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Suggested Citation: Finocchiaro Castro, Massimo; Guccio, Calogero (2021) : Does greater discretion improve the performance in the execution of public works? Evidence from the reform of discretionary thresholds in Italy, ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg

This Version is available at:
https://hdl.handle.net/10419/247648

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Does greater discretion improve the performance in the execution of public works? Evidence from the reform of discretionary thresholds in Italy

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Abstract

In this work, adopting a semi-parametric approach and a quasi-experiment setting, we empirically assess the effects of a reform of public procurement regulation in Italy, approved in 2011, that increased the discretion of bureaucrats in selecting the procurer. To this end, employing a large dataset of public works managed by Italian municipalities in the period 2009-2013, we first estimate contract execution performance; then, we test the impact of the reform on the efficiency of public works execution in an institutional context characterized by large differences in social capital and trust in institutions. The results provide evidence that the reform exerted a positive, albeit small, effect on public works execution performance. However, the beneficial role exerted by increased discretion is positive and significant only in those areas where social capital and trust in institutions have reached higher levels. These results seem to suggest that more discretion leads to greater efficiency but also to greater corruption risks suggesting that increased discretion must be balanced by strengthened ex-post controls, particularly in high-risk areas.

Keywords: Bureaucratic discretion; Social capital; Corruption; Public works contracts; Efficiency; Non-parametric frontier; Semi-parametric methods.

JEL Code: D24; D73; H57; P16.

1. Introduction

The provision of goods and services to the community through procurement from the private sector is one of the largest areas of government intervention worldwide (OECD, 2021). Yet, despite its relevance, the outcomes of public procurement systems remain a relatively understudied area of government activity. In this article, we explore how the strength of procurement regulation affects the outcome of public work performance.

Among the several outcomes of public procurement, one of the most relevant is the efficiency in the provision of goods and services (Bandiera et al., 2009). In public works field, the most well-known expressions of inefficiency in the execution of contracts are cost overruns and time delays. Indeed, the negative effects of cost overruns and delays on the execution of public works contracts have been investigated both worldwide (Bajari et al., 2009; Estache et al., 2009; Flyvberg, 2005) and regarding Italy (Decarolis and Palumbo, 2015; Coviello et al., 2018).

One of the most relevant elements in public procurement concerns the level of discretion granted to contracting authorities. How much to regulate behavior and how much to leave to the discretion of procurement officials is a debated question in literature. Governments often face a trade-off in the regulation they impose *ex-ante* on contracting authorities and bureaucrats in carrying out their functions. In fact, greater discretion potentially may allow for greater efficiency in procurement (Kelman, 1990, 2005). However, more discretion can easily open the door to bribery and corruption inducing the government to limit the discretion of bureaucrats with stringent rules above certain thresholds. On this issue, some recent studies have analyzed the role of contracting authorities and bureaucrats' discretion in public procurement (Coviello et al., 2018; Pertold and Palguta, 2017; Decarolis et al., 2020; Bosio et al., 2020; Baltrunaite et al, 2021; Carril 2021).

Our study contributes to the abovementioned strands of literature with an empirical analysis of public works execution, based on data drawn from a large sample of Italian public works in Italy. Specifically, we leverage on a reform (Law n. 106/2011) introduced in 2011, which gave greater discretion on the choice of contractor, to assess its impact on the efficiency in the execution of public works using a bootstrapped Data Envelopment Analysis (DEA) – (Simar and Wilson, 1998; 2000). We, then, assess whether the reform had a different impact in areas of the country characterized by a different level of social capital and institutional trust using a two-stage semi-parametric bootstrap-based approach (Simar and Wilson, 2007).

In the literature, several contributions have investigated the factors that can lead inefficiency in the execution of contracts, suggesting that they can be ascribed to several factors (Cavalieri et al., 2020). Corruption is also considered a factor influencing the performance, though it is difficult to disentangle the effects of corruption from other forms of waste (Bandiera et al., 2009). Recent empirical studies (Finocchiaro Castro et al., 2014; 2018; Baldi et al., 2016; Coviello and Gagliarducci, 2017; Guccio et al., 2019; Cavalieri et al., 2020) investigate the role of corrupted environment, finding that the characteristics of the local area where public works are executed are significantly associated with the outcome in public procurement.

Previous literature, which analyzed the impact of the Italian reform on regulatory threshold levels, suggests that more discretion could open the doors to misbehaviors and favoritism (Coviello et al., 2018; Decarolis et al., 2020; Baltrunaite et al, 2021). However, although such negative effect of discretion may take place, it does not necessarily lead to a loss of efficiency in public work execution. As pointed out by Coviello et al, (2018), it will depend crucially on how discretion is used. That is, whether more efficient or less efficient firms will be favored. Thus, we believe that it is worth assessing the role of the multifaceted and complex concept of debauched environment in affecting public works execution (Guccio et al., 2019). A well-known way of assessing the effects of social and environmental variables is to investigate the role of social capital and institutional trust in public infrastructure provision. Among the various measures of trust in institutions suggested by the literature, we base our analysis on objective data on Italian primary-school teachers' cheating behavior when administering a nationwide standardized test managed by the Italian institute for the assessment of educational system (Finocchiaro Castro and Guccio, 2020). Strong support in favor of our choice is provided by Finocchiaro Castro and Guccio (2020), who compared teachers' cheating behavior with the most widely adopted measures of social capital such as blood donations (Guiso et al. 2004), voter turnout at the 1974 referendum on divorce and the number of non-sport daily newspapers per 1000 inhabitants (Cartocci 2007). Their results show that the cheating measure is more highly correlated with the Institutional Quality Index (Nifo and Vecchione, 2014), the European Quality of Government Index (Charron et al., 2014) and with some historical data available at sub-national level on historical, regional measures of political institutions, urbanization and educational attainment taken from Tabellini (2010) than other measures of social capital and institutional trust.

Our underlying assumption is that spatial variation on this measure of teachers' cheating behavior is correlated with underlying differences in social capital across Italian

municipalities (Guiso et al. 2016). Also, we conjecture that, in an environment where social trust is low, there is a higher probability to favor connecting firms regardless of their level of efficiency. Differently, where the level of social trust is high, public servants will be more sensitive to the level of efficiency of the firms they favor.

Overall, our analysis has shown that the reform has exerted a positive, although mild, effect on the performance of public works execution. In detail, such positive effect has been highly correlated with the different distribution of social capital levels in Italy. In other words, the positive role of the reform is more significant in those areas where social capital has been higher, regardless of the measures employed. In addition, we employ a different empirical approach and focusing only on completed public works our results are in line with evidence of Coviello et al., (2018) and Decarolis et al., (2020) showing that discretion could lead to improved public work performance, even when it increases the risk of corruption. These results seem to suggest that more discretion leads to greater efficiency but also to greater corruption risks and the need for an effective *ex post* control system to manage this trade-off by limiting discretion for local procedures especially in high-risk areas.

The rest of the study is organized as follows: the next section provides the background for the study. Section 3 presents methodology whereas Section 4 describes the Italian regulatory framework and the dataset. Section 5 reports and discusses the results of the empirical analysis. Finally, some implications for public policies are discussed in Section 6.

2. Background

As mentioned above, the present work is the intersection of two main strands of literature.

