ONLINE APPENDIX
Entry and Subcontracting in Public Procurement Auctions

Appendix A: Theoretical Model

This appendix formulates a stylized model of entry, bidding and subcontracting. The model does not aim to offer a complete characterization of bidders behavior but clarifies the assumptions under which entry and subcontracting decline with a switch from ABAs to FPAs. We present the model set up first and then discuss its equilibria in ABAs and FPAs.

A. Setup

We consider an independent private value model. N risk-neutral firms compete to win a contract. At the time of bidding, for any bidder i the expected cost of completing the project is: $c^i = x^i + y + \theta\varepsilon$, where x^i is a privately observed cost, y and ϵ are commonly observed costs with $0 < \varepsilon < y$ and θ, $0 < \theta < 1$, is the probability that the contract will be expensive to complete. Whether the contract is expensive or not to complete is known only after the auction is held. There are two types of bidders: type L default on their bid if the contract turns out to be expensive and complete otherwise. Type H bidders always complete. Bidders are type symmetric, independently drawing their private cost from F_{X_j}, $j = \{H, L\}$, that is assumed to be absolutely continuous and have support on $[\underline{x}_j, \overline{x}_j]$, where $0 \leq \underline{x}_j < \overline{x}_j < \infty$. We indicate with N_j, the number of bidders of type $j = \{H, L\}$.

This model is a simplified version of that presented in Decarolis (2013). Since our focus is not on the default risk, we defer to that study for a foundation of why bidders can have different default probabilities and why this gives a cost advantage to the bidders more likely to default. Relative to that model, however, we add the presence of entry and subcontracting stages. In particular, the timing of the game is as follows:

1. the auction format (ABA or FPA) is announced;
2. if the FPA is used, firms decide whether to pay a fee to reveal their type (H or L);
3. firms learn their private cost and the number of bidders who submit a bid;
4. firms bid in the main auction;
5. the winner runs a second price auction (SPA) with reserve price to resell the contract.

The presence of multiple stages in the game makes it clear how a large number of different models could result by altering the assumptions regarding any one of them. The assumption on the presence of an entry fee in FPAs try to capture the presence in the data of bid screening in this format. Modeling the resell auction as a SPA helps to simplify the analysis.

The equilibrium concept that we use for our analysis is the type-symmetric Bayes-Nash equilibria (BNE), which consists for every bidder i of type $j = \{L, H\}$ of: *i)* a probability of

entering q_j; *ii)* a continuous function describing bidding in the main auction $b_j : [\underline{x}_j, \overline{x}_j] \rightarrow R_+$; *iii)* a continuous function describing bidding in the resell auction $s_j : [\underline{x}_j, \overline{x}_j] \rightarrow R_+$. The strategy profile (e, b, s) describes all the actions of all the firms that enter into the definition of the equilibrium. Finally, we conduct the analysis under the assumption of the presence of a commonly known reserve price in the main auction, R, which represents the maximum price that the auctioneer is willing to pay. R is assumed to be non binding in the sense that even the least efficient bidder can earn a profit if he wins at the reserve price.

B. Average Bid Auction

The awarding rule is that described in section 2. For convenience, we report it again here: *Disregard the top and bottom 10 percent of the bids; calculate the average of the remaining bids (call it A1); then calculate the average of all the bids strictly above the disregarded bottom 10 percent and strictly below A1 (call this average A2); the first price above A2 wins. Ties of winning bids are broken with a fair lottery and the winner is paid his own price to complete the work.*[1] Despite this rule appearing complex, it induces a surprisingly simple equilibrium:

Claim 1 - *All N bidders enter and offer identical bids equal to R. Bids in the resell auction equal costs and the winner resells with probability* $1 - 1/N$.

