DOES CORRUPTION SAND THE WHEELS IN THE PUBLIC WORKS EXECUTION?

MASSIMO FINOCCHIARO CASTRO, CALOGERO GUCCIO, ILDE RIZZO

Does Corruption Sand the Wheels in the Public Works Execution?

Massimo Finocchiaro Castro*
Mediterranean University of Reggio Calabria, DSSEGS, Department of Law and Social Science
Via Tommaso Campanella, 38/A - 89125 Reggio Calabria,
massimo.finocchiaro@unirc.it, tel. +39 0965 809740, fax +39 0965 809706

Calogero Guccio
University of Catania, Department of Economics and Business
Corso Italia, 55 – 95121 Catania,
cguccio@lex.unict.it , tel. +39 095 7537744, fax +39 095 7537710

Ilde Rizzo
University of Catania, Department of Economics and Business
Corso Italia, 55 – 95121 Catania,
rizzor@unict.it , tel. +39 095 7537721, fax +39 095 7537710

Preliminary draft

[This version 30 June 2012]

Abstract.

This paper investigates the interaction between corruption and infrastructure provision, employing a data set on Italian public contracts for roads and highways in the period 2000-2005, the paper examines whether the environmental characteristics (i.e. in particular the corruption level) in the area where the infrastructure is localised affect the efficient management of the public work contract. For this purpose a two-stage analysis is carried out. In the first stage, a non-parametric approach (Data Envelopment Analysis - DEA) investigates the relative efficiency by each single public work execution; in the second stage, the determinant factors of the scores variability are investigated, paying attention on the effect exerted by corruption. We find evidence that greater corruption is associated with lower efficiency in infrastructure provision.

JEL Code: D73; H57; D24

Keywords: corruption; infrastructure provision; non parametric methods

*Corresponding author.

1. Introduction

Corruption is recognised as being a major problem affecting all countries in the world, though to a different extent. Several studies investigate the negative effects of corruption on economic growth (Mauro, 1995), on financial markets (Guiso et al., 2000) and on the accountability of institutions (Hunt, 2005; Hunt and Laszlo, 2005). This view is also supported by the reports of international organisations such as, IMF, OECD or the World Bank, suggesting corruption as a major obstacle to economic development. Such a negative role of corruption may be tested using "the sand the wheels" hypothesis simply stating that the costs of corruption make it very difficult to foster economic growth especially in a weak institutional context.

However, according to some scholars, corruption may positively affect economic systems (Leff, 1964; Leys, 1965; Huntington, 1968). These authors suggest that corruption may exert positive effects on economic development, leaving aside any moralistic judgements on it. The line of reasoning is that corruption may be able to solve the problem of bureaucracy inefficiency and bad public policies, being these the barriers to economic development. This point of view has been tested using "the grease the wheels" hypothesis (Mauro, 1995; Ades and di Tella, 1997; Meon and Sekkat, 2005; Meon and Weil, 2010). Opponents of this line of reasoning argue that to evaluate the effects of corruption empirically "institutions matter" (Aidt, 2009). From an empirical point of view, this means that in order to assess the effect of corruption one has to recognise its endogeneity with respect of institution.

In this paper, we aim at contributing to the literature on the effect of corruption on economic growth looking at the infrastructures provision. In particular, we focus on the relationship between efficiency and corruption. The existing literature on this topic reports a negative relationship between infrastructures provision and corruption mainly looking at the nature of the procedures for selection contractors and on the specification of the contract (Estache et al., 2010). In this paper, unlike other studies in the field, attention is focused on the execution phase, after the contract has been awarded.

Thus, we carry out an empirical analysis of the Italian public work procurement system that is often characterised by long delays and relevant cost overruns, which are usually

regarded as one of the reasons for the current under-provision of infrastructures (Banca d'Italia, 2011). Employing a data set on Italian public contracts for roads and highways in the period 2000-2005, the paper examines whether the environmental characteristics (i.e. in particular the corruption level) in the area where the infrastructure provision is localised affect the efficient management of the public work contract, in terms of delays and cost overruns. For this purpose a two-stage analysis is carried out. In the first stage, a non-parametric approach (Data Envelopment Analysis - DEA) investigates the relative efficiency scored by each single public work execution; in the second stage, the determinant factors of the scores variability are investigated, paying attention on the effect exerted by corruption.

The analysis develops as follows: we discuss the grease the wheels and the sand the wheels hypotheses in Sect. 2, and, then, in Sect. 3, we describe the methodological issues underlying the empirical analysis. Sect. 4 presents the data and the results of the empirical analysis, and Sect. 5 offers some concluding remarks.

2. Sand vs. Grease the Wheels hypothesis

International organisations such IMF, OECD, and World Bank support the view that corruption represents a big hurdle to economic growth. This opinion has been confirmed by several empirical works focusing on the negative economic consequences of corruption. In many cases, the negative correlation between costs of corruption and the economic development has been found by testing for the sand the wheels hypothesis. It implies that corruption may be detrimental to the economic performance of countries characterised by weak institutional contexts. This hypothesis can be tested by looking at the effects of corruption applied to different situations. For instance, civil servants may cause delay in the provision of public goods to make citizens offering bribes to speed up bureaucratic procedures (Myrdal, 1968; Kurer, 1993). When a new licence has to be assigned, corruption may lower the probability that the winner is the most efficient competitor. For example, he may decrease the quality of the goods or services to be provided given that a portion of his resources have been already wasted to bribe those who award the licence (Rose-Ackerman, 1997). Also corruption is found to negatively affect the efficiency of public investment,

being diverted towards unproductive sectors (Mauro, 1995; Mo, 2001). Méon and Sekkat (2005) find that corruption negatively affects growth independently from its impact on investment. However, these effects worsen when the quality of governance deteriorates. Finally, when the political and institutional context appears uncertain, corruption may be seen as an insurance against risks. However, corruption itself is an illegal agreement very difficult to secure. Thus, the uncertainty due to corrupt acts may just add to that caused by political instability enhancing its negative effect on the efficiency of the economic system (Bardhan, 1997; Lambsdorff, 2003). Hence, corruption seems to impose higher costs in the institutional context than those usually related with the production process, providing a rationale for the sand the wheels hypothesis.