The first strand of literature seeks to understand the impact of more discretionary rules on public procurement performance (e.g., Palguta and Pertold, 2017; Coviello et al., 2018, Decarolis et al., 2020; Baltrunaite et al., 2021). For instance, Bandiera et al., (2009), looking at Italian procurement procedures, report that overall waste is smaller for procurement agencies enjoying more discretion than others. Duflo et al., (2014) run a field experiment in India on environmental regulation showing that regulatory discretion allows the regulator to target inspections more efficiently at high polluters compared exogenous auditing rules. Palguta and Pertold (2017) present evidence of how policies that let the possibility to avoid open competition in procurement lead to the manipulation of

procurement values. Somehow differently. Decarolis et al. (2020) find empirical evidence that greater discretion, by limiting competition, is associated with greater suspicion of corruption in procurement. Although some features of procurement outcomes are evaluated, both contributions look specifically at the contractor selection phase and suggest that greater discretion at this stage of the procurement may lead to potential allocative and technical inefficiency. Baltrunaite et al., (2021) finds that the share of contracts awarded to politically connected firms increased with discretion. In addition, the winning firms have lower average (*ex-ante*) productivity, suggesting a potential misallocation of public resources due larger discretion on supplier selection in public procurement. The paper by Coviello et al., (2018), which looks at outcomes in the execution of public works in connection with the discretion of bureaucrats, is the closest one to our current approach. The authors find that discretion can result in greater favoritism (*i.e.*, the probability that the same firm is awarded a project repeatedly by the same buyer), and that it positively, although weakly, affects delays, whereas cost overruns are not significantly affected by the degree of discretion. Those results on the outcomes of execution of public works are robust to the inclusion of several environmental factors as local corruption levels, social capital, and judicial efficiency in the region of the public buyers running the auctions.

The second strand of literature seeks to assess how environmental factors (i.e., corruption; civic capital; trust in institutions) can explain differential performance in public works execution at local level. Finocchiaro Castro et al., (2014) show that greater corruption, in the area where the infrastructure provision is localised, is associated with lower efficiency in public contracts execution. Looking at the health sector, Cavalieri et al., (2017 and 2018) report that the performance of the contracts is significantly affected by corruption and that healthcare authorities are both less efficient and more at risk of corruption than other procurement agencies. Also, Finocchiaro Castro et al., (2018) provide evidence of the failure of competition as a tool to reduce the negative effects of environmental corruption in public works procurement. On the same vein, Guccio et al. (2019) investigate the channels through which the institutional quality of local environment can affect efficiency in the execution of public works contracts. The author show that time delays are negatively associated with the quality of governance and that cost overruns are positively associated with environmental corruption. Focusing, also, on the role of the quality of institutional environment, Cavalieri et al., (2020) report that it matters in infrastructure procurement, although not all the dimensions of institutional quality have the same weight on the performance in contracts execution. Finally, Finocchiaro Castro and Guccio (2020) offer a test of our measure of social capital and institutional trust applied to

political selection and electoral punishment. The authors show that untrustworthiness is strongly related to both the malfeasance of local representatives and to low levels of electoral punishment of them.

3. Methods

We assess the performance in public works execution through a fully non-parametric approach widely adopted in the relevant literature (Guccio et al., 2012; Finocchiaro Castro et al., 2014; Ancarani et al., 2016; Cavalieri et al., 2017; 2018; Finocchiaro Castro et al., 2018; Cavalieri et al., 2020)[1].

In most of the empirical investigations, the *ex-pos*t assessment of the execution of public work contracts is defined in terms of either cost overruns or time delays. Its measurement is generally carried out by means of the relative excess costs and time with respect to the costs and the time agreed on in the contract with the firm (for an updated survey, see Cavalieri et al., 2019). However, these measures have two main limitations (Guccio et al., 2012; Finocchiaro Castro et al., 2014). Firstly, they represent productivity measures, since they do not arise from a comparison with any, however determined, efficient benchmark. Secondly, considering separately the two phenomena does not allow evaluating the overall performance of the procurer in carrying out the contract.

To consider these two limitations, we aim at measuring the procurers' capacity in achieving both the targeted results of time and costs, through a benchmarking of their performance, regarding as best performers those procurers that minimize the actual time and costs of execution of public works. As for the methods for carrying out benchmarking, we use a nonparametric frontier (Guccio et al. 2012). A well-established and useful nonparametric methodology is Data Envelopment Analysis - DEA (Charnes et al. 1978), a technique generally used to estimate a production function, which is capable to handle multiple inputs and outputs without requiring a priori assumptions of a specific functional form on production technologies and the relative weighting scheme.

[1] For an assessment of efficiency in public procurement of standardised goods, see: Bandiera et al., (2009); Guccio et., al., (2006).

In what follows, we provide a short formalization of the method employed in the analysis[2]. In line with the notation used by Simar and Wilson (2008), we consider a production process using the vector of inputs $\{x = x_i, i = 1, \ldots, n\} \in \Re_+^N$ that is used to produce a vector of outputs $\{y = y_s, s = 1, \ldots, m\} \in \Re_+^M$. The production process is constrained by the production possibility set Ψ, which is the set of physically attainable points (*x*, *y*) given by:

$$\Psi = \left\{(x, y) \in \Re_+^{N+M} | = (x, y) \text{ is feasible } \right\} \quad (1)$$

The efficiency of a generic decision-making unit (DMU) like, for example, a procurer carrying out a public work contract is measured by the distance between the observed input-output mix and the optimal mix located on the frontier of Ψ, which is the boundary of optimal production plans.

The single DMU efficiency score, as defined by Debreu (1951) and Farrell (1957) in the input-oriented case, is:

$$\lambda(x, y) = \inf\{\lambda | (\lambda x, y) \in \Psi\} \quad (2)$$

where a value of $\lambda(x, y) < 1$ measures the radial distance of the DMU from the full efficient frontier and a value of $\lambda(x, y) = 1$ means that the DMU is fully efficient. Being Ψ the frontier and $\lambda(x, y)$ unknown, they should be estimated from a sample of i.i.d. observations $\mathcal{X}_n = \{(x_i, y_i), i = 1, \ldots, n\}$.

The DEA estimator assumes the convexity of the hull and, thus, under the hypothesis of constant returns to scale (CRS), can be defined as:

$$\widehat{\Psi}_{DEA} = \left\{(x, y) \in \mathbb{R}_+^{N+M} | y \leq \sum_{i=1}^{n} \gamma_i x_i;\ x \geq \sum_{i=1}^{n} \gamma_i y_i, \text{for } (\gamma_1, \ldots, \gamma_n) \text{ such that } \gamma_i \geq 0, i = 1, \ldots, n \right\} \quad (3)$$

A DEA non-parametric estimator of the efficiency scores can be calculated by replacing the true production set Ψ in (2) with the estimator $\widehat{\Psi}_{DEA}$:

$$\hat{\lambda}_{DEA}(x, y) = \inf\left\{\theta | (\theta x, y) \in \widehat{\Psi}_{DEA}\right\} \quad (4)$$

where, by construction, $\hat{\lambda}_{DEA}(x, y) \leq \lambda(x, y)$ (Simar and Wilson, 2008).

[2] For more details, see Simar and Wilson (2008).

