American Economic Journal: Applied Economics 2014, 6(1): 108–132
http://dx.doi.org/10.1257/app.6.1.108

Awarding Price, Contract Performance, and Bids Screening: Evidence from Procurement Auctions[†]

By Francesco Decarolis*

This paper presents evidence on the perverse trade-off that first price auctions induce between low prices at the awarding stage and poor ex post performance when bids are not binding commitments. By exploiting the different timing with which first price auctions were introduced in Italy to procure public works, this study finds that at least half of the cost savings from lower winning prices are lost because of ex post renegotiation. Screening the lowest price bid for its responsiveness prevents performance worsening but also reduces the initial cost savings by a third and induces delays in awarding the contract. (*JEL* D44, H54, H57, R42)

Public procurement often relies on first price sealed bid auctions (FPAs) to award contracts for the execution of public works.[1] Even when FPAs are not used, policy reforms fostering their introduction into public procurement are often encouraged, as the World Bank typically does in its receiver countries. Nevertheless, the evidence presented in this paper argues that it is impossible to say whether the FPA is an effective mechanism for public procurement without taking a broader vision that encompasses other procurement institutions, especially those ensuring that bids are binding commitments for contractors.

FPAs are believed to induce low procurement costs through competition and low corruption through transparency. Nevertheless, this paper is among the first to provide evidence in support of the large body of theoretical studies showing that FPAs can have perverse effects when the object of procurement is a contract. Their argument is that high discounts at the awarding stage are obtained at the cost of

* Boston University, Department of Economics, 270 Bay State Road, Boston MA 02215 (e-mail: fdc@bu.edu).
This paper is a revised version of a chapter of my PhD thesis, supported by the Henry Morgenthau dissertation fellowship of the University of Chicago and the Economic Fellowship of the Bank of Italy. I am grateful to Ali Hortacsu, Roger Myerson, Philip Reny, and Timothy Conley for their guidance. I would like to thank the two anonymous referees who helped me to improve this paper. I also benefited from conversations with Susan Athey, Marianne Bertrand, Peter Cramton, Jeremy Fox, Amit Gandhi, Ken Hendricks, J-F Houde, Jakub Kastl, Jonathan Levin, Greg Lewis, Gustavo Piga, Rob Porter, Jesse Shapiro, and Giancarlo Spagnolo, as well as from comments of my colleagues at Boston University and the participants in seminars and conferences where preliminary versions were presented. I also thank Nicola Branzoli, Andrea Guglielmo, and Nate Young for helpful research assistance. I am thankful to the Italian Authority for Public Contracts for having provided the data used in the analysis. All remaining errors are my own.

[†] Go to http://dx.doi.org/10.1257/app.6.1.108 to visit the article page for additional materials and author disclosure statement(s) or to comment in the online discussion forum.

[1] The definition of public works includes a broad category of projects, financed by the government, that includes bridges, parks, roads, dams, railroads, and several other physical assets.

excessively favoring those bidders who are least likely to deliver what has been promised. Depending on the setup, this could mean a failure to respect the promised completion time, cost budget, or work quality, all of which I will consider as measures of ex post contract performance. Adverse selection, moral hazard, or the winner's curse fallacy can all explain the presence of this trade-off between price and performance.

Despite the vast theoretical literature, little is known about the empirical relevance of this trade-off. Indeed, although various studies address whether competition lowers quality, the direct test of the theories regarding FPAs is limited to only one prior study by Cameron (2000).[2] This is particularly surprising given the crucial policy relevance of FPAs,[3] but can be explained by the fact that the auction formats used in public procurement are infrequently modified. In this paper, I contribute to the empirical testing of FPAs effect on price and performance by studying their introduction for the procurement of public works in Italy. In the period between January 2000 and June 2006, I observe the switch of Italian public administrations (PAs) to FPAs for all their procurement of public works. I use differences in the timing of this switch across PAs to study the effect of FPAs on both winning bids and proxies for performance: the extra cost of the completed project (relative to the winning price) and the extra time to complete it (relative to the contractual time).

The main results confirm that the switch to FPAs substantially lowers the winning price, but that it also worsens performance. These results are obtained through a difference-in-differences identification strategy which is applied separately to two different large PAs that switched to FPAs in 2003: the County of Turin and the Municipality of Turin. In particular, the estimates for the latter indicate that FPAs increased the winning discount by approximately 13 percent of the reserve price, cost overruns by 6 percent of the reserve price, and the delay in the completion time by 28 percent of the contractual length of the job. The analogous switch for the County of Turin to FPAs instead generated a smaller increase of the winning discount, in the order of 8 percent of the reserve price, and an increase in the extra cost and extra time that is one-third in terms of magnitude of that estimated for the Municipality of Turin, and not statistically significant. These are quantitatively large effects, implying that in the Municipality of Turin the switch to FPAs almost doubled both the winning discount and the cost overruns.

An interesting finding of this study is that the difference in the effects of FPAs across the two PAs is related to how they screen bids for their reliability. Indeed, as is common in public procurement, PAs might exclude the highest discount if the offer is judged "too good to be true." Using the number of days between when bids are opened and when the contract is awarded as a measure of screening intensity, I observe that in both PAs the switch to FPAs is associated with an increase of this variable. However, the estimates suggest that the increase is almost double for the

[2] Cameron (2000) finds evidence of this trade-off analyzing the awarding of power purchase contracts with either FPAs or negotiated procedures. A few studies analyze the more general question of whether greater competition induces this trade-off. Ambiguous or even opposite findings are reported, like in the case of hospital competition studied in Kessler and McClellan (2000).

[3] For instance, the US Federal Acquisition Regulation (FAR) requires the use of FPAs for almost all the procurement of public works.

County of Turin relative to that for the Municipality of Turin. This finding suggests the presence of a second trade-off. Auctioneers can reduce the performance risk if they screen bids, but this activity is costly. There are two costs associated with bid screening: a direct cost, for instance the cost of the engineers assessing the bid reliability; and an indirect cost, generated by the lessening of competition induced among bidders. Heterogeneity in these costs might explain differences in screening intensity and suggests that a switch to FPAs might not always be successful. Although bid screening is typically required when awarding public works, this paper appears to be the first to quantify its interplay with FPAs.

In the final part of this study, I analyze a more recent wave of reforms that temporarily expand the use of FPAs in Italy, but that were ultimately reversed. Using a different sample that covers the period between July 2006 and July 2011, I present results showing that the mandatory use of FPAs for PAs previously refusing this mechanism reduces the winning price but also significantly increases the screening cost. Hence, the effectiveness of a switch toward FPAs appears to crucially hinge on a separate institution, the ex post bid screening.

The main findings of this paper regard the signs of the two trade-offs generated by the introduction of FPAs. Nevertheless, the large magnitude of the effects estimated has relevant policy implications for Italy, where the contracts affected by the policy change analyzed are worth €10 billion per year. More generally, this paper presents nontrivial policy implications indicating that the benefits of adopting FPAs in procurement depends on the strength of the institutions ensuring that bids are enforceable. When bid enforcement is highly effective, the competitive effect generated by FPAs is likely to produce cost savings. In contrast, when the status quo is characterized by a lack of effective institutions, any cost savings associated with a switch to FPAs will most likely be eroded by large deteriorations in performance.

Literature.—This paper is related to two branches of the literature. The first one concerns the trade-off between price and performance posed by FPAs. On this subject, numerous theoretical studies have shown that the poor ex post performance of FPAs could derive from either adverse selection, when bidders differ along their unobservable cost of reneging their bid (Spulber 1990),[4] or moral hazard, when the contract is incomplete (McAfee and McMillan 1986), or the winner's curse (Kagel and Levin 1986).[5]

This paper belongs to the much smaller empirical literature on this issue. The only other paper that directly tests how FPAs induce a trade-off between price and performance is Cameron (2000). She studies 93 long-term power purchase contracts awarded by utilities in five US states during the 1980s, using either FPAs or negotiations, and finds that FPAs increase the probability of a breach of contract by 50 percent. A related but separate question regards the effects of competition on quality in the context of FPAs. Ashenfelter, Ashmore, and Filer (1997) use 378 construction

[4] More recent developments are Waehrer (1995), Zheng (2001), Rhodes-Kropf and Viswanathan (2005), Board (2007), and Che and Kim (2010).

[5] A related issue is that of the optimal mechanism in this environments which is the object of Manelli and Vincent (1995); Burguet, Ganuza and Hauk (2009); and Chillemi and Mezzetti (2009).

contracts awarded in New York to study the effects of a policy limiting the use of general contractors in favor of competition by many smaller contractors. Their study also finds a worsening of performance, in terms of both cost overruns and delays. Compared to these earlier works, the present study exploits a larger sample consisting of thousands of contracts and a clean difference-in-differences identification strategy.