Sketch of the proof: Following Decarolis (2013), the absolute continuity of the cost distributions, together with appropriate parametric assumption on the relative cost advantage of type L bidders, ensures that the unique symmetric bidding function leading to a positive expected payoff from bidding in the auction entails having all bidders offering R. Therefore, the winner is elected through a random draw across all bidders. The use of a SPA in the resell auction makes bidding truthfully weakly dominant. Hence, given the random allocation in the main auction, the probability of resell equals $1 - 1/N$. □

The intuition is as follows. Without bid screening, there is no entry cost and, hence, all firms enter. It is also clear why there are no unilateral deviations from bidding R when all other firms are bidding this constant: deviating would lead to the certainty of being excluded due to the 10 percent trimming of the lower bids. Moreover, this bidding function is the only one compatible with an equilibrium because of nuances in how tails trimming works: Even when all bids are identical but less than R, an individual bidder who deviates to R wins with probability one and earns the highest possible payoff. The reason being that a bid equal to R will be disregarded in the calculation of A1 and A2, but will then be the closest bid strictly above A2. The more technical discussion is in Decarolis (2013). Finally, notice that since the ABA awards the contract like a fair lottery there is a probability of $1/N$ that the winner is the lowest cost firm. Since we assume that the resell mechanism is a second price sealed bid auction with reserve price equal to the cost of the winner of the main auction, resell will occur with probability $1 - 1/N$.

C. First Price Auction

Integrating FPA with bid screening is a common method in public procurement to limit the default risk. We assume that the screening is costly for the firms since it forces them to produce documentation that allows the auctioneer to perfectly observe whether they are

[1] Details on how the rules deal with other types of bid ties and special cases are in Decarolis (2013).

of type H or L. To simplify, we assume that the auctioneer excludes any bidder that turns out to be of type L. This implies that in any equilibrium, type L bidders decide not to participate. As regards type H bidders, if they stay out they can bid in the resell auction. In the resell auction the winner of the main auction sets a reserve price equal to his cost and the other bidders bid according to the weakly dominant strategy of bidding their cost. Thus, a bidder contemplating whether to pay the entry cost for the main auction knows that if he does not enter his expected payoff equals that of winning the resell SPA with N_H symmetric type H bidders.[2] Let us indicate this quantity as: $E[\pi^*|N, SP]$.

If the firm decides to enter, instead, it has to pay an entry cost (e) and has an expected profit that is determined by two cases. If the winner has the lowest overall cost, it will execute the contract at the price of the FPA. Otherwise, it will resell the contract to the lowest cost firm at the price offered by the second lowest cost firm. At the bidding stage, however, all the firms that have decided to pay the entry cost and bid (we indicate with n their number) assign the same expected profit associated with the possibility of reselling the contract ex post. By a conventional Bertrand argument, we know that since no firm has private information regarding this quantity, this profit must be competed away in equilibrium and equal zero. Thus, conditional on entering the expected profit must equal that induced by the unique symmetric equilibrium of a FPA with n symmetric type H bidders. Let us indicate this quantity by $E[\pi^*|n, FP]$.

This implies that the probability of entry of a symmetric equilibrium (q^*) is pinned down by the following equation:

$$\sum_{n=1}^{N} \binom{N-1}{n-1} (q^*)^{n-1} (1-q^*)^{N-n} E[\pi^*|n, FP] - e = E[\pi^*|N, SP] \tag{1}$$

Conditional on entering, a bidder knows his private cost and the number of other firms entering. Thus, the expected payoff is the difference between his bid and the smallest between his completion cost and the expected resell price. Although the presence of the latter term, identical for all entrants, might induce bidders with high cost draws to pool bids at this price, this would be inconsistent with the bid screening process being able to ensure that bids can cover execution costs. Therefore, to make the analysis both self consistent and simple, we assume that bidders with cost draws higher than the expected resell price bid truthfully. Having ruled out the possibility of bid pooling, the determination of the bid function is then reduced to the standard case of the symmetric private value model. A symmetric equilibrium is then given by the following:

Claim 2 - *Bidders type H enter the main auction with probability q^*. Conditional on exactly n_H firms entering, each entrant bids according to the same strictly monotonic bid function in the main auction and, if losing, bids its cost in the resell auction; the winner resells with probability $1 - n_H/N_H$. All type L stay out.*

Sketch of the proof: Equation (1) is analogous to the one presented in Levin and Smith

[2]To simplify, we are implicitly assuming that subcontracts in FPAs occur only toward type H bidders. Allowing for subcontract to type L too would not alter the qualitative results.