Since DEA does not allow for any statistical inference and measurement error, Simar and Wilson (1998, 2000) introduced a bootstrapping methodology to determine the statistical properties of DEA estimators.[3] The idea is to simulate a true sampling distribution by mimicking their DGP - here the outputs from DEA (Simar and Wilson, 2008) - by constructing a pseudo-data set and re-estimating the DEA model with this new data set. Repeating the process many times allows for achieving a good approximation of the true distribution of the sampling. The Simar and Wilson (1998) bootstrap procedure gives an estimated bias and the variance, which in turn provide confidence intervals. Later, Simar and Wilson (2000) provided an improved and more flexible procedure that automatically corrects for biases without explicit use of a noisy bias estimator.[4] Thus, the latter bootstrapping algorithm (Simar and Wilson, 2000) is used in this paper to control for consistency among the efficiency estimates. This procedure is also adopted because it does not assume homogeneity on the distribution of efficiency, which may be too restrictive for this analysis and may invalidate the inference on the efficiency estimates.[5]

The second step of our analysis is to investigate the impact of environmental variables (Z_i) on technical efficiency in public work execution obtained with DEA. In particular, the relationship between reform and efficiency of public work execution can be estimated in a quasi-experimental and a difference-in-difference estimator can be used to assess the magnitude of the "treatment effect" provided by the reform in 2011. However, as for the two-stage DEA estimates, Simar and Wilson (2007) underline that traditional regression yields biased estimates due to serial correlation of the error term (ε_i) with environmental variables (Z_i). Therefore, they suggest applying a semi-parametric two-step bias-corrected truncated estimator that they indicate as the only known method for ensuring a feasible and consistent inference on the second stage regression (Simar and Wilson, 2011).

Specifically, in this paper the Algorithm#2 of Simar and Wilson (2007) is applied, where the unobserved regressand λ_i is replaced by its bias-corrected estimate $\hat{\hat{\lambda}}_i$ obtained using DEA with bootstrap and a maximum likelihood truncated estimator. More specifically, the second-stage regression can be summarized as follows:

[3] However, some major issues regarding the use of asymptotic results and bootstrap remain: first, the high sensitivity of non-parametric approaches to extreme value and outliers; second, the way to allow stochastic noises in a non-parametric frontier (Simar and Wilson, 2008). Another common problem is given by the dimensionality space (i.e., number of input and output variables included in the efficiency analysis) and by the reliability of the results obtained through the DEA model.

[4] See Simar and Wilson (2008) for technical details on the bootstrap procedures.

[5] See Simar and Wilson (2008) for a more detailed discussion of this point.

a. apply maximum likelihood to estimators of $\hat{\hat{\lambda}}_i$ to obtain estimates of $(\hat{\beta}, \hat{\sigma})$ in a truncated regression, where , $\mathrm{i} = 1, \ldots, \mathrm{n}$, is the number of DMUs.

b. repeat the steps from *i*) to *iii*), L times to obtain b numbers of bootstrap estimates of $\{(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)_b\}_{b=1}^L$:

i) for each DMU, $i = 1, \ldots, n$, *draw* ε_i *from the left-truncated* $(1 - z_i\hat{\beta})$ *normal distribution;*

ii) use ε_i *for each DMUs* $i = 1, \ldots, n$, *to calculate fitted DEA scores:* $\hat{\hat{\lambda}}^*{}_i = z_i\hat{\beta} + \varepsilon_i$ *;*

iii) apply maximum likelihood to estimators of $\hat{\hat{\lambda}}^*{}_i$ *to obtain estimates of* $(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)$ *in a truncated regression.*

c. compute the bias-corrected estimator of $\hat{\hat{\beta}}$ as well as the percentile bootstrap confidence intervals at a given level of significance using the bootstrap estimates obtained from the previous step $\{(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)_b\}_{b=1}^L$ and the original parameters.

4. Institutional setting and data

4.1. Regulatory framework in Italy

In Italy the regulatory framework distinguishes among three available procedures for awarding public works: open procedures, restricted procedures, and negotiated procedures[6]. Open procedures and restricted procedures are ordinary procedures characterized by limited discretionary powers for bureaucrats in selecting contractors.

They suppose that procurement agencies can *ex-ante* define the subject of the contracts and the most important technical characteristics to have bidders submitting final and no renegotiable offers. so that bidders may immediately submit unequivocal, no renegotiable offers. Considering open procedures, before the submission of the bids by all interested firms, the procuring agency issues a contract notice containing, among other things, a detailed description of the subject of the contract. Thus, the administration verifies the

[6] The regulatory framework disciplines the competitive dialogue, which is not of interest for our work.

requisites of bidders. In the case of restricted procedures, bidders' requisites are verified before bids placement. Then, bids can be submitted. Differently, in negotiated procedures the administration is awarded by significant discretionary powers. First, the participation to the tender is restricted to firms individually invited to bid by the procuring agency. Second, the set of bidders in negotiated procedure is lower than in the competitive procedure, even if the adoption of the former implies a requirement to invite a minimum number of bidders (5/10 bidders for tenders below/above €500,000).

Third, procuring agency can consult one or more firms and negotiate the terms of the tenders with them. Thus, the procuring agency can relevantly shape the selection process, representing one of the major differences between the two procedures. Negotiated procedures are admissible only in case of specific conditions such those related to urgency or lack of appropriate offers or applicants and in the case of smaller tenders, that is, those with the base price below the threshold established by the law (Decarolis and Giorgiantonio 2015)[7].

The above-reported Italian regulatory framework has been changed in in July 2011 (Law 106/2011). The reform expanded the set of conditions under which negotiated procedures can be used by increasing the base price threshold below which procuring agencies can use negotiated procedures from €500,000 to €1 million.[8] Moreover, the procurement agency must consult no less than five firms in the case of public contracts between €100,000 and €500,000, whereas for contracts between €500,000 and €1 million the procurement agency must consult no less than 10 firms. Hence, the reform clearly points to achieving higher levels of discretion being granted to procurement agencies in the selection of suppliers. For our empirical analysis, we fully exploit the exogenous variation imposed by the reform of base price threshold.

4.2 Data description

Our main dataset is provided by the Observatory of the Public Contracts at the Italian Anticorruption Authority (ANAC), a public body that oversees public procurement in Italy

[7] In this case, the "lowest price" criterion or "most economically advantageous tender" criterion can be used to award the tender contract. For more details, see Decarolis and Giorgiantonio (2014).

[8] One of the aims of the reform was to accelerate the awarding of public works, as by construction negotiated procedures are faster.

and includes information on 5,052 contracts awarded in Italy by municipalities in the period between 2009 and 2013. As in Coviello (2018), all contracts in our sample have been concluded, leading to the execution of public work. For each contract, we have detailed information about the type of contracting authority, the procedure and the selection criterion used to award the contract, the number of bidders, and the identity of the winning bidder. The data also include information on public work outcomes, such as the initial project value (i.e. reserve price)[9], the winning rebate and the total effective costs, the expected and effective contractual time. We have, then, merged these data with information on the level of corruption computed at the provincial level by Golden and Picci (2005) and with classic measures of social capital (Guiso et al., 2004) also computed at the provincial level. Finallly, we have also considered additional measures of trust in government based on objective data on Italian primary-school teachers' cheating behavior when administering a nationwide standardized test managed by the Italian institute for the assessment of educational system (Finocchiaro Castro and Guccio, 2020). The advantage of this measure is, in our view, twofold. First, the measure captures the average ethical attitude of public officials (teachers) at the provincial level, and thus, it provides us with an ideal measure through which to capture the different expected misbehavior at local level associated to increased discretion. The second advantage is that this measure is available both at the provincial level (Finocchiaro Castro and Guccio, 2020) and at the municipality level (Guiso et al., 2016).

