Corruption in PPPs, Incentives and Contract Incompleteness*

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Abstract

In a public procurement setting, we discuss the desirability of completing contracts with state-contingent clauses providing for monetary compensations to the contractor when revenue shocks occur. Realized shocks are private information of the contractor and this creates agency costs of delegated service provision. Verifying the contractor’s messages on the shocks entails contracting costs that make incomplete contracts attractive despite their higher agency costs. A public official (supervisor) has private information on contracting costs and chooses the degree of contractual incompleteness on behalf of an upper-tier public authority. As the public official may be biased towards the contractor, delegating the contractual choice to that lower-tier may result in incomplete contracts being chosen too often; another source of agency costs. There exists a trade-off between the agency costs that pertain to different tiers of the regulatory hierarchy. As a result, it becomes optimal to leave less discretion to the public official and have complete and incomplete contracts with similar allocative consequences.

Keywords: Corruption, Incomplete Contracts, Moral Hazard, Principal-Agent-Supervisor Model, Public-Private Partnerships, Risk Allocation.

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1 Introduction

When a contractor operates a highway on behalf of the central government, who should bear traffic risk, the contractor or the government? When a change in sector legislation calls for a change in the height of the highway guardrail, who should pay for the adaptation costs? When a contractor operates a staff canteen on behalf of a University, should the concessionaire be compensated if the price of coffee granules increases? When the public authority decides not to go ahead with a project for reasons of public interest, should it compensate the contractor for its lost profit? And should all the possible contingencies be regulated by the contract? These questions typically arise when Public Private Partnerships (PPPs) are used for the provision of a public service.\(^1\)

Contracts used in practice provide different answers to the above questions. For example, in PPPs for highways, the World Bank recommends that traffic risk be borne entirely by the contractor,\(^2\) whilst the Indian’s standardized contract for highways provides for traffic risk to be borne by the contractor unless the fall in traffic is caused by a change in macroeconomic conditions.\(^3\) Standardized contracts can be more or less complete. In the UK, for example, the risk allocation is typically summarized in a “risk matrix” appended to the contract, which spells out the specific risks that may arise under the contract and how they will be shared between the contractor and the public authority (HM Treasury 2007). In Italy instead, risk matrices are rarely used and the risk allocation is often left vague.\(^4\)

The problem with contingent clauses is that they require realized events to be anticipated and clearly described in the contract, without ambiguity. This involves contracting costs which increase with the complexity of the contingency to be verified. Verifying the realized contingencies can also be difficult both in terms of the technologies and competencies required. For example, in the case of highways it may be very difficult to ascertain whether a traffic reduction is caused by a change in macroeconomic conditions or in fuel prices.\(^5\)

Beyond adding these contracting costs, state contingent clauses create scope for corruption at contract execution stage. Many corruption practices in public procurement take place once the tender has been adjudicated and the attention of the various stakeholders has faded (see Soreide, 2005, and references therein, and Piga, 2011).

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\(^1\)PPPs are concession contracts where the supplier takes responsibility for building and managing a public infrastructure. PPPs are widely used across Europe, Canada, the U.S. and a number of developing countries in sectors such as transport, energy, water, IT, prisons, waste management, schools, hospitals and others. For an in depth discussion of the economics of PPP contracts, see Iossa and Martimort (2013).


\(^3\)http://infrastructure.gov.in/mca.htm

\(^4\)See Cori, Giorgiantonio and Parisi (20011).

\(^5\)http://infrastructure.gov.in/mca.htm
PPPs contracts make no exception. In fact, PPP agreements are particularly vulnerable to corruption because of their complexity and of the central role that the contract design plays. It has been documented that many authorities keep poor records of the monetary compensations provided to the contractors during the contract, and little transparency exists on their extent and application (Hemming, 2006). The incidence of corruption has also been recorded (Engel, 2011).6

Furthermore, the planning and design of most PPP contracts involves two different layers of the governmental hierarchy: the central government (for example the national Department of Transport) and the local government (a local authority). The former typically coordinates the national PPP program and provides guidelines for contracts and tenders; the latter implements and monitors specific projects.

In this paper, we investigate the benefits and costs of writing complete contracts in a risky environment with delegated contracting. We focus in particular on the risks involved in the use of self-reporting and in the risk of corruption. We study the two-tier relationships between a public authority (principal), a public official (supervisor) and the firm (the agent) in a public procurement context where project revenues are affected by the contractor’s operating effort and by exogenous shocks. Contingencies may realize at contract execution stage that exogenously affect the revenues from operations. Covering those contingencies in contractual clauses involves costly contracting, which are privately observed by the public official. Incentives to the contractor are provided through a payment structure that allocates revenue risk between the contractor and the public authority. The contractor may receive monetary compensations when revenues are low. Contingent clauses are triggered by self-reports made by the contractor.

We show that when the state is verifiable, optimal risk-sharing calls for contingent clauses to fully compensate the contractor for revenue shocks outside his control. By tightening the link between effort and performance, full insurance on exogenous events reduces the cost of providing incentives for operational effort. The value of a complete contract thus lies in the better insurance it provides, which in turns also helps to give stronger incentives for operational effort. More complete contracts are higher powered.

When instead the state is not verifiable, contract manipulation may occur and this may have an impact on the choice of contract. The contractor may misreport his information, always claiming that a negative shock hit operations to obtain a compensation from the public authority. Full insurance then becomes suboptimal. More risk is left to the contractor and a risk premium is paid. An incomplete contract where the firm is even more exposed to risks would require an even higher compensation, and it thus

6Furthermore, in PPP practice, self-monitoring is often used, with the contractor verifying the contingencies that have realized and his own degree of compliance with the contractual obligations whilst the contract manager, hired by the public authority, supervises the process (see http://www.partnershipsuk.org.uk/uploads/documents/OTF4ps_ContractInManagers_guide.pdf. ).
fares worse than the complete contract. This incomplete contract may however be chosen if the contracting costs of writing contingent clauses are high.