(1994) to analyze an environment without resell. In their case, the payoff on the right hand side of the expression is zero. In equation (1) it is greater than zero but, importantly, it is invariant in n. Therefore, since $E[\pi^*|n, FP]$ is decreasing in n by the same continuity argument of Levin and Smith (1994) we can assert that for certain values of e that are not excessively large or small, there must be a value of $q^* \in (0, 1)$ that satisfies equation (1). As regards bidding in the main auction, under the assumption that type H hazard rate dominates type L (i.e., $\frac{f_{X_H}}{1-F_{X_H}} < \frac{f_{X_L}}{1-F_{X_L}}$.), the existence of a unique strictly monotonic bid function can be established using the main theorem in de Castro and de Frutos (2010).[3] The bidding behavior in the resell auction follows the weakly dominant strategy of SPA. □

The two claims lead to the following comparison of entry and subcontracting among the two auction formats that represents the main prediction of our simple model. For parametrization of the entry cost that do not make the entry probability degenerate:

Claim 3 - *The number of firms entering ABA (N) exceeds that of FPA (q^*N_H); the probability of a subcontract occurring in ABA ($1 - 1/N$) exceeds that of FPA ($1 - q^*$).*

From the previous results we know that the mean number of firms entering FPA is $q^*N_H < N_H < N$. Hence, entry in FPA is lower not only because type L stay out, but also because the positive entry cost discourages entry by some type H bidders. Moreover, a resell in FPA occurs only when the lowest cost firm is one of those that did not enter the main auction. On average this probability is $1 - q^*N_H/N_H = 1 - q^*$ which is less than $1 - 1/N$ for every interesting case where $q^* > 1/N$. In particular, it is enough that at least 2 bidders enter the FPA to ensure that this format has a probability of subcontracting that is less than the ABA because it ensures that the most efficient of the two entrants is selected.

Appendix B: Data

The data used in the paper come from two main sources, plus several ancillary ones. The Authority sample comes from the Observatory on Public Contracts of the Italian Authority for Public Contracts, `http://www.avcp.it/portal/public/classic/_english`. In particular, we use the so called "Schede" dataset which consists of 11 *schede* (i.e., forms) compiled by the PAs procuring public works during the different phases of the procurement process. The small sample containing a panel of bids, instead, comes from the database on road construction works of a private company, `http://www.telemat.it/`. This is a company whose main activity is selling information about public contracts to construction firms.

As regards the ancillary sources, the data about the characteristics of Public Administrations come from Italy's National Statistical Institute: `http://demo.istat.it/index_e.html`. The single year of data employed is 2006. *Fiscal Efficiency*, the ratio between the actual and expected tax revenues, was calculated for the years 2000-2011 for all counties and municipalities in the dataset from the "Certificati Consuntivi" downloaded from `http://finanzalocale.interno.it`.

[3] de Castro, Luciano I., and Maria-Angeles de Frutos. 2010. "How to translate results from auctions to procurements." *Economics Letters*, 106(2): 115118.

Appendix C: Additional Robustness Checks

In this section, we describe additional sets of robustness checks that address important concerns about the identification assumptions of the DD analysis.