The second strand of the literature to which this study contributes is that concerning the strategic role of auctioneers in the procurement process. The theoretical work of Bajari and Tadelis (2001) shows how the auctioneer can influence the contract performance by investing in the completeness of the project design. The main result is that simple projects should have detailed design and be procured using fixed price contracts. Complex projects, instead, are better handled investing less in the project design, but using cost plus contracts. In subsequent empirical work, Bajari, McMillan, and Tadelis (2009) find empirical support for this hypothesis using a dataset of private sector construction contracts awarded in California from 1995 to 2001. Compared to these studies, the contribution of this paper is to present evidence on another channel that auctioneers can use to control the performance risk—the ex post screening of bids. Since this activity is costly for auctioneers, a second trade-off between performance and the screening cost is identified. Its role appears especially important since many public procurement regulations, including those in Italy and the United States, allow for bids screening while they strongly limit the use of other instruments like negotiations and cost plus contracts that, in principle, could also prevent the worsening of performance.

I. Public Procurement System and Policy Changes

A. *The Italian Public Procurement System*

With a few exceptions for military and strategic infrastructures, the procurement of contracts for the construction and maintenance of public works by all types of Italian Public Administrations (PAs) occurs broadly under the same regulation. This regulation experienced two systematic reforms, first in 1994 and then in (July) 2006. This study focuses on the period between January 2000 and June 2006, before the 2006 reform became effective. The 1994 system is shaped by the response to large corruption scandals and is characterized by an emphasis on rigid procedures. Contracts for public works can typically be procured exclusively through auctions based exclusively on price. Between 2000 and 2006, these auctions accounted for 79 percent of all procurements held and 82 percent of the total value of all contracts procured. For the remaining cases, the contracts were awarded either through negotiated procedures or through scoring rule auctions, in which multiple criteria enter to determine the winner. In this study, I will disregard these latter procurement methods. Thus, my results do not necessarily extend to contracts of small economic value (below €300,000), for which negotiations are allowed, and to contracts involving projects of high technical complexity, for which scoring rule auctions are used.

As regards the auctions based only on price, two distinct mechanisms exist: first price auctions (FPA) and average bid auctions (ABA). They are identical in

everything except for the exact way the winner is determined. For both formats the process starts with a PA releasing a call for tenders that illustrates the contract characteristics, including the maximum price the PA is willing to pay (i.e., the reserve price) and the procedure used (FPA or ABA). Then every firm qualified to bid for public contracts can submit its sealed bid, consisting of a discount over the reserve price.[6] If the FPA is used, then the highest "responsible discount" wins. A discount is not responsible if the PA judges that the bidder cannot fulfill the contract at the conditions promised. What characterizes the ABA is that the judgment of which discounts are not responsible is automated through an algorithm that discharges discounts greater than a kind of trim mean.[7] Thus, in an ABA the highest discount is always eliminated. In contrast an FPA only eliminates the highest discount if it does not pass the reliability screening performed by the auctioneer.[8] In about 10 percent of the FPA in my sample the highest discount is excluded because it fails this screening. In theory, the winning bidder selected by the ABA algorithm may be excluded if its bid is judged unreliable, but this rarely happens and never occurs in the ABAs I observe.

B. *Timing of the Reforms*

In the period between January 2000 and June 2006, the regulation required the use of ABAs for all contracts with a reserve price below (approximately) €5 million. The European Union regulation mandates the use of FPAs for contract at or above this value.[9] However, some PAs were dissatisfied with the ABA, judging it as a source of widespread collusion. In January 2003, after a case of collusion in ABAs became public, the Municipality of Turin ruled to replace ABAs with FPAs for all contracts. Two months later, the same reform was followed by the County of Turin. However, the central government challenged these reforms in court on the ground that only State laws could modify the auction format. This fact prevented similar reforms in other PAs. Thus, until the 2006 reform, essentially no other PA could replace ABAs with FPAs. Therefore, although the switch to FPAs is clearly not random, the fact that it occurred first in Turin and only years later in other similar

[6] Firms qualify to bid if they are certified for the typology and value of the contract auctioned off. Certifications last five years, but are reassessed every three years. They are based on various criteria in terms of capital, portfolio of completed public contracts and lack of mafia connections for mangers and owners.

[7] The ABA algorithm works as follows. First, discounts are ordered from the lowest to the highest and a trim mean (A1) is calculated by excluding 10 percent of the highest and lowest bids. Then a new threshold (A2) is calculated as the average between all the discounts greater than A1, but lower than the lowest discount in the top 10 percent of bids. The highest discount *strictly* below A2 wins. All discounts equal or above A2 are eliminated because they are automatically considered too high to be reliable. This rule applies only if at least five bidders participate. Otherwise the winner is the highest responsive bidder. This latter case happens in less than 5 percent of the auctions in my sample.

[8] Notice that ABAs are not an Italian peculiarity and are widely used in various countries (see Decarolis 2009). They were devised by civil engineers (see Ioannou and Leu 1992) to ease competition and, thus, reduce the performance risk posed by FPAs.

[9] The original formulation of the 1994 reform did not include the ABA but only the FPA. Systematic low-balling by unreliable contractors lead first to the introduction of higher security deposits for firms winning with particularly high discounts. Later, this approach was abandoned in favor of a direct modification of the awarding criterion, which, after a few short lived attempts, stabilized in 1998 in the ABA rule described above. After 1998, the system of guarantees was never altered and, hence, it is not explicitly considered in my analysis. It is based on letters of credit whose amount is usually 20 percent of the reserve price in my data.

PAs is due to causes unrelated to the effects of FPAs. In the description of my identification strategy, I will further clarify how I estimate the effects of FPAs on auction outcomes by exploiting this difference in the timing of adoption of FPAs between Turin and other similar PAs. I will also discuss how the presence of collusion in the Turin ABAs influences the coefficients interpretation. In the final part of this study, I will show results based on more recent reforms that, between 2006 and 2011, first expanded and then reduced the role of FPAs. Until that section, the only aspect of the July 2006 reform worth mentioning is that it allowed every PA to freely choose between the ABA and the FPA. Indeed, I will use the characteristics of those PAs adopting FPAs after June 2006 to guide my choice of the control group for the analysis of the 2003 reform in Turin.

II. Theory Overview

In the context of the public procurement of works, it is well known that the standard assumptions under which the optimality of the FPA is derived are not satisfied. Spulber (1990) argues that cost uncertainty is what primarily distinguishes auctions for contracts from auctions for goods. Since transactions do not take place instantaneously, shocks can affect the cost of performing the job over the life of the contract.[10] Under this cost uncertainty, the asymmetric information between the auctioneer and the firms can generate problems of adverse selection, moral hazard, and winner's curse. The implication for the auctioneer is that different auction formats will induce different trade-offs between the savings due to a high winning discount and the losses due to poor ex post performance.

A. *The Trade-Off between the Winning Bid and Performance*

Several studies, referenced in the literature review above, have proposed theoretical models showing how FPAs can exacerbate adverse selection problems. In models of this type, bidders differ in a privately observed cost of defaulting ex post on their bid. In equilibrium, they anticipate the advantage of a low default cost and "gamble" on the final cost of the project offering a high discount that does not cover the production cost if certain states of the world are realized ex post. In these cases, the winner will default unless the PA agrees to renegotiate the terms of the contract. Although the PA faces this ex post risk, at the auction stage it benefits from the high competition FPAs induce. Even if only some of the bidders can credibly threaten a default, their presence induces the other firms to respond by increasing their discounts. An example of a model formalizing these results is in Decarolis (2013). However, isomorphic results can also be derived replacing the risk of default with other measures of performance like low-quality work, cost overruns, and time delays.[11]

[10] For the auctions that I analyze, the deadline for submitting bids is, on average, four months before the starting date of the work, and then the work lasts for about six months.

[11] Similarly, moral hazard can exacerbate the trade-off when the contract does not fully specify all the precautions that the contractor should take. The bidder that underinvests the most in these precautions offers the highest

B. *The Trade-Off between Performance and the Screening Cost*

To preserve the benefits of FPAs while limiting the performance risk, three main systems are typically used: financial guarantees to support bids, ex ante pre-qualification requirements for bidders, and ex post screening of bids reliability. From a theoretical perspective, each of the three systems, or their combinations, could, in principle, solve the risk of ex post performance. The Italian system requires partial insurance[12] and bidder pre-qualification,[13] and allows PAs to conduct ex post screening. As regards this last feature, when FPAs are associated with an ex post bid screening capable of excluding risky bids, equilibrium prices should be higher than without the screening. Indeed, strategic bidders aware of the screening will respond by submitting higher prices that will not be judged unreliable. This will lessen competition across all bidders and, hence, induce lower winning discounts. Nevertheless, the effect on the procurement cost would be ambiguous because costs associated with ex post defaults and renegotiations would be reduced. Moreover, when screening is costly, an auctioneer should also factor in its direct cost.