By contrary, some scholars pointed out the beneficial effects of corruption on boosting development. This point of view can be rooted in the work of Leys (1965) reporting that corruption can speed up bureaucrats in the establishment of new firms. On the same line of reasoning, Lui (1985) shows that corruption represents an efficient way to decrease the time wasted dealing with civil servants. The positive effects of corruption can also be seen when a licence has to be assigned. Leff (1964) suggests that awarding a licence in a corrupt environment resembles a competitive auction, where the winner is the most generous briber with strong incentive to use the licence efficiently. This phenomenon has also been theoretically applied to the assignment of government procurement contracts by Beck and Maher (1986) and Lien (1986) showing that the ranking of corrupt bidders and efficient firms are isomorphic. Also corruption may be able to control for the negative effects of inefficient regulations or bad public policies (Bailey, 1996). Recently, Méon and Weil (2010) have tested for the grease vs. sand the wheels hypotheses on data from both developed and developing countries and found no evidence of the latter but significant evidence of the former. Thus, corruption seems to be less detrimental in countries where the institutional framework is weaker. Summing up, the grease the wheels hypothesis is based on the idea that corruption may positively affect the productivity of an economic system counterbalancing the inefficiency of the governance.

Finally, it is important to put forward that both hypotheses state that corruption negatively affect economic performance when the institutional framework is efficient.

They differ only in the case of inefficient institutional framework suggesting negative (sand) versus positive (grease) effects of corruption on efficiency.

3. Suitable measures for efficiency and corruption in public works execution

In this section we discuss the available options to measure efficiency in public works execution and how we measure the effect of corruption in infrastructure provision.

3.1 The measurement of efficiency in public work management execution

3.1.1 Cost overruns and delays in public work procurement

By and large, the efficient management of public works contracts can be measured alongside different aspects related to both the output/outcome of the work (e.g., the quality of the work, its capability of satisfying the objectives and the needs for which it has been carried out, etc.) and the process of the execution of the contract, which is instrumental to the realisation of the output/outcome. We will focus on the latter issue. In other words, we do not investigate how resources are allocated and whether such a decision is efficient or not, *e.g.* whether the infrastructure which maximizes social welfare is chosen and the best project is selected. When political decision-makers are benevolent the efficiency in the allocation of resources can be taken for granted; whenever this is not the case – as it is stressed in the literature (Estache et al. 2010) the allocation process requires to be evaluated and monitored. This is especially important in the infrastructure case: in such a field, political accountability is weaker than for public service production since citizens/taxpayers are not able to evaluate infrastructure quality per se but only indirectly, through the service they provide. As said before, we concentrate on the execution phase but it is important to outline, however, that the quality of allocation decisions may affect the performance of execution process itself.

The performance of execution of public works contracts can be measured using two indicators: costs overruns and delays, (Guccio et al., 2007) which have a potential negative impact on the social welfare generated by the realisation of public works.

Cost overruns are the additional costs incurred by contracting authorities above those agreed on in the contract; delays refer to the excess time of completion of works with respect to the length agreed on in the contract.

Several factors have been outlined in the literature as drivers of cost overruns in the literature (Guccio et al.,2012). It is widely agreed that there is an unavoidable degree of uncertainty related to the execution of the contract when complex goods are procured and this may cause a difference between what is planned and what is actually realised, or needs to be realised (Ganuza, 2007).

Apart from such 'exogenous' element, there are other possible determinants which are 'endogenous' to the decision-making process, namely what is referred to as 'optimism bias', e.g. a subjective will to underestimate costs, when designing the project (Flyvbjerg, 2005). Such an underestimation can depend on planning fallacy, leading to the overestimation of benefits and the underestimation of costs (Lovallo and Kahneman, 2003) or it can be, instead, determined by the politicians' attitude to look for short term political benefits, as arising from the possibility of increasing the number of works to be started, even if, in the medium or long term they will be delayed or even not completed, because of financial problems.

Another 'endogenous' motivation underlying cost overruns refers to the potential opportunistic behaviour of firms, aimed at exploiting the contract incompleteness, to gain additional money more than what has been agreed upon in the contract. Procurement features connected with the nature of the contract (fixed price *vs*. cost plus contracts) and with the contract awarding procedure (auctions *vs*. negotiations) may affect the strength of the firms' incentives to behave opportunistically (Bajari and Tadelis, 2001; Bajari et al., 2009; Chong et al., 2009; Estache et al., 2009; Guccio et al., 2009). On the other hand, opportunistic behaviour of firms might depend on the relationship they establish with politicians - clear cut corruption as well as too "friendly" behaviour - affecting both the selection process and the possibility of renegotiation (Estache et al., 2010).

As De Carolis and Palumbo (2011) point out, cost overruns and delays can be correlated: the presence of delays in the completion of a work may imply cost overruns, when the delay is representative of problems connected with the realisation of the original project, and additional works are required. However, there can be delays

without cost overruns. Moreover, delays are representative of other costs that are not included in cost overruns for the contracting authorities.