- The first set of robustness checks entails using different control groups. As explained in the text, the control groups used in the main text were selected on a criteria of similarity of the PAs to the treated PA in terms of *Experience* (i.e., the number of all auctions held in the Observatory on Public Contracts data). The robustness check presented here provides the results of the DD when the control group is selected using either *Population* or *Population* and *Experience* jointly instead of exclusively using *Experience*. Indeed, a probit analysis of the determinants of the switch to FPAs after June 2006 indicates that *Population* and *Experience* are the most relevant determinants. Therefore, we report two tables that are isomorphic to Table 6 in the text, but that use different control groups. In Table A.1 we use PAs similar to Turin in terms of *Population*, while in Table A.2 we use both *Population* and *Experience*. The notes to the tables give more detailed indications of how these control groups were selected. As regards the estimates, overall they confirm all the findings reported in the main text.

- The second set of robustness checks deals with the presence of sample selection. To evaluate the extent of this problem, we repeat our baseline estimates using different subsamples of the data. Table A.3 and A.4 present the results. The values in column 1 ("Base") are reported from column 2 in Table 2 for comparison to the other estimates. These other estimates are based on different subsamples of the Authority sample. Sample selection is unlikely to be a major concern for our baseline estimates if the estimates in column 1 of Table A.3 and A.4 resemble those in the subsequent columns. In particular, the estimates in column 2 ("Full") use a larger subsample that does not exclude those auctions with a reserve price below €300,000 (i.e., the threshold below which negotiated procedures are allowed). The estimates in column 3 ("Missing") include also those auctions with only one non missing value among information of subcontracting (total value of subcontracts, number of subcontracts and value of the largest subcontract). To assess whether the effects differ across types of works, column 4 and 5, report separately the estimates for samples of auctions for (relatively) simple and complex types of public works. The results in these two columns are close and they are also close to those of "Base". The last two columns show that shrinking the sample to smaller periods around the 2003 reform do not have a significant effect on the value of the effect of the switch on both entry and subcontracting. Overall, the results for these different samples suggest that the effect of FPAs on all our variables of interest are robust to these changes in the sample analyzed.

- A third set of robustness checks addresses the possibility of the presence of contamination effects (i.e., the control group being influenced by the treatment received by the treatment group). Although the switch to FPAs occurred in Turin only, it occurred simultaneously with the termination of the activity of the cartels that operated in Turin's auctions. Since their termination potentially affected the ABAs of other PAs, this creates potential for contamination. To make sure that our results are not affected

by this issue, we restrict the control group trying to select PAs that are unlikely to be affected by the termination of the cartels active in Turin. We consider three criteria. The first criteria is to include within the control group only auctions held by PA located outside the Piedmont region (the region where Turin is located). The result for this approach are presented in Table 8 in the text. The second criteria uses the information in Conley and Decarolis (2013) on the identity of the 95 firms involved in the case of collusion in Turin: the set of PA in the control group is restricted to those that in the period before 2003 never had either as a winner or a subcontractor one of the 95 colluded firms. Finally, the third criteria is to include in the control group only those PA that in the period before 2003 never had either a winner or a subcontractor of the Turin's auction as their winner or subcontractor. Using the latter two sample splits we produced Tables A.5-A.6. In all cases we find estimates that are similar to the baseline values presented in Table 2 of the paper, both in terms of sign and magnitude.[4]

- A fourth set or robustness checks involves the role of the regulations mandating subcontracting. As explained in section 2, when a winner is not qualified to perform the secondary tasks he must subcontract them out to qualified firms. Moretti and Valbonesi (2012) show that this regulation affects entry and bidding behavior of firms within ABAs. Therefore, a natural concern is that if the switch to FPAs is associated with different sets of contracts being awarded under this formats, mandatory subcontracting requirements might change. Therefore, Table A.7 repeats the baseline estimates including exclusively contracts with no secondary tasks. The results are broadly in line with the basic estimates, with the only difference of the lack of significant effects for the TJV. This latter result, however, is explained by the composition of the contracts analyzed for which a bidder has no need to lock in strategic subcontractor or to limit its exposure to the hold up problem. Additional results (not reported) aimed at controlling for the role of the regulations were obtained by including in the baselines estimates additional controls for the number and type of secondary tasks. With both sets of added controls, our baseline estimates remained qualitatively identical.