C. *The ABA and the Expected Effects of a Switch from ABA to FPA*

The ABA is an auction format suggested (or imposed) by the public procurement regulation of numerous countries to limit the risk of low prices being associated with low performance. Despite its frequent utilization, the ABA has received little attention in the literature. An exception is Decarolis (2013), who shows that the type of ABA used in Italy has a unique equilibrium in which all bidders offer a price equal to the auction reserve price, and that, hence, the allocation of the contract is random across all bidders. Conley and Decarolis (2012) extend this result to show that this equilibrium is weak to collusion, but that even with collusion the allocation resembles an unfair lottery and the awarding price is higher than in an FPA, although typically lower than the reserve price. This bidding behavior has an intuitive explanation. In order to win, every bidder (or coalition of bidders) tries to guess where the other bidders are guessing the relevant trim mean will lie, which creates a concentration of bids in a narrow range. The public disclosure of past winning discounts implies that these discounts can work as a simple coordination device to determine the range within which discounts will lie. Taken together, these findings imply that low ex post performance is less likely in ABA relative to FPA because the most risky firms are not more likely to win and the winner receives a larger payment from completing the job. As regards the trade-off between performance and screening, Decarolis (2013) compares four auction formats: an ABA and an FPA, each of which can be supplemented by screening. The ABA with screening is a dominated

discount but is the most likely to underperform. Finally, the winner's curse might arise in situations involving inexperienced firms or complex contracts when the winner underestimates costs.

[12] As described earlier, this consists in letters of credit covering around a fifth of the contract value. In contrast, in the United States, the Miller Act requires performance bonds covering 100 percent of the contract value.

[13] This consists of mild quantitative requirements (see also footnote 6). Illinois DoT, as an alternative example, admits only firms with an available capacity judged sufficient for the specific project auctioned off.

option because an FPA with screening causes the same direct cost of screening but lowers the winning price, without worsening performance.

To summarize, a switch from ABAs to FPAs should cause a decrease of the price at which the contract is awarded, a worsening of the measures of ex post performance, and an increase in bid screening. The experiment of switching to FPAs when ABAs are the status quo is nearly ideal to study the effects of the FPAs because, relative to ABAs, FPAs should foster a major increase in competition, and because an environment where ABAs are used is likely characterized by weak institutions for contract enforcement.

III. Data

A. *Details about the Chosen Samples*

The analysis is based on the database of the Italian Authority for Public Contracts (Authority sample). The contracts are awarded between January 2000 and June 2006. They are followed until the date of completion or August 2011, whichever comes first. The Authority collects data on all contracts for public works with a reserve price above €150,000 procured by all PAs. However, I restrict my analysis to only the simplest types of public works (consisting mostly of roadwork construction and repair jobs), awarded through either ABAs or FPAs, having a reserve price between €300,000 and €5 million, auctioned off by either counties or municipalities located in five regions in the North (Piedmont, Lombardy, Veneto, Emilia, and Liguria). These simple contracts are among the most commonly procured, representing about a quarter of all the public works procured. Moreover, they are the most appropriate for the analysis of FPAs on winning bids because their reserve prices are comparable across PAs. Indeed, since bids are rebates over the reserve price, the comparability of winning discounts depends on the comparability of auction reserve prices. A key feature of the contracts that I study is that the PA is not in full control of the reserve price. The PA engineers evaluate the types and quantities of inputs needed to complete a project. The reserve price is then obtained by multiplying these inputs by their prices and summing up these products. However, input prices are not the current market prices but list prices set every year for the respective regions and used exclusively by PAs to calculate reserve prices. The similarity of these prices in the five chosen regions helps the comparability of reserve prices. Furthermore, at least in the case of simple roadwork jobs, it seems plausible to assume that there is not too much discretion in the type and quantity of inputs to use. The technology of the work determines them. Since the geographical area that I study is rather homogeneous, similar roadwork jobs likely require the same types and quantities of inputs in all the PAs in my sample.[14]

[14] It is worth noting that PAs cannot set the reserve price in a different way on the basis of the auction format chosen. A regression analysis (not reported) of the reserve price on a list of regressors that include an FPA dummy indicate that this dummy is never statistically significant.

Table 1—Descriptive Statistics: Authority Sample

	January 2000 to December 2002								
	Municipality of Turin			County of Turin			Other PAs		
Variables	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
Winning discount	17.07	5.05	121	17.32	5.90	63	12.83	6.17	1,009
Extra cost	5.79	8.67	83	6.87	16.98	45	5.30	10.66	672
Extra time	47.11	53.17	75	62.80	66.76	47	63.30	75.73	711
Days to award	146.9	40.96	111	97.59	42.66	44	59.38	39.89	768
Reserve price	919.1	776.8	121	914.1	805.4	63	868.8	710.5	1,009
Number of bidders	59.91	26.85	121	40.25	40.49	63	37.54	34.53	1,009
Population	900.6	0	121	2,243	0	63	1,024	1,083	1,009
Experience	523	0	121	416	0	63	186.4	90.98	1,009
Fiscal efficiency	0.75	0.04	121	0.88	0.02	63	0.81	0.14	1,009
	January 2003 to June 2006								
	Municipality of Turin			County of Turin			Other PAs		
Variables	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
Winning discount	30.97	9.84	156	27.66	7.26	137	12.38	5.45	930
Extra cost	13.94	13.88	79	6.666	9.66	62	7.992	13.84	665
Extra time	56.06	66.17	92	79.65	89.51	87	53.73	73.82	697
Days to award	121.4	82.62	94	101.6	49.65	100	30.68	34.32	425
Reserve price	1,371	892.7	156	988.5	760.5	137	922.1	791.0	930
Number of bidders	7.62	9.34	156	12.72	15.32	137	46.99	35.19	930
Population	900.6	0	156	2,243	0	137	388.4	245.9	930
Experience	523	0	156	416	0	137	171.4	75.24	930
Fiscal efficiency	0.81	0.04	156	0.87	0.03	137	0.87	0.09	930

Notes: Winning Discount is the rebate offered by the winning bidder and is expressed as the percentage discount over the reserve price. *Extra Cost* is the difference between the final price paid to the winning bidder to complete the work and the winning price, expressed as a percentage of the reserve price. *Extra Time* is the difference (in days) between the actual time to complete the work and the contractual completion time, expressed as a percentage of the contractual completion time. *Days to Award* is the difference (in days) between when the bids are opened by the awarding commission and when the PA announces the identity of the winner. *Reserve Price* is the reserve price in thousands of Euro. *Number of Bidders* is the number of bidders. *Population* is the resident population in thousands of persons. *Experience* is the number of auctions run by the Public Administration in the sample period. *Fiscal Efficiency* measures for each PA and each year the total actual revenues from taxation over the total expected revenues from taxation.

The summary statistics for the Authority sample are presented in Table 1. The statistics are reported separately by both time (for the periods before and after the reform in Turin) and identity of the auctioneer (the County and Municipality of Turin and All Other PAs). Notice that the County of Turin administers a population that is almost twice that of the Municipality of Turin. However, counties in Italy manage very few public services, and so have more limited resources, relative to municipalities. For instance, the total expenditures of Turin County in 2004 were just one quarter of those of the municipality. Nevertheless, road maintenance, which is the object of most of the contracts in my dataset, is a core activity for counties: in Turin the county is in charge of 3,728 kilometers of roads relative to the 1,678 kilometers of the municipality. In the next section, I will further discuss how these differences might explain some of the empirical findings.

In the final part of the paper, I will discuss a different dataset that I refer to as the Information Entrepreneur sample (or IE sample). It is based on official releases of roadwork jobs auction outcomes that are collected by a specialized firm, the IE, to

resell them to interested bidders. This sample covers a different time period (July 2006 to July 2011) and does not contain information on the contract performance.

B. *The Dependent Variables*

Winning Discount.—The main dependent variable is the *Winning Discount*, through which I measure the rebate (between 0 percent and 100 percent) over the reserve price offered by the firm that is awarded the contract. As discussed below, even in FPAs the winning discount is the highest accepted discount, which is sometimes lower than the highest offered discount.

Performance.—There is no single variable in the data that can fully capture the idea of performance. The Italian Authority for Public Contracts reports statistics on contract performance using two proxies of performance: cost overruns (the difference between the final payment and the winning bid as a percentage of the reserve price) and time delays (the difference between the actual and the contractual time as a percentage of the contractual time). I follow the Authority and use these two measures, which are also the ones used in Ashenfelter, Ashmore, and Filer (1997).[15] In the following analysis, I will refer to these two variables as *Extra Cost* and *Extra Time*. In principle, cost overruns are not allowed by the regulation except in a few exceptional cases (like the presence of errors in the original project). Nevertheless, once the contract is awarded, there can be a hold up problem inducing the PA to accommodate the contractor's request of extra payments. In terms of delays, the rules are less rigid because the penalties (for each day of delay) are generally very small and rarely enforced. Although intuitively *Extra Cost* and *Extra Time* should be positively associated, in the data their correlation is only 0.04. This is because many factors influence them differently. For instance, a contractor might not want to delay the completion of a high-cost project (because penalties are typically linked to the awarding price), but might try to renegotiate its price more forcefully (because bargaining over the renegotiated amount is often done in terms of percentages of the awarding price). Thus, it seems appropriate to analyze whether the switch to FPAs has any effect separately for *Extra Cost* and *Extra Time*.[16]

Screening Cost.—Similarly to the case of performance, I only observe an imperfect proxy. In particular, I use a variable measuring the difference (in days) between when the bids are opened by the awarding commission and when the PA announces the identity of the winner. I will refer to this variable as *Days to Award*.[17] During this period, the engineers of the PA review the bids submitted and can ask bidders

[15] The importance of cost overruns in the context of public procurement has been analyzed by Bajari, Houghton, and Tadelis (2007), while that of time delays is the subject of Lewis and Bajari (2011).