Cost overruns and delays are not only recognised as crucial elements in the economic literature but they are also quite relevant in practice, in the execution of public works contracts in Italy, though the former are less marked than the latter.[1] In the period 2000-2005, 24.90 % of all public works contracts have experienced cost overruns above 10.00% of the original cost while 64.66% of all public works contracts have exhibited a delay longer than 20.00% of the completion time agreed upon in the contract.[2] Therefore, the issue of investigating the performance of public works contract execution is worth exploring.

3.1.2. The use of non-parametric frontier for measuring the efficient management of public work execution

The above mentioned indicators represent an easy and straightforward way to measure the capacity to complete works within the cost (cost overruns) and the time (delay) agreed on in the contract. To compare the performance of different decision-makers, on the basis of the two indicators, so as to ascertain the relative capacity of different decision-makers to achieve both contractual targets, non-parametric frontiers can be used (Guccio et al., 2012). The non-parametric frontier is a technique, generally used to estimate a production or a cost function with minimal assumptions, and it can easily handle multiple inputs/outputs situations. One of the most well-established and useful technique for measuring efficiency in public sector activities is DEA (Data Envelopment Analysis)[3]. The reasons for the widespread use of DEA are summarised as follows: it can handle multiple inputs and outputs without a priori assumptions for a specific functional form of production technologies; it does not require a priori a relative weighting scheme for the input and output variables; it returns a simple

[1] A possible explanation is that severe constraints are imposed by law on the renegotiation of contracted costs while no such constraints do exist for delays.

[2] See Autorità di Vigilanza sui contratti pubblici di lavori, servizi e forniture (2005)

[3] DEA has been already employed in the literature on procurement, to assess the efficiency of suppliers (see de Broer et al., 2001).

summary efficiency measurement for each Decision Making Unit (DMU), and it identifies the sources and levels of relative inefficiency for each DMU.

By constructing envelopment unitary isoquants corresponding to comparable DMU across different situations, DEA identifies as productive benchmarks those DMU that exhibit the lowest technical coefficients, i.e. lowest input amount to produce one unit of output. In so doing, unlike statistical methods, which enable to estimate average performance[4], DEA allows for the identification of best practices and for the comparison of each DMU with the best possible performance among the peers, rather than just with the average.

Once the reference frontiers have been defined, it is possible to assess what would be the potential efficiency improvements available to the inefficient DMU if they were to produce according to the best practice technologies of their benchmark peers. From an equivalent perspective, these simulations identify the necessary changes that each DMU needs to undertake to reach the efficiency levels of the most successful DMU. More formally DEA calculates the efficiency frontier for a set of units (DMU), as well as the distance from the frontier for each unit. This distance (efficiency score) provides a measure of the radial reduction in input that could be achieved for a given measure of output[5].

3.2 Corruption measurement issues and its effects on public works execution

Since the first empirical papers studying the effects of corruption, its measurement has represented a serious problem that lead to different approaches. Different measures of corruption have been suggested in the literature. A first index of corruption is based on the collection of the results of several cross-country surveys of citizens and experts being asked to state their corruption perceptions, such as the Transparency International Corruption Perception index (Lambsdorff, 2003) and the World Bank Governance Indicators (Kaufmann et al., 2005). A massive number of academic studies

[4] Statistical analysis allows for measuring a central tendency that identifies average performance and the performance of each unit is estimated by deviation from the central tendency.

[5] See Cooper et al. (2007).

adopted this index to show that corruption lowers investment and economic growth[6]. These indexes have been criticised and Olken (2009) provides an interesting comparison between objective and perception based index of corruption. He finds a weak correlation between the two indexes, showing that both captures the same phenomenon although perception based measure tends to underestimate its magnitude.

Looking at the Italian context, two measures can be considered. A first index is computed by the Italian National Institute of Statistics (ISTAT) considering the number of crimes against the public administrations (per 100,000 inhabitants).[7] A second index is the one suggested by Golden and Picci (2005). They study the effects of corruption on public infrastructure realisation in Italy and measure corruption as the gap between the number of physically existing public infrastructures and the financial resources cumulatively allocated by government to build them. Golden and Picci (2005) find that corruption increases the costs of public infrastructures realisation, especially in the south of Italy.

Once decided how to measure corruption, we turn to the analysis of the effects of corruption on public works execution. The few works investigating this issue focus on the impact of corruption on the occurrence of renegotiation of public works contracts and on the increase of cost overruns. Regarding the former, being public works contracts usually incomplete, the winning firm may behave opportunistically or illegally through contract renegotiation to maximise its profits (Bajari et al., 2006, 2007a and 2007b; Guccio et al., 2009). Guccio et al. (2009) show that corruption, as measured by the number of crimes in accordance with articles 416 and 416-bis of Italian Criminal Code per 100,000 inhabitants, does not seem to affect the occurrence of renegotiation of public works contracts in Italy. In the second case, some empirical works have shown that cost overruns are affected by corruption. For instance, Auriol (2006) estimates the cost of corruption to be between 4 and 10% of procurement spending. Guccio et al. (2011) show that higher levels of corruption, as measured by

[6] For a detailed discussion of perception based measure of corruption see, for example, Kaufmann et al. (2006).

[7] It is an objective, aggregated and direct measure that, however, takes into account several crimes, such as embezzlement, extortion and conspiracy (Abrate et al., 2012)

the index proposed by Golden and Picci (2005), are associated to higher cost overruns. In the following section we will describe our empirical strategy in details.