As already mentioned, we focus on the reform that took place in July 2011 (Law 106/ 2011). This reform has incresed the base price threshold below which contracting authorities can use negotiated procedures from €500,000 to €1 million. Thus, following Baltrunaite et al., (2021), to obtain a symmetric interval around the threshold affected by the reform (€500,000), we use data on contracts with base price between €200,000 and €800,000. To further control for the heterogeneity of our sample, we consider only public works awarded by municipalities. Moreover, to reduce the heterogeneous nature of public works in the sample, we consider only those related to two categories: one involving civic buildings (OG01), and another including transportation infrastructures such as roads, highways, and bridges (OG03)[10]. Therefore, our sample is relatively homogeneous both in

[9] In this paper, we indifferently employ the terms reserve price or base price to indicate the value of the project.

[10] In Italy, the classification of public works includes 13 categories of ordinary works (OG) and 35 categories of works with special technical and constructive characteristics (OS). The two categories chosen (OG01 and OG03) represent those most used cover about two thirds of all public works awarded annually in Italy during the period (ANAC, 2014).

terms of project value (between 200,000 and 800,000 euros) and technological characteristics (OG01 and OG03) that in terms of the institutional characteristics of the contracting authority.

Because our empirical approach involves at the first stage estimation of performance in public works execution and at the second stage an analysis of its determinants, for convenience, we present first the data used in the performance estimates. In first stage estimates, following the abovementioned literature, we use an input-oriented approach, assuming that for a given target of time and cost, agreed on in the contracts, the most efficient procurers are the ones that minimize the actual time and costs. Furthermore, each public work contract is treated as a separate DMU with its own input and output values. Descriptive statistics for all inputs and outputs used to estimate efficiency scores are provided in Table 1. Table 1 reports statistics for both the full sample and the two subsamples of contracts awarded before and after the reform. The two samples are slightly different in size, with a prevalence of the numbrer of contracts awarded before the reform. However, it should be considered that the reform went into effect on July 1, 2011, and we considered a one-month embargo to account for possible reaction time on the part of contracting authorities. The average agreed cost of public work completion in our sample is about 282,000 euro and with planned time of completion of about 140 days. The difference of these statistics in the two subsamples of contracts awarded before and after the reform are minimal.

<< Table 1 about here>>

To assess the determinants of performance we distinguish between public work outcome variables and other environmental variables. The former group of variables is reported in Table 2. In the table, the descriptive statistics are also split into two subsamples of the contracts awarded before and after the reform. As could reasonably be expected, Table 2 shows that, after the reform, the use of discretionary procedures was notably increased in our sample. At the same time, is evident a marked reduction in the number of bidders whereas the rebate was substantially stable. The other environmental variables are reported in Table 3.

The first group of variables capture the effects of reform. In particulat ABOVE is a dummy variable for procedures with a base price above 500,000 euro and POST is a dummy variable for procedures executed after the introduction of the reform. The variable ABOVE*POST is the interaction between the two former indicators. The second group of

variables are a set of corruption and social capital indicators discussed above. Finally, we consider a number of controls for public work category, year of award, and region.

<< Table 2 about here>>

<< Table 3 about here>>

5. Results

5.1 Efficiency estimates

The DEA efficiency scores can be calculated in several ways. Following a large body of literature (e.g. Guccio et al., 2014a; 2014b; Finocchiaro Castro et al., 2014; 2018; Ancarani et al., 2016; Cavalieri et al., 2017; 2018), we use an input-oriented approach assuming that the contracting authorities achieve the time and cost targets agreed in the contract, minimizing the actual time and costs. In estimating DEA efficiency scores, the hypotheses regarding returns to scale (i.e. Constant Returns to Scale [CRS] vs. Variable Returns to Scale [VRS]) are strictly related to the object of the analysis, with the use of a CRS assumption being more appropriate in the context of two-stage performance assessment because it identifies overall inefficiency. In fact, the CRS DEA model measures the overall efficiency for each DMU, aggregating pure technical and scale efficiency into a single value. Hence, we apply the CRS assumption, in line with the reasoning used in the literature, which employs the same benchmark production model proposed here to assess the performance in public works execution. Moreover, the fact that in our sample there are only public works with a reserve price between 200,000 and 800,000 euros and covering quite omogeneus technical categories reassures us that any economies or diseconomies of scale should not represent a major issue in the efficiency estimates. Efficiency estimates have been run by the package FEAR in R (Wilson, 2008).

Table 4 reports initial and bias-corrected DEA efficiency estimates and DEA estimation by geographical macro area. Overall, municipalities achieve, on average, a low perfomance in managing the execution of the public works in our sample. More precisely, the average efficiency score in the sample is 24.26%, indicating a 76.74% average potential reduction in inputs. However, the picture is slightly different across the country, with the average bias-corrected efficiency values ranging from a maximum of 25.20% in the North-East to a minimum of 23.55% in the South.

As previously mentioned, the results reported in Table 4 show that, on average, each contracting authority can reduce both actual time and costs proportionally by 76.74% given the target value (that is, the time and costs agreed on in the contract). Furthermore, it is important to stress that the fully efficient observations (i.e., those on the DEA frontiers) are not necessarily the ones that fulfil simultaneously time and cost efficiency and that the relatively high (average) efficiency scores do not mean that public contracts for roads in Italy are overall executed efficiently. In fact, in the input-oriented CRS model (Charnes et al., 1978) employed here, the efficiency score measures the radial contraction in the actual achievements of cost and time objectives needed to attain the contract target in relative terms. Thus, it identifies the best performing DMUs, in the relevant trait of the bi-dimensional frontier, as the ones that minimize the "distance" of actual achievements from the targets. This implies that the best-performing DMUs could still exhibit a relatively inefficient performance in one of the targets (i.e., time and costs) agreed on in the contract.

<< Table 4 about here>>

In Figure 1, we show the frequency of DEA CRS efficiency estimates and the kernel density estimates (based on 2,000 bootstraps). The distribution of the DEA CRS efficiency estimates (left-hand side) shows a relevant degree of variability across the DMUs. On the right-hand side of the Figure, the two kernel density functions indicate that the efficiency scores are similar (i.e., the two tracks are practically over-imposed), with minor changes and fewer fluctuations due to the extra estimation tasks required by the bias-corrected procedure. This result reassures us that potential bias in efficiency estimates is not a major issue (Simar and Wilson, 2008).

<< Figure 1 about here>>

5.2 Testing the effects of bureaucratic discretion and the role of environmental corruption on efficiency

In this Section, we empirically explore whether the reform has had an impact on efficiency in public works execution and whether this impact is independent of the environmental restrictions under which purchasing agencies operate.

As a preliminary exercise, we conduct some non-parametric tests (i.e., the Mann-Whitney - MW and the bootstrap-based test proposed by Simar and Wilson, 2008 - SW) on those public works, above the threshold of €500,000, affected by the reform.

Table 5 reports the results of the non-parametric tests, showing that for public works, above 500,000 euros, the reform has produced a fairly small improvement in efficiency. Also, both MW and SW test find significant differences in the performance. Figure 2 describes the kernel density estimates for the two groups of public works above 500,000 euros, confirming our result.

<< Table 5 about here>>

<< Figure 2 about here>>

Regarding the impact of environmental factors, Table 5 shows the non-parametric tests for the classic indices of corruption, social capital, and institutional trust described in Section 4. The results reported in the table are quite ambiguous. While indicators of corruption and social capital do not seem to influence the performance significantly, institutional trust indices show a positive and significant impact. The kernel density estimates reported in Figure 3 seems to confirm this preliminary picture. However, previous estimates between the two groups of contracts do not consider other factors that may impact performance in the execution of public works. To better understand the effects of reform on performance, we need to control for these effects through second-stage estimation that better assesses the determinants of different contract efficiency.