[16] A different measure of performance is the quality of the job done. Although I do not directly observe quality, I present results using different splits of the data separating relatively simple and complex jobs. Quality concerns matter more when the project design is incomplete, which happens more frequently for complex jobs (Bajari and Tadelis, 2001).

[17] In an earlier version of this study titled *First Price Auctions and the Trade-off between Performance and Screening Costs*, this variable was measured differently for the Authority sample. In the current version, there is no difference in the measurement of *Days to Award* between the Authority and the IE samples.

to justify the prices they offered. Even if in the data there is a near zero correlation between this variable and the two measures of performance, this measure is useful to assess the screening intensity of the PA. Indeed, for the IE sample (but not for the Authority sample), I observe the decision of the PA officials to disqualify a bid because of its inadequate cost justifications. In about 10 percent of the FPAs the highest discount is disqualified for this motive. In contrast, it is never the case that the firm indicated by the ABA algorithm as the winner is disqualified for these motives. Typically, in the cases when the highest bidder is disqualified, the second highest bidder wins, but in a few cases there are further rounds of firm eliminations. Thus, it is conceivable that the increase in the number of days to award the contract comes at the benefit of the selection of a more reliable contractor. When a firm bid is judged unreliable, it can appeal a court to overrun the PA decision. In this case the PA lawyers need to intervene. In addition to the direct costs of engineers and lawyers, screening induces indirect costs by slowing the procurement process and generating transaction costs. Thus, my measure of screening cost is a coarse measure that proxies for several distinct costs.

IV. Empirical Analysis

A. *Empirical Strategy*

In this section, I explain the empirical strategy used to identify the effect of the FPA on auction outcomes. The methodology will be analogous to a difference-in-differences (DD) regression exploiting the difference in the timing with which Turin adopted FPAs relative to other PAs. Compared to a standard DD analysis, the only differences are due to some features of the pretreatment regime.

Therefore, the model to be estimated is

$$Y_{ist} = a_s + b_t + c\mathbf{X}_{ist} + \beta FPA_{st} + \varepsilon_{ist}, \tag{1}$$

where the index i indicates the auction, s indicates the PA, and t indicates the year. The coefficient of interest is β, the effect on the dependent variable of a dummy equal to one for FPAs and zero for ABAs, conditional on fixed effects for the PA (a_s) and time (b_t), and on other covariates $(\mathbf{X})$. There are two main challenges to interpret β as the causal effect of the switch to FPAs.

The first challenge is that the treated PAs are not randomly assigned to the FPA, but switch to it voluntarily. Therefore, an obvious concern is that improvements in auction outcomes observed for Turin might overstate the positive effects of FPAs for the other PAs. My main strategy to address this problem consists of appropriately defining the control group for the DD analysis.[18] This strategy relies on two assumptions. The first one asserts the essential randomness that the switch observed in 2003 occurred in Turin and not in another one of the PAs that would have abandoned the

[18] The spirit is similar to that of the DD matching strategy of Heckman et al. (1998), but, as clarified in the main text, the matching is on the PAs and not on the single auctions.

ABA had the central government not challenged the Turin reform. This assumption is justified by the fact that the switch in Turin was triggered by a large case of collusion in ABAs becoming public.[19] However, the ABAs of many other PAs were also affected by collusion. In fact, several of the firms accused in Turin were from other regions and regularly bid in ABAs all over the country. Moreover, in the same period, various other collusion cases were brought to court by other PAs.[20] Therefore, it is likely that Turin was the first to abandon the ABA only because its collusion case was the first to emerge publicly. This fact is not related to the expected effects of the introduction of FPAs in Turin but to the timing of the specific judicial case. Moreover, as discussed earlier, the opposition of the central government to any reform of the auction method at a local level blocked other switches to FPAs. Thus, it is plausible to consider as quasi-random the fact that the switch occurred in Turin and not in another PA that would have chosen to switch to FPAs absent the ban from the government.

The second assumption on which my identification strategy relies is that we can reasonably infer which PAs would have switched together with Turin if so allowed. The justification for this second assumption is based on what happened after July 2006 when all PAs became free to switch to FPAs.[21] In this period, the data reveal that counties and the larger municipalities were the PAs most likely to switch to FPAs. In the IE sample, in the period between July 2006 and October 2008, there are 26 PAs that voluntary abandon ABAs in favor of FPAs (157 PAs remain with ABA). Compared to the PAs remaining with ABAs, the ones adopting FPAs administer larger populations and award more auctions. I will refer to these two measures of PAs size as *Population* and *Experience*, respectively. The results of probit regressions (reported in the online Appendix) confirm that *Experience* and *Population* are the only relevant determinants of the adoption of FPAs.[22] Indeed, potentially relevant variables for the decision to switch to FPAs, such as competitiveness of the ABAs and measures of PA corruption and political orientation, are shown not to be statistically significant. Therefore, since only *Experience* and *Population* drive the adoption of FPAs after 2006, I consider the PAs similar to the treated PAs along these two dimensions as being likely to have switched in the period of interest (i.e., around 2003) if so allowed. More precisely, I construct three different control groups for the DD analysis. In the first one, the PAs chosen are close to the treated one in terms of *Experience*, in the second they are close in terms of *Population,* and in the third they are close along both dimensions. The exact measures used are reported in the note to Table 2 and were subject to extensive robustness checks.

Comparing the observed quasi-experiment in Turin to an "ideal experiment" reveals why these two assumptions permit the identification of a causal effect and what are the main caveats. The ideal experiment would be an assignment to the

[19] This case involved about 95 firms that were accused of having formed eight cartels rigging ABAs in the Turin area. Further details are described in Conley and Decarolis (2012).

[20] All the cases of collusion brought to court involve ABAs and not FPAs. Moreover, the winning discounts in FPAs appear rather competitive averaging around 30 percent of the reserve price. Since collusion in the FPAs that I observe is at most a second order effect, I will ignore it in my discussion of this mechanism.

[21] This liberalization, mandated by the European Union is described in the next section.

[22] This is consistent with the idea of FPAs being advantageous only for large PAs that can spread the large fixed cost of the ex post screening over many auctions.

FPA that is both at contract level and fully random. The observed quasi-experiment, instead, assigns the FPAs at the PA level. This requires that the interpretation of β has to be at the PA level (which, however, is the most relevant level for policy analysis). The second aspect, the nonfully random assignment, is more problematic. The two assumptions stated above are meant to argue that random assignment occurs at the PA level within the union of the treatment and control groups. This randomization ensures the identification of β, but the required asymptotic is that the number of PAs goes to infinity. Evidently, since only Turin is treated, we are far from satisfying such asymptotic condition. Anything that happened in Turin at the same time of the switch to FPAs and that affected all the contracts will bias the results. A solution to this problem, often plaguing DD studies, has been proposed by two closely related papers: Abadie, Diamond, and Hainmueller (2010) and Conley and Taber (2011). These studies show that under random assignment at the PA level, the PAs in the control group can be used to construct a distribution of PA-level shocks permitting us to conduct valid inference on β. Hence, the asymptotic requirement regards only the PAs in the control group and is likely satisfied in the current setting, where a large number of PAs can be included in the control group.

The second challenge to the DD strategy lies in features of the pretreatment regime, which matter for both the construction of the DD estimator and for the interpretation of the estimates. The major feature of ABAs is that a basic range for winning discounts is predictable across auctions within a PA. For instance, for ABAs of the Municipality of Turin, the winning discount is typically around 18 percent and, within each single auction, almost all bids are concentrated around this discount. The approximate mode of the bid distribution changes across PAs, but it is rather stable within PAs over time and across contracts. Intuitively, this happens in a way reminiscent of the *p*-mean games of Nagel (1995). In an ABA, a firm trying to win must bid close to the discount that it believes the other firms are thinking will win. Coviello and Mariniello (2011) offer a detailed account of the disclosure of information in this market showing that information on both past and future auctions is easily available. In turn, the availability of this type of information is what makes the bidding behavior described above feasible. Conley and Decarolis (2012) show that this behavior is compatible with an equilibrium when both colluding and independent firms are bidding. The implication for the DD estimator is that it is essential to include PA fixed effects. Moreover, multiple observations of the winning discount, both before and after the treatment date, are needed to have a more precise estimate of the approximate mode.[23]

Furthermore, this aspect matters for the interpretation of the estimates. Although the central objective of this study is to test coefficient signs, their magnitude has relevant policy implications. The baseline estimates are an average treatment on the treated, which is of interest given the economic relevance of Turin. This effect might differ from the average treatment effect because Turin might differ from other PAs in terms of the prevailing discount under ABAs. But, by restricting the set of control

[23] However, as the number of auctions observed in each period rises, the number of PAs usable for the treatment group rapidly declines. For this reason, I require observing at least five auctions both before and after the treatment date for each of the PAs in the control groups.

