase.[32]

This evidence is also confirmed in Table 8, column 5, where we estimate the probability

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[32]In the probit regressions, perfectly predicted observations have been dropped.

of very high rebates, which could be associated with a higher risk of holding up the buyer ex-post. The estimation results show that optional subcontracting firms do not have a significantly different probability of offering rebates that are higher than the winning bid. In other words, our data do not provide empirical evidence supporting the hypothesis that high rebates are associated with ex-post hold-up in performance of the contract.

### Table 8: Ex-post performance

| Dependent variable: | Probability of: | | | | |
| --- | --- | --- | --- | --- | --- |
| | time overrun | cost overrun | time overrun | cost overrun | rebate>Win |
| Mean outcome: | 0.894 | 0.834 | 0.915 | 0.859 | 0.349 |
| | Probit regression | | | | |
| CA: | Regional Gov. | | Several CA | | Regional Gov. |
| | 1 | 2 | 3 | 4 | 5 |
| Sub | 0.757 | 0.999 | 0.019 | 0.075 | |
| | (0.593) | (0.718) | (0.301) | (0.268) | |
| Sub*Optional | -0.542 | -0.886 | -0.152 | -0.109 | |
| | (0.465) | (0.692) | (0.241) | (0.245) | |
| Optional | | | | | 0.028 |
| | | | | | (0.042) |
| Res.price; Exp.dur.; No.part. | YES | YES | YES | YES | YES |
| Category of work dummy | YES | YES | YES | YES | YES |
| Type of auction dummy | YES | YES | NO | NO | YES |
| Type of CA dummy | NO | NO | YES | YES | NO |
| Firm size; Backlog; Distance | YES | YES | YES | YES | YES |
| Year dummy | YES | YES | YES | YES | YES |
| Observations | 170 | 199 | 411 | 462 | 13,331 |

Note: See Appendix A for the definitions of the variables.
Inference: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

## 7 Conclusion

We empirically investigate the public procurement in Italy, where the existing regulation on firms' pre-qualifications for performing public works contracts determines two different subcontracting positions for firms: (i) the contractor is fully qualified and may choose to either subcontract part of the contract or to complete the work on its own (optional subcontracting); or (ii) the contractor is partially qualified and is obliged to subcontract part of the work to a qualified firm (mandatory subcontracting).

We examine the two subcontracting positions by analyzing data on auctions for public

works and bidders' characteristics. We find that bidders in an optional subcontracting position offer lower prices (i.e., higher rebates on the reserve prices set by the contracting authority awarding the contract) than those in a mandatory subcontracting position.

Our findings are confirmed by different estimates and robustness tests. In particular, when we focus only on the bids made by auction winners that subsequently subcontracted part of the contract, we find that the costs of completing contracts are lower when firms actually engage in optional subcontracting than when firms are mandate to engage in subcontracting. Moreover, we find no significant differences in contract performance (i.e., the probability of cost and time overruns) between the two subcontracting positions.

We interpret these findings as follows. Having the option to use subcontractors induces firms to do so only when subcontracting part of the work is profitable and when it puts them in a stronger position regarding information asymmetry and bargaining power. Firms obliged by regulation to engage in mandatory subcontracting lack these advantages and include the higher expected costs of such outsourcing in their bids.

Our results are consistent with those from an empirical survey by Lafontaine and Slade (2008) on vertical arrangements. Both our empirical results and the findings of these authors indicate that voluntary arrangements tend to improve, while imposed arrangements tend to worsen market performance.

These findings have interesting policy implications for public procurement, a setting in which pre-qualification rules to prevent low quality procurement transactions are often adopted. Our results suggest that limiting discretion of the firms on their supply chain choices determines a cost (i.e., higher price) in public procurement. A way to reduce this cost in the context we addressed could be, on the one hand, by defining relatively wider categories of work for firms' qualification. Indeed, in so doing, winning firms will result more often fully qualified and thus more often will exert their efficient discretional choices on subcontracting. Contextually, this lighter regulatory design should be coupled both with the adoption of reputation criteria in the awarding of the contract (i.e. suppliers' past performance) and with the entitlement of procurement authorities' with the power to

disqualify unsuitable firms (Spagnolo 2012): in this way the potential reduction in quality provided by contractors as a consequence of the less strict pre-qualification screening would be dynamically counterbalanced. Future research is still needed to make the trade-off.