<< Figure 3 about here>>

We now identify the effect of the reform extending the scope of bureaucrats' discretion on the efficiency of public works execution by exploiting the natural experiment run in Italy. As mentioned, the relationship between reform and efficiency of public work execution can be estimated in a quasi-experimental setting using a difference-in-difference (DID) methodology. The DID estimator can be used to assess the magnitude of the "treatment effect" provided by the reform in 2011. More specifically, we use a DID estimation to compare the change in the performance variable $\hat{\theta}_{DEA\ ijt}$ for public work above

and below the threshold of 500,000 euro, before and after the reform of 2011. Thus, in the second stage we estimate the following general model:

$$\hat{\theta}_{DEA\ ijt} = \alpha + \beta_1 ABOVE_i + \beta_2 POST_t + \gamma\ ABOVE_i * POST_i + \eta_{ijt} + \varepsilon_{ijt} \quad (5)$$

where $\hat{\theta}_{DEA\ ijt}$ is the outcome variable for the public work *i* managed by municipality *j* at time *t*; $ABOVE_i$ is an indicator for procedures with a reserve price above 500,000 euro; $POST_t$ is an indicator for procedures executed after the introduction of the reform; $ABOVE_i * POST_t$ is the interaction between the two indicators. The coefficient of interest is γ. We have also included a broad set of fixed effects η_{ijt} to account for the type of public works, regional and time effects. Finally, ε_{ijt} is the error term that accounts for the statistical noise.

Given that estimated efficiency scores are truncated from below, in the estimated equation (5) we use the two-step bias-corrected semi-parametric truncated estimator proposed by Simar and Wilson (2007), underlining that traditional estimator yields biased estimates due to serial correlation of DEA efficiency scores. Therefore, they suggest applying a two-step bias-corrected semi-parametric estimator that was shown to be the only known method for ensuring a feasible and consistent inference on the second stage regression (Simar and Wilson, 2011). We estimate equation (5) both with and without the inclusion of a full set of fixed effects to assess the role of environmental variables in the two-stage approach.

Some issues should be emphasized before presenting the estimates. First, the credibility of our DID identification strategy crucially relies on the assumption that, in absence of the treatment, the outcome variable $\hat{\theta}_{DEA ijt}$ for the treated and the control units would have followed parallel paths over time. However, as pointed out by Baltrunaite et al. (2021), it is not possible to control for unobservable differences at the contract level, as no contract is awarded both with and without discretion. Our estimates, therefore, rest on an additional implicit assumption that there are no unobservable changes in contract characteristics before and after the reform. A second issue is related to the condition of separability assumption in two-stage estimates (Simar and Wilson, 2007). This condition requires that uncontrollable factors employed in the second stage do not affect the shape of the production possibility set (Bădin et al., 2014). As pointed out by Finocchiaro Castro et al. (2014), for this assumption to be satisfied, uncontrollable factors should only influence the distribution of inefficiencies inside the production possibility set and not the attainable set and its frontier. This seems to be the case in our second-stage analysis.

Finally, one might argue that a more robust empirical strategy for testing the effects of a threshold variation could be an RDD approach because the ease to use negotiated procedures changes discontinuously at a cutoff. However, a RDD method relies on the identifying assumption that there is no strategic manipulation of the running variable at the cutoff. As suggested by Baltrunaite et al., (2021), in our empirical setting there is a strong suspicion that bureaucrats strategically manipulate the reserve price to gain (unobserved) benefits. To check for manipulation of the reserve price around the threshold in our sample, in Figure 4 we report the empirical distribution of the reserve price before and after the reform, with contracts grouped into 300 bins for each period. Figure 4 confirms, also in our sample, the evidence reported by Baltrunaite et al, (2021) of a spike below the €500,000 threshold in both periods, though it is substantially larger in the pre-reform period. These results validate the hypotheses that bureaucrats strategically respond to the discontinuous change in procedural costs across the threshold by manipulating the reserve price so that it falls below it. This empirical feature of the data hinders the application of RDD approach in our setting and confirms the appropriateness of the chosen empirical strategy, DID estimator namely.

<< Figure 4 about here>>

As already illustrated, to assess the effects of the reform on the performance of public works execution we employ the two-step bias-corrected semi-parametric truncated estimator proposed by Simar and Wilson (2007). Thus, in Table 6, we estimate equation (5) both with and without the inclusion of a full set of fixed effects. The role of the reform can be inferred from analyzing the coefficient of the interaction term of the ABOVE*POST covariate. The sign confirms that in both models the reform mildly and positively affects the performance of public works execution.

<< Table 6 about here>>

Table 7 investigates the role of environmental corruption on the performance of public works execution. We measure corruption by means of the Golden and Picci (2005) corruption index, distinguishing between areas characterized by low and high levels of such

index. It appears that corruption does not seem to affect the performance once the reform has been in action, especially after including all the controls in the models.

<< Table 7 about here>>

Then, we focus on the role of different measures of social capital on the efficiency of public works execution together with the introduction of the reform on regulatory threshold. For instance, Table 8 reports the estimates for the first two measure of social capital under analysis, blood donations at provincial level and turnout in the referendum on divorce (1974) at the provincial level namely. Those two measures have been taken from Guiso et al., (2004). The reform has played a positive and significant role on the execution of public works located in areas characterized by high level of social capital. This result holds regardless of the adoption of all the controls in the models. In particular, the role exerted by the social capital index referring to turnout in the referendum on divorce (1974) at the provincial is more significant than the one played by blood donations levels.

<< Table 8 about here>>

Table 9 shows the effects of two measures of institutional trust on the efficiency of public works execution, teachers' cheating at provincial level (Finocchiaro Castro and Guccio, 2020) and teacher's cheating in mathematical tests at municipality level (Guiso et al, 2008) namely. Also in this case, the reform seems to positively affect the execution of public works in those areas characterized by high levels of institutional trust, regardless of the adoption of all the available controls. Moreover, the index proposed by Guiso et al., (2008) turns out to be more significant that the other one.

<< Table 9 about here>>

6. Concluding remarks

As highlighted at the beginning of this work, one of the most relevant elements in public procurement design concerns the level of discretion granted to contracting authorities and

public officials to strike a balance between rules and discretion. In very general terms, governments must decide whether the benefits of preventing potential waste and abuse outweigh the costs of stringent regulation.

In this manuscript, we investigated the relationship between social capital and performance in public works execution. Taking the start from a 2011 reform that expanded bureaucrats' discretion in contractor selection, we first assessed the impact of the reform on efficiency in public works delivery and then investigated the impact of the reform in contexts characterized by different levels of social capital. Overall, our analysis has shown that the reform has exerted a positive, although mild, effect on the performance of public works execution. In detail, such positive effect has been highly correlated with the different distribution of social capital and trust in institutions levels in Italy. In other words, the positive role of the reform is larger in those areas where social capital and trust in institutions have been higher. These results seem to suggest that more discretion leads to greater efficiency but also to greater corruption risks.

From a policy perspective, our results suggest that caution should be applied in enlarging the discretion accrued to procurement agencies without considering those environmental variables that may affect bureaucrats' behaviors and the need for an effective *ex post* control system. Increased discretion in *ex-ante* behaviour must be balanced by strengthened ex-post controls, particularly in high-risk areas. This requires a change in the regulation perspective that shifts the emphasis from a formal compliance of the rules to the accountability. Furthermore, our results show that such regulation paradigm shift is more likely to make efficiency gains largely prevail in areas where social capital and trust in institutions are higher.