PAs to those having a prevailing discount similar to that of Turin, it is possible to evaluate the estimates as an average treatment effect for these PAs and to compare them with the previously found average treatment on the treated.

In the remaining part of this section, I first introduce a set of baseline DD estimates obtained using the three groups of control PAs described above and two model specifications differing in the set of covariates considered. Then, I assess the robustness of these baseline estimates relative to the various threats to identification discussed in the first part of this section. In the online Appendix, I also explore a different identification strategy based on matching treated and control auctions along their observable characteristics. The results available in the online Appendix are qualitatively very similar to the ones that follow.

B. *Effects of the FPA on Price, Performance, and Bids Screening: Baseline Estimates*

The DD estimates for the Municipality of Turin and the County of Turin are presented in Table 2 and 3, respectively. Each table has four panels, one for each of the dependent variables studied: the winning discount, the cost overrun, the time delay and the number of days taken to award the contract. Within each panel, the results of six regressions are reported. These are the results obtained using the three different control groups described above and, for each of them, estimating the effect of the FPA dummy with and without controls for the contract and the PAs characteristics. The exact details are given in the notes of each table.

For the Municipality of Turin, the results indicate that the switch from ABAs to FPAs is associated with a large and statistically significant increase in the winning discount.[24] The increase ranges between 12 and 14 percent of the reserve price. Suggesting a potential saving at the time of the auction of about €180 thousand per auction. Nevertheless, part of this savings at the awarding stage is lost to higher cost overruns. Indeed, FPAs are associated with an increase of the final price paid to the contractor. With FPAs, PAs are paying more than the contractual price, and that amount is roughly equal to 4–7 percent of the reserve price. Thus, between one-third and one half of the initial savings are lost due to ex post renegotiation. Moreover, the completion times are often delayed. Completing the work takes between 19 and 39 percent longer than what was written in the contract. Finally, as regards the effect of the FPA on the proxy for screening costs, the estimates reveal an increase ranging between 24 and 34 days in the time taken to award the contract.

The results for the County of Turin are similar although they reveal some potentially interesting differences. As regards the winning discount, the switch to the FPA has a positive and statistically significant effect of about 8 percent. Since under the ABA both the County of Turin and the Municipality of Turin had an approximate mode of the winning bid distribution at 18 percent, it is legitimate to compare the increases in the winning discount estimated for the two PAs concluding that the increase is weaker for the County of Turin. Nevertheless, the County of Turin also experiences less worsening

[24] Since three control groups are used, standard Bonferroni and Dunn-Sidak corrections for multiple testing were checked without finding losses of significance such as to alter the sense of the findings.

Table 2—Difference-in-Differences: Municipality of Turin

	W. Discount (1)	W. Discount (2)	W. Discount (3)	W. Discount (4)	W. Discount (5)	W. Discount (6)
Panel A. Winning discount (percentage of reserve price)						
First price auction	13.10***	11.99***	13.32***	12.02***	13.71***	12.26***
	(1.609)	(1.315)	(1.770)	(1.469)	(1.720)	(1.380)
Observations	1,262	1,262	1,275	1,275	880	880
R^2	0.505	0.639	0.493	0.614	0.526	0.644
	Extra cost (1)	Extra cost (2)	Extra cost (3)	Extra cost (4)	Extra cost (5)	Extra cost (6)
Panel B. Cost overrun (percentage of the reserve price)						
First price auction	5.092**	4.197*	7.108***	5.719***	7.158***	5.557**
	(2.177)	(2.220)	(2.029)	(2.168)	(2.271)	(2.395)
Observations	1,203	1,203	1,215	1,215	865	865
R^2	0.184	0.206	0.107	0.143	0.153	0.197
	Extra time (1)	Extra time (2)	Extra time (3)	Extra time (4)	Extra time (5)	Extra time (6)
Panel C. Completion time delay (percentage of contract length)						
First price auction	25.23**	34.18***	19.36*	27.98***	27.73**	39.28***
	(12.05)	(12.13)	(9.814)	(10.14)	(10.78)	(12.00)
Observations	1,110	1,110	1,084	1,084	747	747
R^2	0.085	0.122	0.111	0.148	0.095	0.147
	Days award (1)	Days award (2)	Days award (3)	Days award (4)	Days award (5)	Days award (6)
Panel D. Days to award the contract (after bids are opened)						
First price auction	28.70***	26.23**	27.29**	23.54**	34.05***	33.04**
	(10.78)	(11.18)	(10.50)	(11.64)	(11.72)	(14.40)
Observations	777	777	777	777	549	549
R^2	0.554	0.566	0.531	0.547	0.546	0.565

Notes: Standard errors clustered by public administration and year. The columns in the tables report the results using the DD with different control groups and controls. Columns 1 and 2 use as control group all PAs with a value of experience that is within 75 percent of that in the treated group (either the Municipality or the County of Turin). I will refer to this as control group 1. Columns 3 and 4 use as the control group all PAs with a value of population that is within 75 percent of that in the treated group (either the Municipality or the County of Turin). I will refer to this as control group 2. Columns 5 and 6 use as control group the intersection between control group 1 and 2. For each control group used, the two columns report results of DD estimated with different control variables. Odd number columns include only year and public administration dummies. Even number columns include year, public administration, municipality type, and work type dummies, and the reserve price.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

of performance. Indeed, although the sign of the estimates of the FPA on cost overruns and time delays is positive, in none of the specifications are these estimates statistically significative. Moreover, the magnitude of the coefficients is smaller. For both cost overruns and time delays the coefficients are approximately one-third of those estimated for the Municipality of Turin. Finally, an additional difference between the two PAs concerns the change in the number of days to award the contract. The effect for the County of Turin is highly statistically significant with a magnitude almost twice that found for the Municipality of Turin, ranging between 35 and 59 days.

TABLE 3—DIFFERENCE-IN-DIFFERENCES: COUNTY OF TURIN

	W. Discount (1)	W. Discount (2)	W. Discount (3)	W. Discount (4)	W. Discount (5)	W. Discount (6)
Panel A. Winning discount (*percentage of reserve price*)						
First price auction	8.653***	8.688***	8.579***	8.294***	8.784***	8.663***
	(1.151)	(1.101)	(1.311)	(1.166)	(1.332)	(1.099)
Observations	1,355	1,355	653	653	567	567
R^2	0.419	0.579	0.544	0.671	0.553	0.675
	Extra cost (1)	Extra cost (2)	Extra cost (3)	Extra cost (4)	Extra cost (5)	Extra cost (6)
Panel B. Cost overrun (*percentage of the reserve price*)						
First price auction	1.054	1.052	0.0426	0.153	1.597	1.168
	(3.183)	(3.309)	(3.287)	(3.573)	(3.171)	(3.298)
Observations	650	650	1,290	1,290	577	577
R^2	0.147	0.167	0.117	0.139	0.150	0.173
	Extra time (1)	Extra time (2)	Extra time (3)	Extra time (4)	Extra time (5)	Extra time (6)
Panel C. Completion time delay (*percentage of contract length*)						
First price auction	12.95	10.76	9.688	7.987	10.36	9.590
	(17.84)	(18.72)	(16.12)	(18.27)	(17.65)	(20.00)
Observations	1,206	1,206	560	560	498	498
R^2	0.089	0.126	0.065	0.106	0.067	0.106
	Days award (1)	Days award (2)	Days award (3)	Days award (4)	Days award (5)	Days award (6)
Panel D. Days to award the contract (*after bids are opened*)						
First price auction	35.02***	37.49***	48.00***	53.45***	53.53***	59.33***
	(7.862)	(8.295)	(6.994)	(7.866)	(8.821)	(9.401)
Observations	817	817	443	443	386	386
R^2	0.383	0.409	0.390	0.434	0.428	0.473

Notes: Standard errors clustered by public administration and year. The structure of the table is the same as Table 2. Refer to that table for the description of the control groups and the controls used in the different regression models.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Analyzing in detail why the behavior of the two PAs differs is beyond the scope of this paper. Nevertheless, it is worth noting that counties are typically associated with lower cost overruns and delays than municipalities. This is mainly due to three reasons. First, while municipalities derive most of their revenues directly from local taxes, counties mostly rely on state transfers.[25] Therefore, counties have less flexibility to adjust to cost overruns ex post. Second, counties have smaller budgets and administrative structures than large municipalities. Therefore, counties might be particularly sensitive to hold up in a contract with a potentially unreliable contractor.