4. Empirical findings

4.1 Data

For the purpose of this study, the main source of data come from the Observatory of Public Works (Osservatorio per i lavori Pubblici) of the Public Contracts Authority (Autorità di Vigilanza sui contratti pubblici di lavori, servizi e furniture) (AVCP).[8] The sample refers to 3,113 Italian public works contracts for roads and highways, whose engineering estimated costs[9] range from 150,000 euros to 5 million euros, awarded in the period 2000-2004 and completed by 2005. This data set has been used for the first stage of the analysis to compute the efficiency scores of infrastructures provision on the same line of Guccio et al. (2012). The authors measure the efficiency of execution of public work contracts using the following production function specification: actual time of completion and actual cost are regarded as inputs, and planned time of completion and agreed cost as outputs[10].

Given that the aim of our work is to evaluate whether the environmental characteristics (i.e. in particular the corruption level) in the area where the infrastructure is localised affect the efficient management of the public work contract, additional data become necessary to perform the second stage analysis. Table 1 provides a concise description of the variables used in the first and second stage whereas table 2 provides the descriptive statistics.

[8] AVCP is a national independent authority monitoring and regulating public procurement in Italy.

[9] Engineering estimated costs are used as reserve price in tendering procedures.

[10] It has to be noted that these inputs and outputs appear consistent with the literature reviewed in Section 3 on performance in infrastructure provision.

Table 1 – Variables employed

Variables	Definition	Source
A_TIME	Actual time of infrastructure completion	Osservatorio per i lavori Pubblici, AVPC
A_COST	Actual cost of infrastructure completion, in thousand	Osservatorio per i lavori Pubblici, AVPC
P_ TIME	Planned time of infrastructure completion and cost	Osservatorio per i lavori Pubblici, AVPC
W_BID	Agreed cost of infrastructure completion, in thousand (winning bid)	Osservatorio per i lavori Pubblici, AVPC
CORR_PA	Crimes against public administration per 100,000 inhabitants at provincial level	ISTAT, Statistiche giudiziarie, several years.
CORR_G&P	Corruption index proposed by Golden and Picci (2005), at provincial level	Golden and Picci (2005)
CORR_PA_SQ	CORR_PA square	ISTAT, Statistiche giudiziarie, several years.
CORR_G&P_SQ	CORR_G&P square	Golden and Picci (2005)
WCI	Weighted public work composition index	Osservatorio per i lavori Pubblici, AVPC
BIDDERS	Number of bidders	Osservatorio per i lavori Pubblici, AVPC
BIDDERS*CORR_PA	Interaction between number of bidder and CORR_PA	ISTAT, Statistiche giudiziarie, several years. And Osservatorio per i lavori Pubblici, AVPC
BIDDERS* CORR_G&P	Interaction between number of bidder and CORR_ G&P	Golden and Picci (2005) and Osservatorio per i lavori Pubblici, AVPC
REBATE	Rebate of the winning bidder (percent)	Osservatorio per i lavori Pubblici, AVPC
SUB	Dummy for subcontracting	Osservatorio per i lavori Pubblici, AVPC
DISPUTE	Dummy for legal dispute	Osservatorio per i lavori Pubblici, AVPC
YEAR	Dummies for year of public work award: 2000, 2001, 2002, 2003.	Osservatorio per i lavori Pubblici, AVPC

Table 2 – Summary statistics of variable employed

Variables	Mean	St. Dev.	Minimum	Maximum
A_TIME	277.07	184.60	6.00	1553.00
A_COST	345.01	356.10	95.25	5884.72
P_ TIME	176.65	123.45	7.00	1095.00
W_BID	318.15	318.39	94.11	4278.35
CORR_PA	4.86	3.10	0.27	17.35
CORR_G&P	1.12	0.93	0.41	6.44
CORR_PA_SQ	33.18	44.26	0.07	301.02
CORR_G&P_SQ	2.11	5.91	0.17	41.47
WCI	1.14	0.36	0.00	3.92
BIDDERS	32.92	33.42	1.00	250.00
BIDDERS*CORR_PA	167.85	247.54	1.00	2223.00
BIDDERS* CORR_G&P	42.83	82.92	1.00	1249.36
REBATE	13.78	9.88	0.00	57.00
SUB	0.76	0.43	0.00	1.00
DISPUTE	0.02	0.13	0.00	1.00

Source: our computation

4.2. Performances in public work execution

In this section we report the estimates of DEA efficiency scores[11]. As frontier estimates are based on finite samples, the DEA measurements based on these estimates are

[11] Differently by Guccio et al. (2012) we perform our DEA estimates on the whole sample without distinguishing between new and maintenance public works and between different levels of reserve price. However, the results do not substantially differ from those of Guccio et al. (2012).

subject to sampling variation in the frontier. To control for sampling variation, we use a bootstrap procedure with 1,000 bootstrap developed by Simar and Wilson (1998, 2000) to correct the DEA estimate bias, generate confidence intervals and control for sampling variation.

Table 3 reports the distribution of the estimate results by different class of relative reserve prices.

Our estimation shows that the efficiency scores ranges from 41.06% to 100% and that the mean efficiency is about 92.73%. It needs to be underlined that the fully efficient observations, those on the DEA frontiers, are not necessarily the ones that simultaneously fulfil time and cost efficiency.[12]

Of course, it is also important to stress that the mean efficiency value of 92.75% does not imply that public contracts for roads in Italy are overall executed in an efficient way. In fact, as it is showed by Figure 2, the variability of efficiency scores is very high: more than 25% of the contracts have a level of inefficiency between 10% and 60% and about the 75% of contracts has a level of inefficiency below 10%, confirming that cost overruns and delays are relevant phenomena.

In addition, the average level of DEA efficiency remains almost unaffected by the different classes of reserve price. Finally, our results indicate that, on average, each DMU can reduce both actual time and costs proportionally by 7.3%, given the targets values (that is, the time and costs agreed on in the contract).