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# Appendix A

## Variables, definitions and abbreviations

**Rebate (or percentage of the price reduction or discount)** The price cut offered by participants in an auction, expressed as a percentage of the auction's reserve price.

**Optional** A dummy variable taking a value of 1 if the firm can choose whether to horizontally subcontract part of the contracted work; this firm is fully qualified to complete the project alone, but it can opt to subcontract part of the work to firms with similar qualifications. The dummy takes a value of 0 if it is required by law to subcontract part of work (that it is not qualified to perform).

**Mandatory** A dummy variable taking a value of 1 if the firm is required by law to subcontract part of the work; this firm does not have all the qualifications to complete the project, and it is required by law to subcontract the work for which it is not qualified to perform to firms with the required qualifications. The dummy takes a value of 0 if the firm (being fully qualified to handle the work) can choose whether to subcontract part of the work.

**Reserve price** The auction's starting value (in euros) decided by the contracting authority - CA (all the projects considered here had a reserve price higher than 150,000 euros).

**Expected duration** The expected duration of the work (in days), decided by the CA.

**No. of participants** The number of bidders participating in an auction.

**Firm size** A set of dummy variables that are used as proxies for the size of bidding firms. Because we do not have data on the number of their employees or their total assets, we construct proxies based on the type of business entity (there is a positive correlation between the type of business entity and the size of the Italian firms). In particular, our proxies are defined as: *Small* (one-man businesses, limited and ordinary partnerships); *Medium* (limited liability companies); or *Large + cooperatives* (public corporations and cooperatives).

**Distance** It is a proxy for the distance between the firm and the project. Because we do not have information for the exact location of the project and of the firm, it is defined as the distance in kilometers from the capital city of the province in which the firm is located and the city of Aosta (where the CA is located). We assign a distance of 30 kilometers to firms located in Valle d'Aosta.

**Backlog** A proxy for the firms' capacity constraints, defined as the number of pending projects (considering also public procurement works tendered in other Italian regions) the firm has at the date of bidding.

**Consortia** A dummy variable taking a value of 1 when it refers to a temporary association of firms, and 0 otherwise. Firms can join forces, pool their qualifications and form a consortium to participate in a given auction, so we assume that the variable *Optional* takes a value of 1 for consortia.

**Type of auction** A set of dummy variables describing the auction mechanism.
*Average price* is an average price auction defined as follows. Given the distribution of all bids received for an auction, a first average (A1) is computed by averaging all bids except those located in the first and last deciles; then, a second average (A2) is computed by averaging all bids above A1 (again excluding those bids located in the last decile). The winning bid is the one immediately below A2 (see Figure 1 in Appendix B). If there are fewer than ten bidders, the lowest and highest bid are not considered to compute the first average (A1). If there are fewer than five bidders, the project is awarded to the firm that has offered the highest rebate.

*Average price+lottery* is an average price auction defined as follows. Given the threshold A2 computed as above, a random number is extracted from the set of the nine equidistant numbers between the lowest bid above the first decile and the bid just below A2. Averaging R with A2, the winning threshold W is obtained and the winning bid is the one immediately above W (see Figure 1, Panel B, in Appendix B).

**Category of work** A set of dummy variables representing the main category of work in a project (e.g., road works, buildings, hydraulic works, etc.).

**Sub** A dummy variable taking a value of 1 if the winning firm subcontracts part of the work in a project, and 0 otherwise.

**No. of subcontractors** The number of subcontractors working on a project.

**Value of subcontract** The value (in euros) of the subcontracts for a project.

**Bidder-subcontractor** A dummy variable that takes a value of 1 if, for a given contract, at least one subcontractor participated as a bidder in the auction. It takes a value of 0 otherwise.

**Type of CA** A set of dummy variables representing the type of contracting authority auctioning the work (e.g., regional or local governments, public health authorities, etc.).

# Appendix B

## Figure 1: Awarding mechanisms



PANEL A: Average bid auction
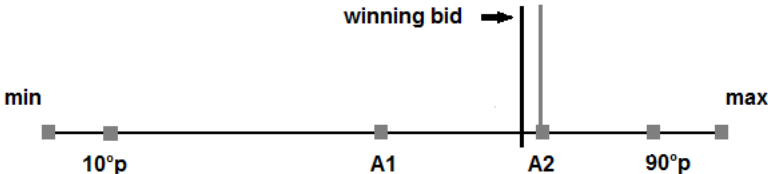
PANEL B: Average bid auction + lottery