[4]Except for one case, a single specification for TJV in the PAs with no common bidders with Turin, all estimates are significant. This may be driven by the large drop in the number of observations available.

Table A.1: Control group: Population

Panel A: Municipality of Turin

VARIABLES	(1) N.Bidders	(2) N.Bidders	(3) TJV Wins	(4) TJV Wins	(5) Perc.Subc.	(6) Perc.Subc.	(7) Perc.Largest Subc.	(8) Perc.Largest Subc.
Year-PA	(-75.22 - -48.98)	(-48.75 - -16.31)	(-0.0373 - 0.145)	(0.00478 - 0.316)	(-13.92 - -7.304)	(-9.698 - 1.196)	(-10.63 - -5.197)	(-9.012 - 0.568)
PA	(-76.13 - -48.08)	(-43.18 - -21.89)	(0.000622 - 0.107)	(0.108 - 0.213)	(-13.41 - -7.823)	(-7.232 - -1.269)	(-11.22 - -4.606)	(-8.123 - -0.321)
Conley-Taber	(-116.4 - -31.35)	(-41.88 - -20.64)	(-0.00709 - 0.106)	(0.102 - 0.216)	(-13.47 - -6.921)	(-8.034 - -0.884)	(-11.24 - -5.475)	(-7.977 - -0.728)
Obs.	1,589	1,589	1,581	1,581	1,588	1,588	907	907
R-squared	0.450	0.498	0.124	0.134	0.132	0.172	0.790	0.791

Panel B: Province of Turin

VARIABLES	(1) N.Bidders	(2) N.Bidders	(3) TJV Wins	(4) TJV Wins	(5) Perc.Subc.	(6) Perc.Subc.	(7) Perc.Largest Subc.	(8) Perc.Largest Subc.
Year-PA	(-72.02 - -33.50)	(-43.05 - 21.78)	(0.0321 - 0.244)	(-0.0952 - 0.275)	(-9.180 - -3.512)	(-11.95 - -0.874)	(-8.848 - -3.393)	(-15.49 - -7.216)
PA	(-72.68 - -32.84)	(-30.14 - 8.865)	(0.0480 - 0.228)	(-0.0449 - 0.225)	(-9.653 - -3.039)	(-13.26 - 0.433)	(-9.028 - -3.213)	(-17.51 - -5.203)
Conley-Taber	(-104.9 - -33.10)	(-28.55 - 8.602)	(0.0357 - 0.231)	(-0.0417 - 0.221)	(-10.65 - -2.064)	(-14.53 - 1.603)	(-8.952 - -3.674)	(-18.12 - -4.673)
Obs.	842	842	841	841	840	840	633	633
R-squared	0.453	0.504	0.157	0.163	0.097	0.148	0.242	0.263

Note: This table reports the 95 percent confidence interval, CI, estimates of the effect of the FPA dummy. For each one of the two panels, the first row reports the CI obtained when standard errors clustered by Public Administration and Year, the second when they are clustered by PA and the third when they are calculated as in Conley and Taber (2011). The table structure follows that of Table 4: all regressions control for Year, Public Administration, Municipality type of PA and Work Type dummies as well as for the Reserve Price. For odd numbered columns, the regression model also includes the variable Fiscal Efficiency among the controls. For even numbered columns, the regression model also includes both a time trend and PA-specific time trends among the controls. Results obtained using as control group auctions held by PAs with a value of Population that is within 75% of that in the treated group (either the Municipality or the County of Turin).