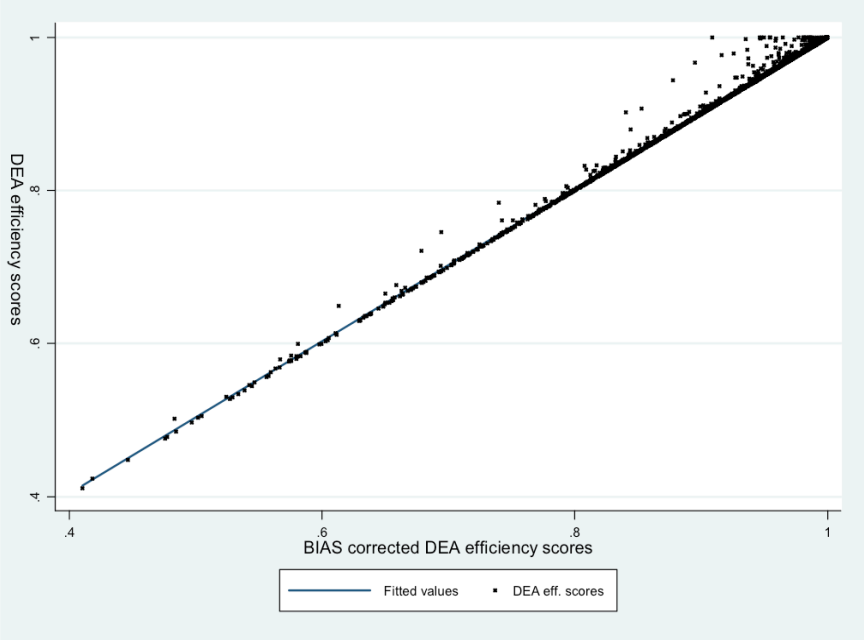
Table 3 – Distribution of bias corrected and DEA efficiency scores, by different classes of reserve price

Classes of reserve prices		Mean	St. dev.	Median	Min	Max
150,000 - 500,000	DEA eff. scores	0.9298	0.0850	0.9607	0.4111	1.0000
	BIAS corr eff. scores	0.9286	0.0851	0.9587	0.4106	0.9999
500,000 - 1,500,000	DEA eff. scores	0.9149	0.0969	0.9463	0.4479	1.0000
	BIAS corr eff. scores	0.9131	0.0971	0.9446	0.4464	0.9978
1,500,000 - 5,000,000	DEA eff. scores	0.9101	0.0939	0.9406	0.5016	1.0000
	BIAS corr eff. scores	0.9052	0.0944	0.9322	0.4833	0.9987
All sample	DEA eff. scores	0.9273	0.0870	0.9566	0.4111	1.0000
	BIAS corr eff. scores	0.9258	0.0872	0.9548	0.4106	0.9999

Source: our computation

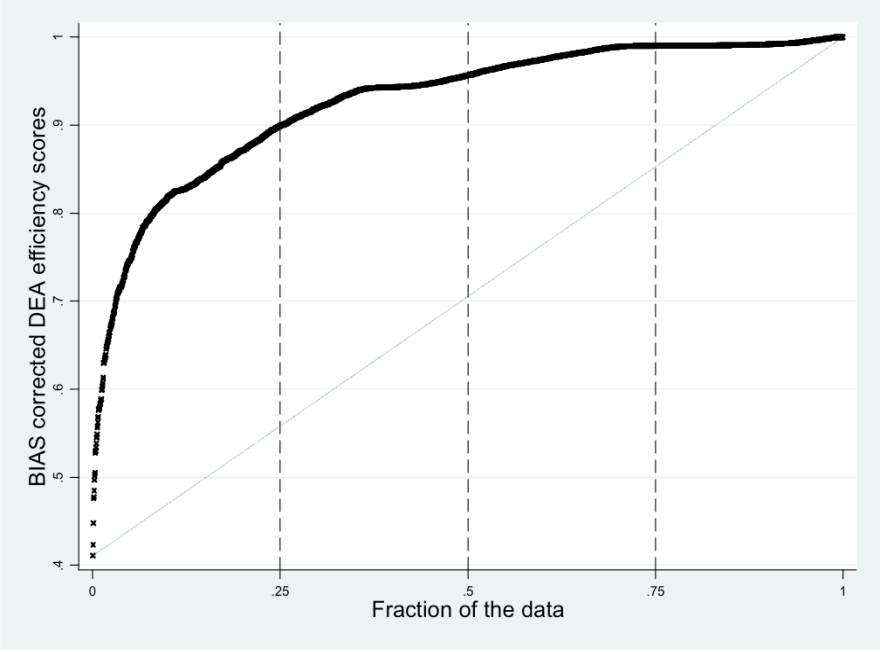
[12] The bootstrap bias correction procedure slightly affects the estimates (92.58%). This is clearly shown by Figure 1 that jointly scatters DEA efficiency scores and bias corrected ones.

Figure 1 – Scatter plot between bias corrected and DEA efficiency scores



Source: our computation

Figure 2 – Cumulate distribution of bias corrected DEA efficiency scores



Source: our computation

In the next section we will try to explain the observed variability of efficiency scores, paying special attention on the effect exerted by corruption.

4.3. The relation between the performance and corruption

In section 3 it has been outlined that corruption plays an important role in the provision of infrastructures and some measures of corruption have been examined. To examine the hypothesis that the performance in public works execution is affected by level of corruption in the area where the infrastructure provision is localised controlling for other public work characteristics, we followed the two-step approach, as suggested by Coelli et al., (1998) so as to regress DEA efficiency scores on a set of explanatory variables. In the DEA literature, Tobit regression has been used to investigate whether performance would be affected by exogenous factors. Nevertheless, Simar and Wilson (2007) illustrated that Tobit regression was inappropriate to analyse the efficiency scores under DEA. They also developed a truncated-regression model that ensures a feasible, consistent inference for the parameters estimated in the second stage of the regression. Thus, in the following, we apply the two-step biased-corrected efficiency method proposed by Simar and Wilson (2007).