[25] For instance, in 2004 the Municipality of Turin derived 620 million euros from taxes and 270 million euros from transfers. Instead, the County of Turin derived 190 million euros from taxes and 220 million euros from transfers.

Table 4—Robustness Checks: PA-Time Variables (*Control Group 1*)

	W. Discount (1)	W. Discount (2)	Extra cost (3)	Extra cost (4)	Extra time (5)	Extra time (6)	Days award (7)	Days award (8)
Panel A. Municipality of Turin								
FPA	12.18***	6.136***	32.43**	5.323	5.987***	−0.821	30.51***	25.44
	(1.329)	(1.305)	(12.67)	(28.38)	(1.937)	(3.583)	(11.21)	(22.61)
Fiscal effic.	YES	NO	YES	NO	YES	NO	YES	NO
Time trend	NO	YES	NO	YES	NO	YES	NO	YES
Observations	1,262	1,262	1,110	1,110	1,092	1,092	777	777
R^2	0.639	0.651	0.122	0.135	0.156	0.170	0.568	0.597
	W. Discount (1)	W. Discount (2)	Extra cost (3)	Extra cost (4)	Extra time (5)	Extra time (6)	Days award (7)	Days award (8)
Panel B. County of Turin								
FPA	8.705***	5.685***	11.20	14.99	0.294	−5.445	36.45***	17.71**
	(1.086)	(1.258)	(18.75)	(32.97)	(3.587)	(5.257)	(8.347)	(8.322)
Fiscal effic.	YES	NO	YES	NO	YES	NO	YES	NO
Time trend	NO	YES	NO	YES	NO	YES	NO	YES
Observations	1,355	1,355	1,206	1,206	1,167	1,167	817	817
R^2	0.579	0.592	0.126	0.141	0.149	0.175	0.410	0.466

Notes: Standard errors clustered by public administration and year. The dependent variable is reported at the top of each column. All regressions control for year, public administration, municipality type, and work type dummies as well as for the reserve price. A YES in the row "fiscal effic." indicates that the regression model also includes the variable *Fiscal Efficiency* among the controls. Instead, a YES in the row "time trend" indicates that the regression model also includes both a time trend and PA-specific time trends among the controls. Results obtained using Control Group 1 (Experience). Results for the other two control groups are in the online Appendix.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Finally, as discussed earlier, the maintenance of roads is one of the few core activities of counties. Hence, counties might be more concerned about the negative influence of project delays on the functioning of the road network.

C. *Robustness Checks*

In the final part of this section, I illustrate several robustness checks for the DD estimates. The first set of robustness checks deals with the presence of common time trends among the treated and control groups. As it is well known, the presence of these common trends is fundamental for the DD analysis. As it is common in the DD literature, I conduct this robustness check by augmenting the models of Table 2 and 3 with PA-specific, time-varying variables. In particular, for each of the four dependent variables, the first coefficient in Table 4 is obtained by including among the controls a measure of fiscal efficiency often used in public finance—the ratio between the actual and expected tax revenues. The second coefficient is obtained by including among the controls a PA-specific time trend. To confirm the baseline estimates, the estimated coefficient on the FPA dummy should not be affected by the inclusion of PA-specific, time-varying controls. I report the results only for the

experience-based control group and the model with auction and PA covariates.[26] The results in Table 4 confirm the large effect of FPAs on the winning discount, even though the inclusion of the time trend reduces the magnitude of the estimates for both PAs. This is possibly due to the winning discount not only jumping in 2003 but also increasing in the following years due to firms learning to compete in FPAs. A confirmation of the previous results also comes from the last two columns, which reveal that a strong and statistically significant increase in the days to award occurs only for the County of Turin. Contrary to the previous results, none of the estimates of FPAs on the performance measures retains significance at the 5 percent level. However, since these variables are at greater risk of measurement error relative to the other two dependent variables, the spurious variation due to measurement error might confound the detection significant effects. Alternatively, this could result from a sample selection bias driven by the fact that contracts with more extreme time delays are more unlikely to be in the sample the closer they are to 2006. However, I will argue that sample selection does not appear to be a major concern.

The second set of robustness checks focuses on the standard errors used to conduct inference about the effect of FPAs. The baseline results, as well as the estimates reported in Table 4, report standard errors clustered at the PA-year level. This level of clustering is conventionally used in DD studies and seems particularly appropriate here because of the presence of a PA-specific approximate mode for winning discounts that might change across years. Nevertheless, the well-known criticism of Bertrand, Duflo, and Mullainathan (2004) regarding errors autocorrelation causing the PA-year level clustering to produce statistical significance when significance is in fact absent, requires assessing whether the estimate of β remains significant once standard errors are clustered at PA level. Table 5 reports the 95 percent confidence intervals (CI) obtained when replicating the regressions presented in Table 4 using different sets of standard errors. The first row shows the CI when the standard errors are clustered at the PA-year level, while the second row reports the CI when clustering is performed at the PA level. None of the estimated coefficients show a worsening of significance in the second row and, in a few cases, the significance increases.[27] The third row of Table 5, instead, addresses the problem described by Conley and Taber (2011) that standard errors (clustered at PA-year or PA level) are inadequate for inference on β since only one PA is treated. Therefore, this row reports the CI obtained using valid standard errors calculated following Conley and Taber (2011).[28] This third set of CIs closely resembles those obtained by clustering at the PA-year level and confirms a positive and large effect that is significant at the 95 percent confidence level, especially for the winning discount.

The third set of robustness checks deals with the presence of a sample selection bias. As before, I report the results only for the experience-based control group and

[26] Qualitatively similar results, obtained with the other two groups, are reported in the online Appendix.

[27] Analogous results were found with a second method suggested by Bertrand, Duflo, and Mullainathan (2004), collapsing the sample at PA-level means and performing the DD analysis on this new sample.

[28] The CI were calculated using the Stata code made available by the authors on their website. The example code fits exactly the DD model analyzed in the current setting in which there is a single PA treated and many control PAs, with each PA awarding many auctions. For the estimates reported in the paper, an average of 20 PAs was used. I also considered gradually relaxed restrictions on *Experience* and *Population* up to including all the 269 PAs in the sample. The results broadly confirmed those shown in the paper.

Table 5—Robustness Checks: 95 Percent Confidence Intervals with Different Standard Errors

	W. Bid (1)	W. Bid (2)	Extra cost (3)	Extra cost (4)	Extra time (5)	Extra time (6)	Days award (7)	Days award (8)
Panel A. Municipality of Turin								
PA-Year	(10; 15)	(4; 9)	(7; 58)	(−51; 62)	(2; 10)	(−8; 6)	(8; 53)	(−20; 70)
PA	(10; 14)	(4; 8)	(17; 48)	(−25; 35)	(4; 8)	(−6; 4)	(5; 56)	(4; 47)
Conley-Taber	(10; 16)	(5; 8)	(19; 45)	(−47; 21)	(3; 9)	(−4; 4)	(6; 63)	(10; 44)
	W. Bid (1)	W. Bid (2)	Extra cost (3)	Extra cost (4)	Extra time (5)	Extra time (6)	Days award (7)	Days award (8)
Panel B. County of Turin								
PA-Year	(7; 11)	(3; 8)	(−26; 48)	(−50; 80)	(−7; 7)	(−16; 5)	(20; 53)	(1; 34)
PA	(8; 10)	(4; 7)	(−1; 23)	(−7; 37)	(−2; 3)	(−10; −1)	(20; 53)	(3; 33)
Conley-Taber	(7; 14)	(4; 8)	(−2; 23)	(−35; 31)	(−3; 3)	(−8; −1)	(17; 57)	(3; 38)

Notes: The dependent variable is reported at the top of each column. For each dependent variable, the 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 are 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 Control Group 1 (*Experience*). Results for the other two control groups are in the online Appendix.

the model with auction and PA covariates. Table 6 presents the results regarding the effect of FPAs on the winning discount. The values in column 1 ("Base") of this table are reported from column 2 in the top panels of Table 2 and 3 for comparison to the other estimates. These other estimates are based on different portions of the Authority sample. Estimates similar to those in column 1 would suggest that sample selection is not driving the previous findings. In particular, the estimates in column 2 ("Full") do 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") use only auctions for which both the final time and cost are missing. The results for both "Full" and "Missing" suggest that the effect of FPAs on the winning discount is robust to these changes in the sample study. To assess whether this effect differs significantly across types of works, column 4 and 5, report separately the estimates for 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 lack of a systematic tendency for more complex jobs to experience higher discounts might be driven by the fact that I am already restricting the sample to relatively simple construction jobs or to the higher prequalification requirements imposed on these jobs which discourage low-ball bidding. The last two columns show that shrinking the sample to smaller periods around the 2003 reform lowers the estimates, but without affecting their sign or significance. Possibly, this effect is due to some learning phenomena: bidders gradually adjust to the greater competitiveness of FPAs. By excluding the years closer to 2006, I help to rule out the influence of projects for the 2006 Winter Olympic Games that took place in Turin. The lack of influence from the Winter Olympics is explained by the fact that almost all the contracts for the Olympics were assigned using special procedures excluded from my sample. A