Table A.2: Control group: Experience and Population

Panel A: Municipality of Turin

VARIABLES	(1) N.Bidders	(2) N.Bidders	(3) TJV Wins	(4) TJV Wins	(5) Perc.Subc.	(6) Perc.Subc.	(7) Perc.Largest Subc.	(8) Perc.Largest Subc.
Year-PA	(-80.30 - -46.27)	(-52.40 - -8.524)	(-0.0526 - 0.130)	(-0.00202 - 0.301)	(-14.44 - -5.163)	(-8.433 - 3.949)	(-13.47 - -5.868)	(-7.800 - 4.743)
PA	(-86.60 - -39.97)	(-44.68 - -16.24)	(-0.0154 - 0.0923)	(0.0778 - 0.221)	(-14.82 - -4.778)	(-6.409 - 1.925)	(-13.69 - -5.647)	(-6.049 - 2.992)
Conley-Taber	(-115.0 - -31.63)	(-43.35 - -12.87)	(-0.00609 - 0.0666)	(0.0555 - 0.229)	(-14.92 - -3.609)	(-7.204 - 3.051)	(-13.49 - -6.082)	(-5.400 - 2.247)
Obs.	1,049	1,049	1,041	1,041	1,044	1,044	774	774
R-squared	0.447	0.501	0.124	0.127	0.144	0.187	0.937	0.938

Panel B: Province of Turin

VARIABLES	(1) N.Bidders	(2) N.Bidders	(3) TJV Wins	(4) TJV Wins	(5) Perc.Subc.	(6) Perc.Subc.	(7) Perc.Largest Subc.	(8) Perc.Largest Subc.
Year-PA	(-72.13 - -29.79)	(-43.17 - 31.72)	(0.0376 - 0.247)	(-0.0976 - 0.292)	(-8.452 - -2.416)	(-8.398 - 3.152)	(-8.389 - -4.158)	(-12.15 - -4.116)
PA	(-74.71 - -27.21)	(-29.42 - 17.98)	(0.0342 - 0.251)	(-0.0682 - 0.263)	(-9.178 - -1.690)	(-7.678 - 2.432)	(-8.803 - -3.744)	(-13.39 - -2.878)
Conley-Taber	(-104.5 - -32.01)	(-24.53 - 12.80)	(0.0147 - 0.263)	(-0.0857 - 0.276)	(-10.16 - -0.224)	(-7.789 - 3.313)	(-8.287 - -4.121)	(-14.49 - -1.841)
Obs.	710	710	709	709	708	708	542	542
R-squared	0.440	0.500	0.155	0.158	0.097	0.155	0.242	0.254

Note: This table reports the 95 percent confidence interval, CI, estimates of the effect of the FPA dummy. For each one of the two panels, the first row reports the CI obtained when standard errors clustered by Public Administration and Year, the second when they are clustered by PA and the third when they are calculated as in Conley and Taber (2011). The table structure follows that of Table 4: all regressions control for Year, Public Administration, Municipality type of PA and Work Type dummies as well as for the Reserve Price. For odd numbered columns, the regression model also includes the variable Fiscal Efficiency among the controls. For even numbered columns, the regression model also includes both a time trend and PA-specific time trends among the controls. Results obtained using as control group auctions held by PAs with a value of Population and Experience that is for each variable within 75% of the corresponding value in the treated group (either the Municipality or the County of Turin).

Table A.3: Robustness Check - Subsamples: Municipality of Turin

N.Bidders

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	-60.48***	-59.78***	-60.48***	-89.72***	-35.91***	-58.78***	-40.32***
	(6.088)	(5.697)	(6.088)	(10.17)	(3.197)	(8.129)	(5.127)
Obs.	1,470	2,389	1,470	786	684	1,150	704
R-squared	0.431	0.377	0.431	0.492	0.548	0.410	0.421

TJV Wins

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	0.097**	0.084**	0.097**	0.089	0.188***	0.160***	0.105***
	(0.041)	(0.032)	(0.041)	(0.064)	(0.058)	(0.026)	(0.035)
Obs.	1,462	2,375	1,462	778	684	1,149	704
R-squared	0.123	0.101	0.123	0.141	0.170	0.134	0.151

Perc.Subc.

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	-9.804***	-9.824***	-9.804***	-14.95***	-5.189**	-8.445***	-11.70***
	(1.955)	(1.598)	(1.955)	(2.718)	(2.336)	(1.806)	(1.779)
Obs.	1,465	2,381	1,465	782	683	1,146	704
R-squared	0.110	0.121	0.110	0.166	0.093	0.104	0.109

Perc.Largest Subc.