We assume that the efficiency scores can be regressed on a vector of environmental variables in the following general specification:

$$\theta_i = f(z_i)+\varepsilon_i \qquad [1]$$

where θ_i is Farrell's bias-corrected efficiency score derived from the previous portion of the analysis, and the right side of the equation reports the environmental controls shown in Table 1 and 2 and better described below, and ε_i is a vector of error terms.

The first environmental controls refer to corruption index. Due to the nature of our data set, we adopt, as measures of corruption at provincial level, the crimes against public administration per 100,000 inhabitants (CORR_PA) computed by ISTAT and the index of corruption (CORR_G&P) proposed by Golden and Picci (2005).

We also control for other variables that may affect the performances in the execution of public works. First, public works vary in terms of complexity. It is, thus, reasonable to assume that contract execution becomes more uncertain as the degree of complexity of the work increases. Previous works on this subject (e.g., Bajari et al., 2009; Guccio et al., 2012) assume the total value of the work and duration of the work, as estimated by the contracting authority at the bidding stage, as proxies for complexity. However such variables are strictly correlated with variables used in the first stage. Thus, as a proxy for complexity, we use the weighted composition index of a work, calculated on the different sub-categories involved in the work, weighted for their relative amount (WCI). [13]

Previous studies on public works execution find that competition exerts a positive effect on infrastructures provision and seems to moderate the weight of corruption (Rose-Ackerman, 1996). To capture this influence we employ the number of bids (BIDDERS) and the rebates of the winning bidder (REBATE). Thus, when the level of competition is higher the most efficient firm should be chosen and the management of public works should be efficient. However, Celentani and Ganuza (2001) show that the relationship between competition and corruption is not straightforward and that a higher level of competition may also lead to higher level of corruption. To account for these effects, we include an interaction term between each of the two adopted corruption indexes and the competition levels in the econometric analysis.

The Italian system of public works award seems to provide considerable chances of opportunistic behaviours to firms that may offer strong rebates to win the procurement and exploit the possibility of further renegotiation (Guccio et al., 2009). [14]

To control for this effects we employ the rebate of the winning bidder (REBATE). The rebate may depend on the behaviour of the winning bidder during the awarding procedure, since as he lowers his bid to increase the chance of being awarded the work, he will have a stronger incentive to exploit any opportunity to renegotiate the contract

[13] According to De Carolis (2009) the Italian procurement rules to exclude anomalous bids turns out not to work properly and to cause significant efficiency losses in bidder selection.

[14] According De Carolis (2009), the Italian procurement rules to exclude anomalous bids turns out not to work properly and to cause significant efficiency losses in bidder selection.

and to ask for larger increases of the original compensation. Thus, we expect that large rebate negatively affects public works execution.

The other features of public works that can significantly affect their performance at the execution stage are: the presence of subcontractors in the execution of the work (SUB) and the existence of legal disputes between the firm and the contracting authority (DISPUTE). We hypothesise that the presence of subcontractors and legal disputes tend to increase the completion time and the likelihood of a low performance in infrastructure provision. Finally, we controll for the year of award (YEAR).

The effects of corruption on the performance of public works execution can be presented by means of the following questions to be tested:

Q 1: is the performance of public works execution affected by corruption?

Q 2: do the two adopted measures of corruption provide similar results?

Q 3: is there a positive (grease the wheels) or negative (sand the wheels) effect of corruption on efficiency?

Q 4: is the relationship between corruption and efficiency linear or U-shaped (higher efficiency with low level of corruption and lower efficiency with high level of corruption)?

Q 5: Is the competition increasing or decreasing in corruption?

To provide the most robust evaluation of our empirical findings, we decided to use a parsimonious strategy to evaluate the relative marginal effects. Table 4 provides the results of our estimate. Column (1) shows the results for baseline specification; whereas columns from (2) to (7) show the results of the estimations for different effects of corruption index on the performance in public works execution, according to each of the questions previously described.

The results reported in Table 4 provide the answers to the five points raised above. The first three questions can be addressed by looking at the coefficients of the two corruption indexes (CORR_PA and CORR_G&P). Given that both indexes turn out to be significant, they clearly affect efficiency levels in public works execution. Their effects are quite similar although the index of Golden and Picci (2005), CORR_G&P, has a stronger marginal effect, as shown by its coefficients in model 2, 4 and 6. This implies that if we measure the effects of corruption in terms of efficiency losses, they would be

stronger than if we adopt the other index (CORR_PA). In addition, both indexes show negative signs in specification (2) and (3) supporting the "sand the wheels" hypothesis against the "grease the wheels" one. In other words, we provide some support to the well-established result stating that corruption has detrimental effects on efficiency of institutions.