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TABLES AND FIGURES

Table 1 – Descriptive statistics of DEA inputs and outputs for the whole sample and the subsample

Variables	Definition	Obs.	Mean	St. Dev.
Whole sample				
A_COST	Actual cost of public work completion	5,052	320.479	164.441
A_TIME	Actual time of public work completion (in days)	5,052	243.509	159.508
W_BID	Agreed cost of public work completion (i.e., winning bid)	5,052	282.085	115.400
P_ TIME	Planned time of public work completion (in days)	5,052	139.127	87.252
Before the reform				
A_COST	Actual cost of public work completion	2,826	317.162	160.840
A_TIME	Actual time of public work completion (in days)	2,826	255.257	165.308
W_BID	Agreed cost of public work completion (i.e., winning bid)	2,826	278.762	115.117
P_ TIME	Planned time of public work completion (in days)	2,826	144.622	86.127
After the reform				
A_COST	Actual cost of public work completion	2,226	324.690	168.844
A_TIME	Actual time of public work completion (in days)	2,226	228.594	150.547
W_BID	Agreed cost of public work completion (i.e., winning bid)	2,226	286.303	115.648
P_ TIME	Planned time of public work completion (in days)	2,226	132.150	88.187

Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC.
Note: Monetary values in thousand euros at current prices. Time in days.

Table 2 – Descriptive statistics of variables of public work outcomes for the whole sample and the subsamples

Variables	Definition	Obs.	Mean	St. Dev.
Whole sample				
NEGOTIATED	A dummy equal to 1 for works assigned with a discretionary procedure	5,052	0.482	0.500
BIDDERS	Number of bidders	5,052	37.516	56.426
REBATE	The percentage discount over the P_VALUE	4,925	18.308	10.277
P_VALUE	Public work reserve price (thousand euros at current prices)	5,052	343.376	133.248
Before the reform				
NEGOTIATED	A dummy equal to 1 for works assigned with a discretionary procedure	2,826	0.348	0.476
BIDDERS	Number of bidders	2,826	44.658	59.015
REBATE	The percentage discount over the P_VALUE	2,821	18.511	9.563
P_VALUE	Public work reserve price (thousand euros at current prices)	2,826	340.623	133.427
After the reform				
NEGOTIATED	A dummy equal to 1 for works assigned with a discretionary procedure	2,226	0.651	0.477
BIDDERS	Number of bidders	2,226	28.450	51.565
REBATE	The percentage discount over the P_VALUE	2,104	18.035	11.160
P_VALUE	Public work reserve price (thousand euros at current prices)	2,226	346.870	132.969

Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC.

Table 3 – Descriptive statistics of the environmental variables used in the second stage

Variables	Definition	Obs.	Mean	St. Dev.
ABOVE	Dummy =1 if the public work reference price is larger of 500,000 euro	5,052	0.1134	0.3171
POST	Dummy =1 if the public work was awarded after the reform	5,052	0.4406	0.4965
ABOVE*POST	Interaction term between ABOVE and POST	5,052	0.0491	0.2161
GP_INDEX	Corruption index proposed by Golden and Picci (2005), at the provincial level	4,898	1.2333	1.0096
BLOOD	Blood donation at provincial level (Guiso, Sapienza & Zingales, 2004)	4,722	0.0281	0.0209
DIVORCE	Turnout in the referendum on divorce (1974) at the provincial level (Guiso, Sapienza & Zingales, 2004)	4,676	0.8899	0.0646
CHEATING	Standardized cheating index proposed by Finocchiaro Castro & Guccio (2020), at the provincial level	4,945	0.7002	0.8452
CHEATING_MAT	Cheating in mathematical tests at the municipality level (Guiso, Sapienza & Zingales, 2008)	4,866	0.0744	0.0761
TYPE_ OG01	Dummy variable for type of public work OG01	5,052	0.4572	0.4982
TYPE_ OG03	Dummy variable for type of public work OG03	5,052	0.5428	0.4982
REGION	Dummy variables for region (from 1 to 20 regions)			
YEAR	Dummy variables for year of award (from year 2009 to year 2013)			

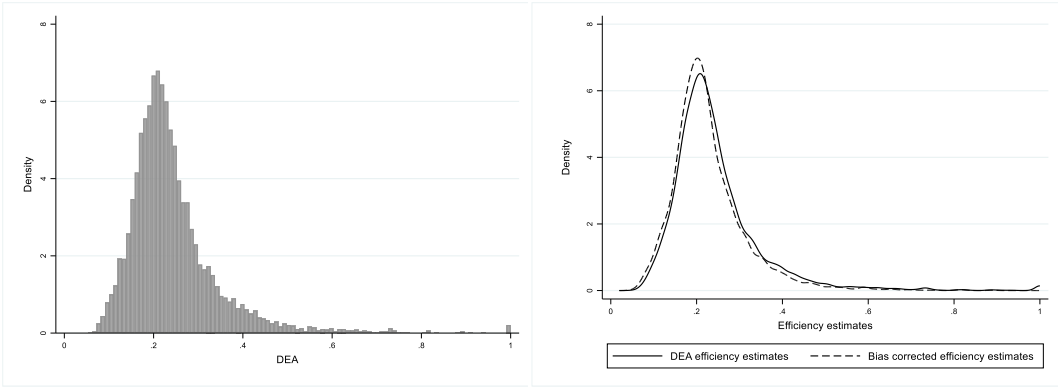
Source: our elaboration on data provided by Observatory of the Public Contracts – ANAC, Golden and Picci (2005) Finocchiaro Castro & Guccio (2020), Guiso, Sapienza & Zingales, (2004) and Guiso, Sapienza & Zingales, (2008).

Table 4 – Descriptive statistics of the efficiency estimates by geographical area (DEA – CRS)

Macroarea	Efficiency estimates	Obs.	Mean	Std. Dev.
North-West	DEA_CRS	949	0.2428	0.1103
	DEA_CRS bias corrected	949	0.2221	0.0883
North-East	DEA_CRS	1,460	0.2520	0.1038
	DEA_CRS bias corrected	1,460	0.2283	0.0878
Centre	DEA_CRS	1,092	0.2425	0.0913
	DEA_CRS bias corrected	1,092	0.2189	0.0936
South	DEA_CRS	923	0.2355	0.1080
	DEA_CRS bias corrected	923	0.2133	0.0769
Islands	DEA_CRS	628	0.2389	0.1103
	DEA_CRS bias corrected	628	0.2177	0.0901
All sample	**DEA_CRS**	**5,052**	**0.2426**	**0.1026**
	DEA_CRS bias corrected	**5,052**	**0.2189**	**0.0866**

Source: our elaboration on data provided by Observatory of the Public Contracts – ANAC.