TABLE 6—ROBUSTNESS CHECKS: SUBSAMPLES

Sample:	Base (1)	Full (2)	Missing (3)	Simple (4)	Complex (5)	2001–2005 (6)	2002–2004 (7)
Panel A. Regressions for the winning discount–Municipality of Turin, authority sample							
First price auction	11.99***	10.43***	14.64***	12.74***	11.08***	9.461***	9.056***
	(1.315)	(1.578)	(3.201)	(2.145)	(1.068)	(0.726)	(0.815)
Observations	1,262	2,098	266	706	556	1,004	620
R^2	0.639	0.595	0.771	0.635	0.709	0.654	0.677

Sample:	Base (1)	Full (2)	Missing (3)	Simple (4)	Complex (5)	2001–2005 (6)	2002–2004 (7)
Panel B. Regressions for the winning discount–county of Turin, authority sample							
First price auction	8.688***	8.784***	11.36***	9.411***	7.529***	7.606***	7.474***
	(1.101)	(1.273)	(2.036)	(1.786)	(1.851)	(0.564)	(0.776)
Observations	1,355	2,275	302	744	611	1,109	720
R^2	0.579	0.577	0.780	0.578	0.639	0.600	0.623

Notes: Standard errors clustered by public administration and year. The dependent variable is the winning discount. For the Municipality of Turin, "base" repeats model (2) of the the top panel of Table 2. For the County of Turin, "base" repeats model (2) of the the top panel of Table 3. Refer to those tables for the control group and the set of controls. The same control group and controls of "base" are used for all the regressions models reported in the table. The only difference between these models is that different subsamples of the Authority sample are used. "Full" also includes all the auctions with a reserve price lower than €300,000. "Missing" includes only those auctions with a missing value for either the cost overrun or the delay. "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 2002 and 2004.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

similar set of robustness checks was conducted for the performance and screening measures. However, the results (not reported) are more mixed, sometimes showing a loss of statistical significance relative to the estimates described earlier.[29]

V. Discussion and Policy Implications

The previous findings suggest that reforms toward FPAs can be successful only if their design carefully accounts for the features of the institutions ensuring bids reliability, which include financial guarantees, ex ante prequalification, and ex post screening.

The reform in the County of Turin and Municipality of Turin appears successful to the extent that, despite the increased cost overruns, the final cost of the project under FPAs declines by approximately 8 percent of the original reserve price. This is a large savings ranging between €80,000 and €100,000, that is likely high enough

[29] Other robustness tests not reported in the text were conducted, confirming the findings in the paper. For example, I performed a placebo analysis by repeating the baseline estimates as if in 2003 the treated PAs were not the County of Turin and Municipality of Turin, but those of the regional capitals of Emilia, Liguria, and Veneto. Overall, this placebo analysis broadly confirms the previous results. In none of the other PAs are there effects of the magnitude observed in Turin.

to compensate for the increased cost of bid screening[30] and for the possible presence of transaction costs associated with contract renegotiation. As argued earlier, these estimates should be interpreted as an average treatment on the treated and might differ from the ATE. Nevertheless, by restricting the set of control PAs to those having ABAs with winning discounts clustered at values close to those observed in the Turin ABAs, we should obtain an estimate closer to the appropriate average treatment effect for this subgroup of PAs.[31] The estimates so obtained for the effect of the FPA on the winning discount range from 14.6 to 15.8 for the Municipality of Turin and from 11.9 to 16.5 for the County of Turin. The 95 percent confidence intervals of these estimates include the corresponding point estimates reported earlier.

A further indication of the usefulness of the estimated effects comes from the analysis of a more recent series of reforms starting in 2006 that expanded the use of FPAs. Analyzing such reforms is also interesting because the Italian government reversed them in 2011 due to problems with the transition to FPAs. More precisely, the timing of these reforms is as follows. First between July 2006 and October 2008, PAs could freely choose between ABAs and FPAs; then from November 2008 to May 2011, they were forbidden from using ABAs for contracts with a reserve price above €1 million; but finally the possibility of using ABAs for all contracts up to €5 million was restored in May 2011.[32] The complaints against FPAs causing the reintroduction of ABAs have been of two types. For the Municipality of Milan FPAs, by delaying the procurement process, threatened the timely realization of the infrastructures for the 2015 World Expo. Small PAs, instead, complained that they lacked the resources to conduct an effective bid screening, which regulations require being performed by in-house personnel. This anecdotal evidence is in line with the previous finding that FPAs cause delays in both the awarding stage and the work execution, and that bid screening, entailing mostly a fixed cost of having in-house engineers and lawyers, is particularly costly for small PAs running auctions infrequently.

To further investigate the effects of these more recent reforms, I collected a second dataset, IE sample, covering the period between July 2006 and July 2011. Table 7 presents the summary statistics. They are reported separately for two distinct groups of PAs. "Voluntary switchers" to FPAs are those PAs that between July 2006 and October 2008 held at least one FPA for a contract below the €5 million threshold. "Forced switchers" are those PAs never using FPA for contracts below €1 million and using FPAs for contracts between €1 million and €5 million only during the period of the 2008–2011 reform. Although this dataset does not contain information

[30] Although I do not observe the cost of this process, the average daily wage of a PA engineer is about €165, all inclusive. Thus, assuming that two engineers are involved, under the highest estimate of an increase of 58 days, the resulting cost would be €19,000. Additional expenditures would occur if the PA were brought to court by an excluded firm.

[31] In practice, I implement this idea by calculating the mean winning bid separately for the ABAs in the County of Turin and Municipality of Turin (both are around 18 percent), and then calculating the baseline estimates under the additional restriction that the PAs in the control group have a mean winning discount in their ABAs that is no more than 3 points larger/smaller than that of the treatment PA (thus, from about 15 percent to 21 percent).

[32] The increased use of the FPA was imposed on Italy by the European Union regulation. Indeed, to avoid conflicts with the EU, the reintroduction of the ABAs in May 2011 was ruled to be transitory, lasting only until December 2013.

TABLE 7—DESCRIPTIVE STATISTICS: IE SAMPLE

	AB Auctions				FP Auctions			
Variables	Mean	SD	p50	N	Mean	SD	p50	N
Panel A. PAs voluntary switching to FPAs								
Winning discount	15.77	5.052	15.88	1,648	32.36	10.07	33.15	494
Days to award	21.23	25.57	11.0	654	69.87	49.14	56.0	338
Reserve price	407.4	516.2	262.9	1,648	1,007	3,305	408.7	494
Number of bidders	58.74	43.69	49.0	1,648	10.85	8.412	9.0	494
Contract duration	179.8	158.2	147.0	1,596	248.1	168.4	210	427
Miles PA from Turin	149.7	75.77	161.9	1,239	94.54	80.13	114.0	467
Experience	15.55	21.99	5.0	1,648	100.9	63.01	129.0	494
Population	137.5	213.1	24.27	1,648	1,003	797.2	900.6	494

	AB Auctions				FP Auctions			
Variables	Mean	SD	p50	N	Mean	SD	p50	N
Panel B. PAs forced to switch to FPAs								
Winning discount	15.80	7.54	16.12	321	35.63	7.78	35.72	74
Days to award	30.21	38.22	16.0	172	112.6	54.45	115.5	52
Reserve price	600.2	636.7	397.6	321	2,756	5,170	1,563	74
Number of bidders	66	47.88	59.0	321	17.55	11.59	15.0	74
Contract duration	204.2	134.6	152.0	306	415.7	204.8	400.0	66
Miles PA – Turin	153.9	46.50	141.2	208	156.6	52.83	141.2	23
Experience	62.32	42.99	39.0	321	58.30	37.92	84.0	74
Population	1,039	856.6	1,182	321	1,123	897.3	1,309	74

Notes: Variables: *Winning Discount* is the rebate offered by the winning bidder and it is expressed as the percentage discount over the reserve price. *Days to Award* is the difference (in days) between when the bids are opened by the awarding commission and when the PA announces the identity of the winner. *Reserve Price* is the reserve price in thousands of Euro. *Number of Bidders* is the number of bidders. *Contract Duration* is the maximum number of days to complete the work specified by the the contract. *Miles PA– Turin* is the distance in miles of the Public Administration from Turin. *Experience* is the number of auctions run by the Public Administration in the sample period. *Population* is the resident population in thousands of person.

on ex post performance, it contains the winning discount and the number of days to award the contract, as well as other PA and contract covariates.