Table 4 – Estimate results on determinants of efficiency scores (truncated regressions)

Variables	Bias-adjusted coefficient [a]						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	0.968***	0.971***	0.973***	0.959***	0.951***	0.975***	0.968***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.007)	(0.010)
CORR_PA		-1.94^{-4} ***		-2.02^{-4} ***		-1.09^{-4} *	
		(4.69^{-5})		(4.70^{-5})		(6.77^{-5})	
CORR_G&P			-0.008***		0.022***		-0.004*
			(0.002)		(0.005)		(0.002)
CORR_PA_SQ				-7.38^{-5} ***			
				(3.51^{-5})			
CORR_G&P_SQ					-0.005***		
					(0.001)		
WCI	-0.013***	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
BIDDERS	2.74^{-4} ***	2.77^{-4} ***	2.75^{-4} ***	2.77^{-4} ***	2.74^{-4} ***	3.43^{-4} ***	3.71^{-4} ***
	(5.18^{-5})	(5.17^{-5})	(5.17^{-5})	(5.16^{-5})	(5.18^{-5})	(6.53^{-5})	(7.03^{-5})
BIDDERS*CORR_PA						-1.72^{-6} *	
						(1.02^{-6})	
BIDDERS* CORR_G&P							-7.46^{-5} *
							(3.69^{-5})
REBATE	-0.003***	-0.002***	-0.002***	-0.002***	-0.003***	-0.002***	-0.002***
	(1.80^{-4})	(1.89^{-4})	(1.92^{-4})	(1.91^{-4})	(1.94^{-4})	(1.89^{-4})	(1.92-4)
SUB	-0.008**	-0.009**	-0.011***	-0.010***	-0.008**	-0.009**	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
DISPUTE	-0.013*	0.004	-0.0010*	-0.004	-0.009*	0.005	-0.008
	(0.008)	(0.007)	(0.06)	(0.008)	(0.005)	(0.007)	(0.06)
Control for year of award	yes	yes	yes	yes	Yes	yes	
Observation	3,113	3,113	3,113	3,113	3,113	3,113	

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] Double bootstrap truncated estimates (n=1000), as suggested in Simar and Wilson (2007), algorithm 2.

To answer question 4, we add a quadratic term of each of the two corruption indexes (CORR_PA_SQ and CORR_G&P_SQ) to capture non-linearities in the effect of corruption on performance. Using both indexes, our results provide evidence of the U-shaped effects of corruption. The two coefficients are significant and negative meaning

that when corruption is low, it has positive effects on efficiency whereas when corruption is high it has a negative impact on efficiency.

The last question we have considered refers to whether, in procurement, corruption may be increasing or decreasing in competition (Celentani and Ganuza, 2002). For this purpose, we use two interaction terms obtained multiplying each corruption indexes by our measure of competition (BIDDERS*CORR_PA and BIDDERS* CORR_G&P). Both interaction terms turn out to be significant and negative. This means that increasing in competition does not mitigate the negative effects of corruption in public works executions as suggested by Celentani and Ganuza (2002). Finally, almost all the other variables included in the empirical analysis show to be significant and with the expected signs.

5. Conclusions

In this paper, we tried to investigate the effect of corruption on the efficiency in the execution of public contracts for roads, in terms of delays and cost overruns, to see whether such an effect is positive (grease the wheels) or negative (sand the wheels). A two-stage analysis was carried out: in the first stage, using a non-parametric approach (Data Envelopment Analysis - DEA), the relative efficiency scores were estimated and in the second stage, the determinant factors of the scores variability were investigated, paying special attention on the effect exerted by corruption.

Our results confirmed that corruption affected the efficiency of the execution of public contracts. The estimated effects were negative, supporting “the sand the wheels” hypothesis against “the grease the wheels” one. However, it is interesting to stress that the effects of corruption turned to be U-shaped, suggesting that low corruption has positive effects on efficiency whereas high corruption has a negative impact on efficiency. Finally, our results seems to support the conjecture of Celentani and Ganuza (2002) stating that competition does not mitigate the detrimental effects of corruption.

References

Abrate, G., Erbetta, F., Fraquelli, G., and Vannoni, D. (2012). The costs of corruption in the Italian solid waste industry, University of Turin, Department of Economics and Statistics, WP series, n°4.

Ades, A., Di Tella, R., (1997). The new economics of corruption: A survey and some results, Political Studies, 45 (special issue), 496-515.

Aidt, T., (2009). Corruption, institutions and economic development, Oxford Review of Economic Policy, 25 (2), 271-291.

Auriol, E., (2006). Corruption in procurement and public purchase, International Journal of Industrial Organization, 24, 867-885.

Banca d'Italia (2011). Le infrastrutture in Italia: dotazione, programmazione, realizzazione, Banca d'Italia, Roma,

Bailey, D. H. (1966). The effects of corruption in a developing nation. Western Political Quarterly, 19(4), 719–732, Reprint in Political corruption: A handbook, A. J. Heidenheimer, M. Johnston, & V. T. LeVine (Eds.), Oxford, Transaction Books, 1989, pp. 934–952.

Bajari, P. and Tadelis, S. (2001) Incentives versus transaction costs: a theory of procurement contracts, Rand Journal of Economics, 32, 387–407.

Bajari, P., McMillan, R. and Tadelis, S. (2009) Auctions versus negotiations in procurement: an empirical analysis, Journal of Law, Economics and Organization, 25, 372–99.

Bardhan, P. (1997). Corruption and development: A review of issues, Journal of Economic Literature, 35(3), 1320–1346.

Beck, P. J., and Maher, M. W. (1986). A comparison of bribery and bidding in thin markets, Economics Letters, 20(1), 1–5.

Benitez, D., A. Eustache and Søreide, T., (2010). Dealing with Politics for money and power in infrastructure. The World Bank, Policy Research Working Paper n° 5455.

Celentani, M. and Ganuza J.-J. (2002). Corruption and competition in procurement, European Economic Review 46 (2002) 1273–1303

Chong, E., Staropoli, C. and Yvrande-Billon, A. (2009) Auctions versus negotiations in public procurement: looking for new empirical evidence, mimeo. Available at http://economix.u-paris10.fr/pdf/colloques/ 2009_Florence/Anne-Carine-Eshien.pdf.