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	-0.049***	-0.088**	-0.049***	-0.090***	-0.016	-0.036**	-0.044***
	(0.017)	(0.044)	(0.017)	(0.018)	(0.024)	(0.017)	(0.014)
Obs.	1,070	1,535	1,070	561	509	824	481
R-squared	0.923	0.242	0.923	0.970	0.075	0.126	0.187

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors clustered by Public Administration and Year. The top of each panel reports the dependent variable. The column labeled "Base" repeats model (2) of Table 2 in the paper. "Full" includes also all the auctions with a reserve price lower than €300,000. "Missing" includes also those auctions with only one non missing value among information of subcontracting (total value of subcontracts, number of subcontracts and value of the largest subcontract). "Simple" and "Complex" divide the sample on the basis of the complexity of the work. The former includes auctions for the simplest kind of roadwork jobs, while the latter includes all other auctions. "2001-2005" considers only auctions held between 2001 and 2005. "2002-2004" considers only auctions held between 2001 and 2005. All results obtained using control group based on Experience.

Table A.4: Robustness Check - Subsamples: County of Turin

N.Bidders

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	-45.18***	-44.10***	-45.18***	-64.46***	-24.02***	-44.66***	-30.17***
	(8.175)	(5.950)	(8.175)	(14.33)	(3.413)	(9.769)	(7.477)
Obs.	1,617	2,633	1,617	849	768	1,304	835
R-squared	0.397	0.356	0.397	0.472	0.464	0.376	0.383

TJV Wins

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	0.159***	0.154***	0.159***	0.072	0.277***	0.157***	0.203***
	(0.048)	(0.047)	(0.048)	(0.045)	(0.102)	(0.057)	(0.024)
Obs.	1,615	2,625	1,615	847	768	1,304	835
R-squared	0.146	0.140	0.146	0.125	0.198	0.161	0.183

Perc.Subc.

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	-4.738***	-5.031***	-4.738***	-10.09***	1.075	-6.164***	-6.686***
	(1.642)	(1.354)	(1.642)	(2.981)	(1.527)	(1.196)	(1.133)
Obs.	1,610	2,622	1,610	845	765	1,299	834
R-squared	0.103	0.106	0.103	0.147	0.102	0.097	0.094

Perc.Largest Subc.

VARIABLES	(1) Base	(2) Full	(3) Missing	(4) Simple	(5) Complex	(6) 2001-2005	(7) 2002-2004
FPA	-0.146***	-0.111***	-0.146***	-0.234**	-0.022	-0.072***	-0.089***
	(0.055)	(0.036)	(0.055)	(0.100)	(0.023)	(0.020)	(0.020)
Obs.	1,159	1,670	1,159	609	550	936	592
R-squared	0.425	0.180	0.425	0.518	0.065	0.079	0.080

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors clustered by Public Administration and Year. The top of each panel reports the dependent variable. The column labeled "Base" repeats model (2) of Table 2 in the paper. "Full" includes also all the auctions with a reserve price lower than €300,000. "Missing" includes only those auctions with at least two non missing values among information of subcontracting (total value of subcontracts, number of subcontracts and value of the largest subcontract). "Simple" and "Complex" divide the sample on the basis of the complexity of the work. The former includes auctions for the simplest kind of roadwork jobs, while the latter includes all other auctions. "2001-2005" considers only auctions held between 2001 and 2005. "2002-2004" considers only auctions held between 2001 and 2005. All results obtained using control group based on Experience.