Figure 1 - Frequency of DEA CRS efficiency estimates (on the left) and kernel density estimates of DEA CRS and DEA CRS bias-corrected efficiency estimates (on the right)



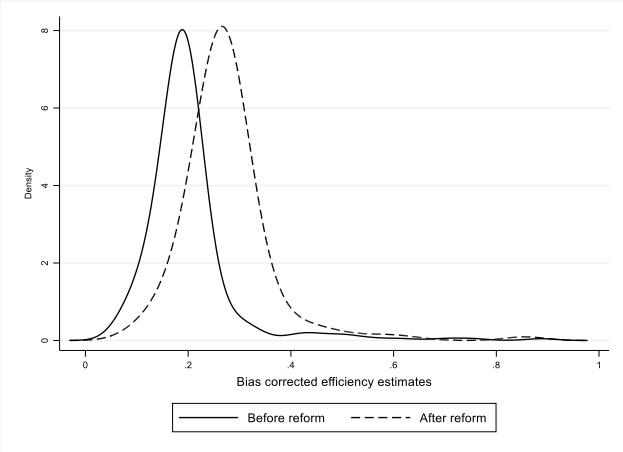
Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC. *Note*: Figures show the frequency, and the kernel density estimates of DEA efficiency scores under the CRS assumption, respectively. DEA CRS bias-corrected scores are estimated with the procedure proposed by Simar and Wilson, (2000). The kernel density functions for the efficiency of contracts for roads are derived from bias-corrected DEA efficiency scores using a univariate kernel smoothing distribution and the appropriate bandwidth (Simar and Wilson, 2008).

Table 5 – Conditional distribution of average bias-corrected DEA efficiency estimates for public work above 500,000 euro

Variables define the group	**First group** mean (st. dev.)	**Second group** mean (st. dev.)	**MW test** (*p-values*)	**SW test** (*p-values*)
REFORM (first group if REFORM=1)	0.2109 (0.0671)	0.1961 (0.0769)	(0.0000)	(0.0068)
GP_INDEX (first group if GP_INDEX larger that the median)	0.1994 (0.0680)	0.2091 (0.0865)	(0.0965)	(0.1142)
BLOOD (first group if BLOOD larger that the median)	0.2009 (0.0798)	0.1998 (0.0801)	(0.4011)	(0.6877)
DIVORCE (first group if DIVORCE larger that the median)	0.2082 (0.0702)	0.1960 (0.0874)	(0.0091)	(0.0165)
CHEATING_MAT (first group if CHEATING_MAT larger that the median)	0.1965 (0.0800)	0.2094 (0.0811)	(0.0119)	(0.0262)
CHEATING (first group if CHEATING larger that the median)	0.1957 (0.0836)	0.2041 (0.0820)	(0.0180)	(0.0331)

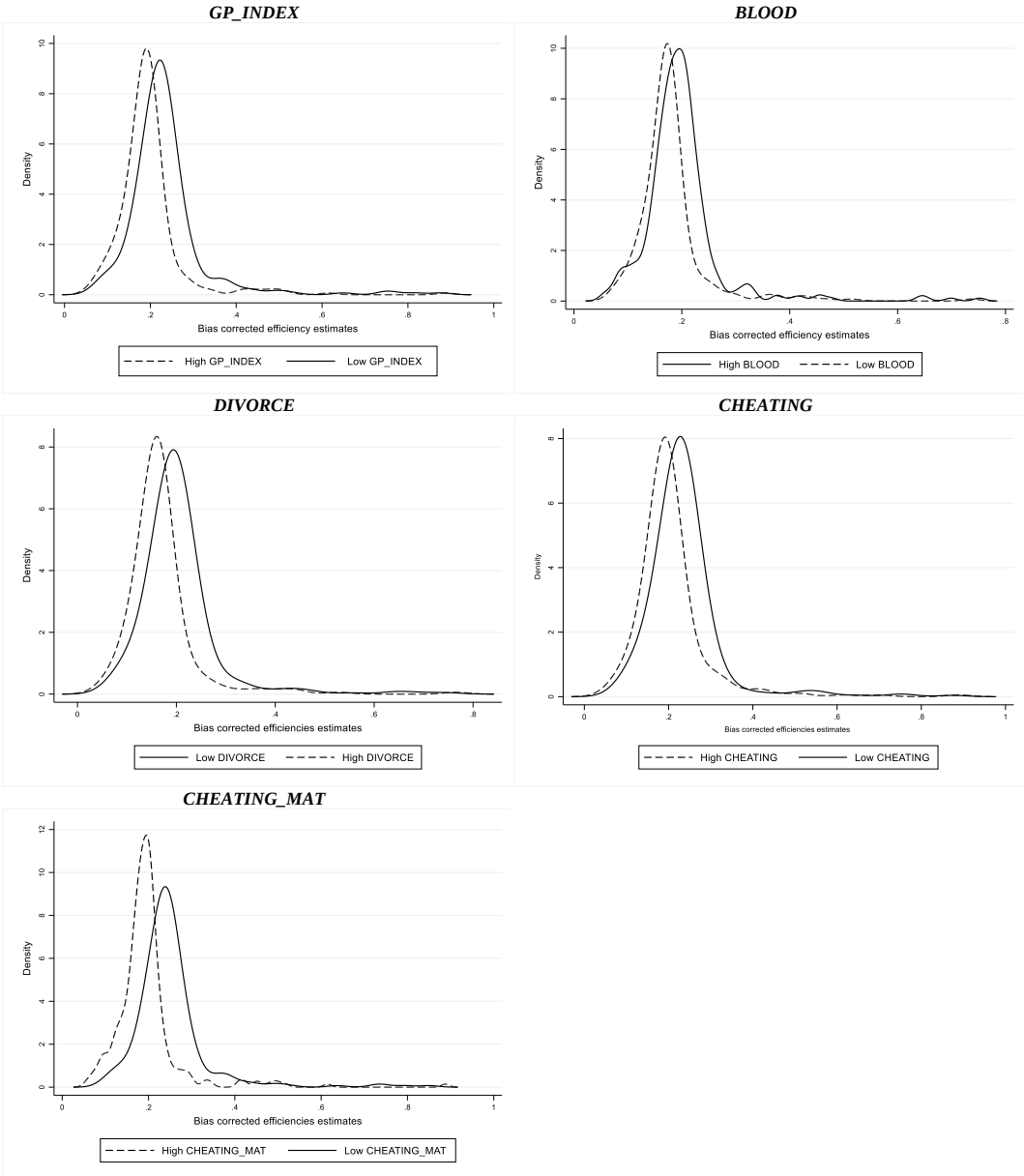
Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC.
Note: Mann–Whitney (MW) test; (SW) mean equivalence test proposed by Simar and Wilson (2008, 471-476). *p-values* in parentheses.

Figure 2 - Kernel density estimates bias-corrected DEA efficiency estimates for public work above 500,000 euro



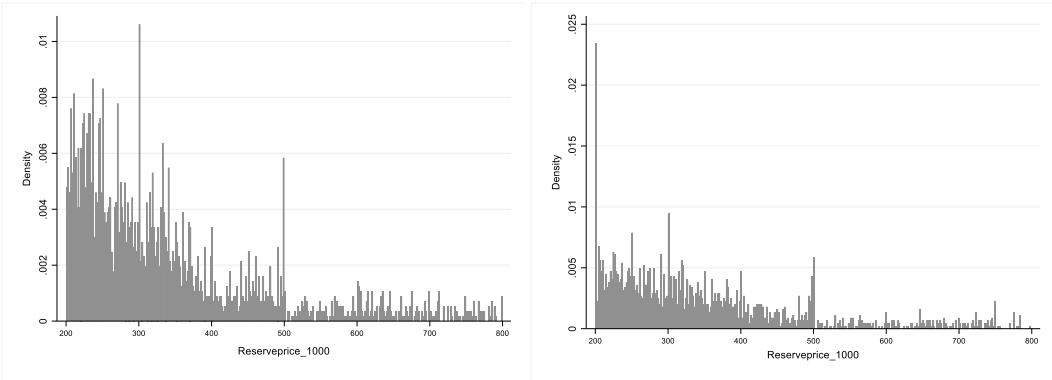
Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC.
Note: Figures show the kernel density estimates of DEA efficiency scores under CRS assumption for public work above 500,000 euro. DEA CRS bias-corrected scores are estimated with the procedure proposed by Simar and Wilson, (2000). The kernel density functions for the efficiency of contracts for roads are derived from bias-corrected DEA efficiency scores using a univariate kernel smoothing distribution and the appropriate bandwidth (Simar and Wilson, 2008).