The statistics in Table 7 offer a very clear descriptive evidence on the effects of the switch toward FPAs. For the PAs voluntary switching, the winning discount passes from about 16 percent to 33 percent; while for those forced to switch, it passes from 16 percent to 36 percent. This is a large and statistically significant increase. Furthermore, the data also reveal a positive and significant association between FPAs and the number of days taken to award the contract. The summary statistics are suggestive that the magnitude of this effect is twice as large for the PAs forced to switch relative to those voluntarily switching.[33] Drawing firm conclusions from the wave of reforms started in 2006 is complex because, contrary to the reform in Turin, numerous aspects of the procurement system were simultaneously affected. However, various regression results reported in the online Appendix deliver findings in line with those discussed here. In particular, they suggest a magnitude of the

[33] These effects appear also to be larger than those recorded in Turin. This is consistent with the fact that, contrary to the reform in Turin, the 2006 reform modified the screening process to make it less discretionary, mandating that when a bid is subject to the screening the firm engineers have no less than 15 days to provide a written justification. Then, if needed, no less than five days to provide a written response to the remarks of the PA engineers and no less than three days to schedule an oral discussion.

effect of FPAs on winning discounts ranging from 9 percent to 16 percent (a range close to that of the baseline DD estimates of Turin).

These results seem to confirm that FPAs significantly reduced the awarding price but greatly increased the screening cost, particularly for those PAs forced to switch. Therefore, these findings indicate that a straightforward policy recommendation is to reform the screening process. For instance, abandoning the requirement that each PA screens bids in-house in favor of a centralized system (at county or even regional level) that can spread the cost of engineers and lawyers over a larger number of auctions. More centralization could also allow more stringent prequalification requirements based on an assessment of the match between the project characteristics and the firm available capacity. In Italy, centralization of the ex ante qualification and the ex post screening likely dominates alternative solutions like the use of negotiations or higher financial guarantees since Italy ranks among the countries with both the highest perceived risk of corruption and the longest times to recover a credit in all international comparisons.[34]

VI. Conclusions

The procurement of public works is both a major source of public spending and a key policy variable that governments try to use to influence employment and investment. Therefore, it is extremely important to correctly design the institutions through which public procurement occurs. The main contributions of this study have been to provide empirical support for the trade-off that FPAs induce between awarding price and contract performance and to show that the functioning of FPAs in public procurement depends on the effectiveness with which bids screening ensures that bids are binding commitments for contractors. Therefore, the results of this paper might help to explain what the problems were in the policy reforms of several countries that, like Italy, led them to cycle between FPAs and various formats similar to ABAs in recent years.[35]

Nevertheless, this study also leaves several questions open. First, too little is still known about the properties of the various mechanisms that auctioneers using FPAs could adopt to limit the performance risk. For instance, is it better to require high financial guarantees or to invest in the prequalification of bidders and ex post screening of bids? Second, to properly redesign procurement institutions it would be important to empirically test whether adverse selection, moral hazard or the winner's curse are causing the worsening of performance. This analysis might follow the spirit of the tests developed by Chiappori and Salanié (2000) to test moral hazard and adverse selection in insurance contracts. However, to do so would require more detailed data on bidder characteristics relative to those typically available in auction datasets. Third, the analysis in this paper was mostly concerned with the

[34] The 2009 "Doing Business" report of the World Bank, ranks the United States as sixth and Italy 156th in terms of the efficiency of the judiciary system for the recovery of a credit.

[35] In Colombia, for instance, the replacement of FPAs with a form of ABAs recently occurred with law 1150 of 2007. The same happened in the Nagano prefecture (Japan) with a reform that became effective on April 2003 and in the Guangdong region (China) with a series of reforms that started around 2004. Instead, the opposite route was recently taken by Taiwan and Peru that recently reintroduced forms of FPAs after having used ABAs for many years.

procurement cost paid by the auctioneer. However, the fact that a worsening of performance affects the final users of the projects suggests that a welfare analysis would be desirable. In the spirit of Lewis and Bajari (2011), this analysis should account for how much individuals value the various characteristics of public works, like their timely completion.

REFERENCES

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2010. "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program." *Journal of the American Statistical Association* 105 (490): 493–505.

Ashenfelter, Orley, David Ashmore, and Randall Filer. 1997. "Contract form and procurement costs: the impact of compulsory multiple contractor laws in construction." *RAND Journal of Economics* 28 (Special Issue): S5–16.

Bajari, Patrick, Stephanie Houghton, and Steve Tadelis. 2007. "Bidding for Incomplete Contracts: An Empirical Analysis." Unpublished.

Bajari, Patrick, Robert McMillan, and Steven Tadelis. 2009. "Auctions Versus Negotiations in Procurement: An Empirical Analysis." *Journal of Law, Economics, and Organization* 25 (2): 372–99.

Bajari, Patrick, and Steven Tadelis. 2001. "Incentives versus Transaction Costs: A Theory of Procurement Contracts." *RAND Journal of Economics* 32 (3): 387–407.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. "How Much Should We Trust Differences-In-Differences Estimates?" *Quarterly Journal of Economics* 119 (1): 249–75.

Board, Simon. 2007. "Bidding into the Red: A Model of Post-Auction Bankruptcy." *Journal of Finance* 62 (6): 2695–2723.

Burguet, Roberto, Juan-José Ganuza, and Esther Hauk. 2009. "Limited Liability and Mechanism Design in Procurement." Barcelona Graduate School of Economics (GSE) Working Paper 383.

Cameron, Lisa J. 2000. "Limiting Buyer Discretion: Effects on Performance and Price in Long-Term Contracts." *American Economic Review* 90 (1): 265–81.

Che, Yeon-Koo, and Jinwoo Kim. 2010. "Bidding with Securities: Comment." *American Economic Review* 100 (4): 1929–35.

Chiappori, Pierre-André, and Bernard Salanié. 2000. "Testing for Asymmetric Information in Insurance Markets." *Journal of Political Economy* 108 (1): 56–78.

Chillemi, Ottorino, and Claudio Mezzetti. 2009. "Procurement Under Default Risk: Auctions or Lotteries?" Unpublished.

Conley, Timothy G., and Francesco Decarolis. 2012. "Detecting Bidders' Groups in Collusive Auctions." https://economics.sas.upenn.edu/system/files/event_papers/Decarolis-02102012.pdf.

Conley, Timothy G., and Christopher R. Taber. 2011. "Inference with 'Difference in Differences' with a Small Number of Policy Changes." *Review of Economics and Statistics* 93 (1): 113–25.

Coviello, Decio, and Massimo Mariniello. 2011. "The Role of Publicity Requirements on Entry and Auction Outcomes." Unpublished.

Decarolis, Francesco. 2009. "When the Highest Bidder Loses the Auction." PhD thesis University of Chicago.

Decarolis, Francesco. 2013. "Comparing Public Procurement Auctions." Unpublished.

Decarolis, Francesco. 2014. "Awarding Price, Contract Performance, and Bids Screening: Evidence from Procurement Auctions: Dataset." *American Economic Journal: Applied Economics*. http://dx.doi.org/10.1257/app.6.1.108.

Heckman, James, Hidehiko Ichimura, Jeffrey Smith, and Petra Todd. 1998. "Characterizing Selection Bias Using Experimental Data." *Econometrica* 66 (5): 1017–98.

Kagel, John H., and Dan Levin. 1986. "The Winner's Curse and Public Information in Common Value Auctions." *American Economic Review* 76 (5): 894–920.

Kessler, Daniel P., and Mark B. McClellan. 2000. "Is Hospital Competition Socially Wasteful?" *Quarterly Journal of Economics* 115 (2): 577–615.

Lewis, Gregory, and Patrick Bajari. 2011. "Procurement Contracting With Time Incentives: Theory and Evidence." *Quarterly Journal of Economics* 126 (3): 1173–1211.

Manelli, Alejandro M., and Daniel R. Vincent. 1995. "Optimal Procurement Mechanisms." *Econometrica* 63 (3): 591–620.

McAfee, R. Preston, and John McMillan. 1986. "Bidding for contracts: a principal-agent analysis." *RAND Journal of Economics* 17 (3): 326–38.

Nagel, Rosemarie. 1995. "Unraveling in Guessing Games: An Experimental Study." *American Economic Review* 85 (5): 1313–26.

Rhodes-Kropf, Matthew, and S. Viswanathan. 2005. "Financing Auction Bids." *RAND Journal of Economics* 36 (4): 789–815.

Spulber, Daniel F. 1990. "Auctions and Contract Enforcement." *Journal of Law, Economics, and Organization* 6 (2): 325–44.

Waehrer, Keith. 1995. "A Model of Auction Contracts with Liquidated Damages." *Journal of Economic Theory* 67 (2): 531–55.

Zheng, Charles Z. 2001. "High Bids and Broke Winners." *Journal of Economic Theory* 100 (1): 129–71.