Cooper, W.W., Seiford, L.M., Tone, K. and Zhu, J. (2007). Some models and measures for evaluating performances with DEA: Past accomplishments and future prospects, Journal of Productivity Analysis, vol. 28 (3), 151-163.

de Boer, L., Labro, E., and Morlacchi P. (2001). A review of methods supporting supplier selection, European Journal of Purchasing & Supply Management, vol.7 (2), 75-89.

De Carolis (2009) When the highest bidder loses the auctions: theory and evidence for public procurement, Temi di discussione n. 717, Banca d'Italia.

De Carolis, F., & Palumbo, G. (2011). "La rinegoziazione dei contratti di lavori pubblici: un'analisi teorica e empirica." In Banca d'Italia, Le infrastrutture in Italia: dotazione, programmazione, realizzazione, Roma, pp. 489-518. Available at http://www.bancaditalia.it/pubblicazioni/seminari_convegni/infrastrutture/7_infrastrutture_italia.pdf

Estache, A., Iimi, A. and Ruzzier, C. (2009) Procurement in infrastructure. What does theory tell us?, World Bank Policy Research Working Paper No. 4994, World Bank, Washington, DC.

Flyvberg, B. (2005) Policy and planning for large infrastructure projects: problems, causes, cures, World Bank Policy Research Working Paper No. 3781, World Bank, Washington, DC.

Ganuza, J. J. (2007) Competition and cost overruns in procurement, Journal of Industrial Economics, 55, 633–60.

Golden, M.A., Picci, L., (2005). Proposal for a new measure of corruption, illustrated with Italian data, Economics and Politics, 17 (1), 37-75.

Guccio C., Pignataro G. and I., Rizzo (2007), 'Efficienza delle procedure di appalto dei lavori pubblici: un'analisi empirica del caso italiano', mimeo (http://www-3.unipv.it/websiep/wp/200762.pdf)

Guccio, C., Pignataro, G. and Rizzo, I. (2009) Procedure di selezione dei fornitori e incentivi alla rinegoziazione in contratti incompleti: un'applicazione al settore dei lavori pubblici, Rivista Italiana degli Economisti, XIV, 69–102.

Guccio, C., G. Pignataro and Rizzo, I., (2012). Measuring the efficient management of public works contracts: A non-parametric approach, *forthcoming* on the Journal of Public Procurement.

Guiso, L., P. Sapienza and Zingales, L., (2000). The role of social capital in financial development. Working Paper n°7563, NBER.

Hunt, J., (2005). Why are some public officials more corrupt than others?, in S. Rose-Ackerman, ed., The Handbook of Corruption. Edward Elgar Publishers, Cheltenham, UK and Northampton, USA.

Hunt, J., S. Laszlo, (2005). Bribery: who pays, who refuses, what are the payoffs?. Working Paper n°11635, NBER.

Huntington, S. P., (1968). Political order in changing societies. New Heaven: Yale University Press.

Kauffman. D., Kraay, A., and Mastruzzi, M., (2006a). Measuring governance using cross-country perceptions data, in S. Rose-Ackerman, ed., International

Handbook on the Economics of Corruption. Edward Elgar Publishers, Cheltenham, UK and Northampton, USA.

Kauffman. D., Kraay, A., and Mastruzzi, M., (2006b). Measuring corruption: Myths and realities. Development outreach, September issue, The World Bank.

Kurer, O. (1993). Clientelism, corruption and the allocation of resources, Public Choice, 77(2), 259–273.

Lambsdorff, J. G. (2003). How corruption affects productivity, Kyklos, 56(4), 457–474.

Leff, N. H., (1964). Economic development through bureaucratic corruption. American Behavioral Scientist, 8 (3), 8-14. Reprint in Political corruption: A handbook, A. J. Heidenheimer, N. Johnston, and V. T. LeVine (eds.), Oxford Transaction Books, 1989, pp. 760-781.

Leys, C., (1965). What is the problem about corruption? Journal of Modern African Studies, 3(2), 215-230. Reprint in Political corruption: A handbook, A. J. Heidenheimer, N. Johnston, and V. T. LeVine (eds.), Oxford Transaction Books, 1989, pp. 51-66.

Lien, D. H. D. (1986). A note on competitive bribery games, Economics Letters, 22(4), 337–341.

Lovallo, D. and Kahneman, D. (2003) Delusions of success: How optimism undermines executives' decisions, Harvard Business Review, 81, 56–63.

Lui, F. T. (1985). An equilibrium queuing model of bribery, Journal of Political Economy, 93(4), 760–781.

Mauro, P., (1995). Corruption and growth, Quarterly Journal of Economics 110, 680-712.

Méon, P.-G., Sekkat, K., (2005). Does corruption grease or sand the wheels of growth? Public Choice, 122(1-2), 69-97.

Méon, P.-G., Weill, L., (2010). Is corruption an efficient grease? World Development, 38(3), 244-259.

Mo, P. H. (2001). Corruption and economic growth, Journal of Comparative Economics, 29(1), 66–79.

Myrdal, G. (1968). Asian drama: An enquiry into the poverty of nations (Vol. 2). New York: The Twentieth Century Fund, Reprint in Political corruption: A handbook, A. J. Heidenheimer, M. Johnston, & V.T. LeVine (Eds.), Oxford, Transaction Books, 1989, pp. 953–961.

Olken, B., (2009). Corruption perceptions vs. corruption reality, Journal of Public Economics, 93, 950-964.

Rose-Ackerman, S., (1996). Redesigning the state to fight corruption. Public Policy for Private Sector, The World Bank.

Rose-Ackerman, R. (1997). The political economy of corruption. In K. A. Elliott (Ed.), Corruption and the global economy (pp. 31–60). Washington, DC: Institute for International Economics.