Figure 3 - Kernel density estimates of bias-corrected DEA efficiency estimates for indices of corruption, social capital, and social trust - public work above 500,000 euro



Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC.
Note: Figures show the kernel density estimates of DEA efficiency scores under CRS assumption for public work above 500,000 euro. DEA CRS bias-corrected scores are estimated with the procedure proposed by Simar and Wilson, (2000). The kernel density functions for the efficiency of contracts for roads are derived from bias-corrected DEA efficiency scores using a univariate kernel smoothing distribution and the appropriate bandwidth (Simar and Wilson, 2008).

Figure 4. Distribution of the of public works reserve price before and after the reform



Source: our elaboration on data provided by Observatory of the Public Contracts - ANAC.

Notes: Public work reserve price in thousand euros at current prices

Table 6 – Effects of the reform on the performance of public works execution – semi-parametric bootstrap truncated estimates, full sample

Variables	**Truncated estimates** [a]	
	(1)	(2)
	$\hat{\hat{\theta}}$	$\hat{\hat{\theta}}$
Constant	0.2231***	0.2230***
	(0.0017)	(0.0064)
ABOVE	-0.0300***	-0.0289***
	(0.0050)	(0.0049)
ABOVE*POST	0.0177**	0.0142*
	(0.0080)	(0.0080)
POST	-0.0078***	-0.0003
	(0.0027)	(0.0056)
Other controls	no	yes
Control for year	no	yes
Control for region	no	yes
Observations	5,052	5,052

Source: our elaboration on data provided by sources reported in Table 3.

Notes. ***, **, and * denote significance at the 1%, 5% and 10% level using the bootstrap-estimated confidence intervals. All estimates include year of award fixed effects.

[a] Bias-adjusted coefficient using double bootstrap truncated estimates algorithm # 2 (n=2000), (Simar and Wilson, 2007).

Table 7 – Role of corruption – semi-parametric bootstrap truncated estimates, full sample

Variables	Truncated estimates [a]			
	GP_INDEX			
	(1)	(2)	(3)	(4)
	Low	High	Low	High
Constant	0.2260***	0.2199***	0.2125***	0.2307***
	(0.0025)	(0.0024)	(0.0086)	(0.0074)
ABOVE	-0.0369***	-0.0234***	-0.0352***	-0.0233***
	(0.0075)	(0.0066)	(0.0073)	(0.0065)
ABOVE*POST	0.0248*	0.0107	0.0191	0.0110
	(0.0131)	(0.0090)	(0.0131)	(0.0090)
POST	-0.0081**	-0.0076**	-0.0055	0.0044
	(0.0041)	(0.0036)	(0.0089)	(0.0067)
Other controls	no	no	yes	yes
Control for year	no	no	yes	yes
Control for region	no	no	yes	yes
Observations	2,464	2,434	2,464	2,434

Source: our elaboration on data provided by sources reported in Table 3.
Notes. ***, **, and * denote significance at the 1%, 5% and 10% level using the bootstrap-estimated confidence intervals. All estimates include year of award fixed effects.
[a] Bias-adjusted coefficient using double bootstrap truncated estimates algorithm # 2 (n=2000), (Simar and Wilson, 2007).

Table 8 – Role of social capital – semi-parametric bootstrap truncated estimates, full sample

Variables	Truncated estimates [a]							
	BLOOD				DIVORCE			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Low	High	Low	High	Low	High	Low	High
Constant	0.2142***	0.2323***	0.2082***	0.2225***	0.2163***	0.2297***	0.2286***	0.1998***
	(0.0022)	(0.0027)	(0.0152)	(0.0082)	(0.0023)	(0.0026)	(0.0075)	(0.0162)
ABOVE	-0.0182***	-0.0430***	-0.0176***	-0.0415***	-0.0115*	-0.0545***	-0.0124*	-0.0535***
	(0.0070)	(0.0069)	(0.0068)	(0.0069)	(0.0067)	(0.0068)	(0.0065)	(0.0068)
ABOVE*POST	0.0052	0.0303**	0.0005	0.0272**	-0.0038	0.0467***	-0.0033	0.0368***
	(0.0101)	(0.0128)	(0.0101)	(0.0131)	(0.0098)	(0.0132)	(0.0097)	(0.0136)
POST	-0.0062*	-0.0067	0.0084	-0.0102	0.0008	-0.0168***	0.0122*	-0.0156*
	(0.0035)	(0.0042)	(0.0069)	(0.0090)	(0.0038)	(0.0040)	(0.0067)	(0.0093)
Other controls	no	no	yes	yes	no	no	yes	yes
Control for year	no	no	yes	yes	no	no	yes	yes
Control for region	no	no	yes	yes	no	no	yes	yes
Observations	2,337	2,397	2,337	2,397	2,195	2,493	2,195	2,493

Source: our elaboration on data provided by sources reported in Table 3.
Notes. ***, **, and * denote significance at the 1%, 5% and 10% level using the bootstrap-estimated confidence intervals. All estimates include year of award fixed effects.
[a] Bias-adjusted coefficient using double bootstrap truncated estimates algorithm # 2 (n=2000), (Simar and Wilson, 2007).

Table 9 – Role of social trust – semi-parametric bootstrap truncated estimates, full sample

Variables	Truncated estimates [a]							
	CHEATING				CHEATING_MAT			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Low	High	Low	High	Low	High	Low	High
Constant	0.2242***	0.2213***	0.2111***	0.2355***	0.2276***	0.2158***	0.2198***	0.2266***
	(0.0024)	(0.0025)	(0.0093)	(0.0089)	(0.0023)	(0.0025)	(0.0079)	(0.0108)
ABOVE	-0.0372***	-0.0205**	-0.0350***	-0.0209**	-0.0462***	-0.0090	-0.0449***	-0.0104
	(0.0060)	(0.0085)	(0.0060)	(0.0083)	(0.0059)	(0.0083)	(0.0059)	(0.0082)
ABOVE*POST	0.0321**	0.0010	0.0278**	-0.0013	0.0379***	-0.0072	0.0337***	-0.0078
	(0.0126)	(0.0106)	(0.0128)	(0.0107)	(0.0121)	(0.0111)	(0.0122)	(0.0112)
POST	-0.0080**	-0.0065*	-0.0078	0.0105	-0.0104**	-0.0017	-0.0087	0.0094
	(0.0041)	(0.0037)	(0.0079)	(0.0073)	(0.0041)	(0.0037)	(0.0078)	(0.0072)
Other controls	no	no	yes	yes	no	no	yes	yes
Control for year	no	no	yes	yes	no	no	yes	yes
Control for region	no	no	yes	yes	no	no	yes	yes
Observations	2,498	2,447	2,498	2,447	2,456	2,410	2,456	2,410

Source: our elaboration on data provided by sources reported in Table 3.
Notes. ***, **, and * denote significance at the 1%, 5% and 10% level using the bootstrap-estimated confidence intervals. All estimates include year of award fixed effects.
[a] Bias-adjusted coefficient using double bootstrap truncated estimates algorithm # 2 (n=2000), (Simar and Wilson, 2007).