Table A.5: Robustness Checks: PA without cartel bidders

Panel A: Municipality of Turin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N.Bidders		TJV		Perc.Subc.		Perc.Largest Subc.	
First Price Auction	-68.16***	-49.06***	0.119***	0.0987**	-8.782***	-7.905***	-10.56***	-7.930***
	(11.04)	(8.877)	(0.0397)	(0.0462)	(2.267)	(2.480)	(2.445)	(2.532)
Observations	479	479	472	472	479	479	290	290
R-squared	0.320	0.538	0.058	0.109	0.090	0.120	0.163	0.241

Panel B: Province of Turin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N.Bidders		TJV		Perc.Subc.		Perc.Largest Subc.	
First Price Auction	-44.52***	-39.63***	0.197**	0.174**	-5.454***	-4.858**	-7.327***	-6.277***
	(10.29)	(9.326)	(0.0763)	(0.0771)	(1.972)	(1.842)	(1.619)	(1.593)
Observations	496	496	495	495	496	496	284	284
R-squared	0.253	0.448	0.068	0.148	0.095	0.139	0.147	0.252

Note: *** p<0.01, ** p<0.05, * p<0.1. Baseline estimates including within the control group only auctions held by PA that, in the period before 2003, never had either as a winner or a subcontractor one of the colluded firms. Odd number columns include Year and Public Administration dummies. Even number columns include Year, Public Administration, Municipality, Work Type dummies and Reserve Price. See Table 2 in the paper for additional details.

Table A.6: Robustness Checks: PA without common bidders with Turin

Panel A: Municipality of Turin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N.Bidders		TJV		Perc.Subc.		Perc.Largest Subc.	
fpsb_auction	-51.26***	-44.36***	0.0292***	0.0262	-8.330***	-7.090***	-6.449***	-6.289***
	(0)	(5.451)	(0)	(0.0425)	(0)	(1.046)	(0)	(0.895)
Observations	240	240	234	234	240	240	161	161
R-squared	0.703	0.803	0.037	0.127	0.137	0.194	0.181	0.260

Panel B: Province of Turin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N.Bidders		TJV		Perc.Subc.		Perc.Largest Subc.	
fpsb_auction	-56.99***	-57.37***	-0.0500***	-0.0248	-4.524***	-4.539***	-2.547***	-2.868**
	(0)	(2.324)	(0)	(0.0343)	(0)	(0.656)	(0)	(0.888)
Observations	191	191	191	191	191	191	121	121
R-squared	0.366	0.481	0.063	0.207	0.090	0.135	0.095	0.167

Note: *** p<0.01, ** p<0.05, * p<0.1. Baseline estimates including within the control group only auctions held by PA that, in the period before 2003, never had either a winner or a subcontractor of the Turin's auctions as their winner or subcontractor. Odd number columns include Year and Public Administration dummies. Even number columns include Year, Public Administration, Municipality, Work Type dummies and Reserve Price. See Table 2 in the paper for additional details.

Table A.7: Robustness Checks: Contracts with no secondary tasks

Panel A: Municipality of Turin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N.Bidders		TJV		Perc.Subc.		Perc.Largest Subc.	
First Price Auction	-63.23***	-66.32***	0.0144	0.0442	-6.750***	-7.219***	-8.781***	-8.526***
	(11.86)	(10.21)	(0.0846)	(0.0688)	(2.369)	(2.547)	(2.455)	(3.067)
Observations	538	538	536	536	537	537	306	306
R-squared	0.447	0.530	0.055	0.276	0.178	0.239	0.269	0.397

Panel B: Province of Turin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N.Bidders		TJV		Perc.Subc.		Perc.Largest Subc.	
First Price Auction	-69.22***	-66.96***	0.0624	0.0657	-6.463***	-6.138***	-6.971***	-8.357***
	(13.36)	(12.32)	(0.0503)	(0.0472)	(1.460)	(1.645)	(1.429)	(1.807)
Observations	624	624	622	622	623	623	365	365
R-squared	0.443	0.527	0.044	0.162	0.182	0.221	0.267	0.386

Note: *** p<0.01, ** p<0.05, * p<0.1. Baseline estimates restricting the sample to contracts with no secondary tasks. See Table 2 in the paper for additional details.