The possibility that different contracts are optimal, depending on the contracting costs, creates the need for leaving some discretion to the informed public official. The possibility to use information available locally (here given by the contracting costs) captures the benefit from decentralization. But discretion can be abused: As incomplete contracts are associated with higher risk-premia, they constitute a higher stake for corruption. The corrupted supervisor has incentive to choose incomplete contracts too often, compared to what the upper-tier public authority would like him to do.

Depending on specific conditions, we show that delegation of contracting may result in a trade-off between the agency cost of delegated contracting and the agency cost of delegated service provision. As a result, it may become optimal to distort the contract design so as to reduce the risk of corruption at contract negotiation stage. In particular, it may be optimal to reduce the transfer of revenue risk under the incomplete contract, and the associated risk-premium, so as to make the contract less attractive for the firm and reduce the stake of corruption. A corresponding increase in the transfer of revenue risk under the complete contract is also desirable so as to make the complete contract more attractive.

A consequence of the above trade-off is also that, when corruption is a possibility, the public authority will reduce the discretion allowed to the public official, by giving less weight to the public official’s choice of contract. In particular, the difference in design and in risk transfer between the complete and the incomplete contract gets blurred. Nonetheless, the residual discretion allowed to the public official still creates distortionary policies in terms of contract choice: delegation of contracting may result in incomplete contracts being chosen too often.

The paper is organized as follows. Section 2 discusses the related literature. Section 3 presents our model. Section 4 discusses the case of strong institutions where productivity shocks are verifiable, and analyzes the value of complete contracts. Section 5 studies the case of nonverifiable shocks with a benevolent public official but costly contracting. Section 6 allows for corruption between the public official and the contractor on the contract choice. Section 7 discusses the policy implications of our results. Proofs are relegated to an Appendix.

2 Related Literature

On costly contracting and endogenous contract incompleteness. In a seminal paper, Dye (1985) assumes that the cost of writing contracts is increasing in the number of contingencies, and shows that the complexity of writing contracts can indeed be a source of contractual incompleteness. Battigalli and Maggi (2002) take this approach to endogeneize contract completeness. They study when it is preferable to leave discretion
to the agent, by not specifying the agent’s task with sufficient precision, or have a rigid contract where the agent’s obligation is not sufficiently contingent to the external state. Contrary to our paper, information is symmetric. Bajari and Tadelis (2001) introduce asymmetric information on the cost of making contracts adaptations when the contract is incomplete. They show that fixed-price contracts are more costly to renegotiate, therefore, they must be used when incentives are important and the optimal contract is relatively complete. Kvaloy and Olsen (2009) explicitly analyze the relationship between contracting costs and the power of incentive schemes when the probability of court enforcement increases with the costs spent on contracting. They show that there is no monotonic relationship between contracting costs and incentives intensity, and that an increase in contracting costs may lead to higher-powered incentives.

In this literature the contract choice is made by the principal himself and the contract design only affects the agents’ incentives. Instead, in our paper, the contract choice is delegated to another agent and the contract design affects the incentives of both lower tiers of the regulatory hierarchy, sometimes in a conflicting way. The relationship between the power of incentives and contract incompleteness that we derive reflects the trade-offs between the agency cost of delegated contract negotiations and the agency cost of delegated service provision.

**On corruption and contract design.** Our paper is related to the literature on corruption in principal-agent-supervisor relationships dating back to Tirole (1986) and Laffont and Tirole (1993). This literature has shown that in standard adverse selection models, the stake of collusion is given by the informative rent of the firm or the risk premium. Reducing this stake calls for an allocation of resources that is less sensitive to the supervisor’s information. Contract forms to fight collusion need to be low-powered and with less risk transfer, but this comes at the cost of weakened incentives.

In our context, the stake of collusion is given by the difference in the risk-premium under either a complete or incomplete contract. To fight collusion, the principal needs to increase the risk-premium of the complete contract and reduce that of an incomplete contract. Thus, fighting corruption may call for raising risk transfer, contrary to what is suggested in the standard literature, discouraging the use of incomplete contracts.

**On delegated contracting.** Delegation of contracting to an agent whose objective differs from that of the principal has been shown to be potentially advantageous in terms of commitment (see Drazen, 2000, for an overview), or as a bargaining strategy (see e.g., Fershtman, Judd and Kalai, 1991). Bennett and Iossa (2007) extend these results to service provision under PPPs in an incomplete contract framework, and show that delegation may result in improved incentive for cost-reducing investment and in worsening of incentives for social benefit. These papers focus on how delegating contracting can help providing incentives to the contractor. Instead, we focus on the agency costs of delegating contracting, and emphasize a trade-off between these agency costs and those related to the delegation of service provision.
On concession contracts. Finally, from a more applied side, our paper is related to the literature on PPPs, dating back to Hart (2003), Bennett and Iossa (2006) and Martimort and Pouyet (2008). In Iossa and Martimort (2012) we showed that the better risk allocation obtained when states are verifiable helps to improve the gain from bundling. The paper however does not consider the possibility of corruption. Martimort and Pouyet (2008) study corruption in PPPs but the focus is on corruption at planning stage. The firm may bribe a public official to secure that the service is provided through a PPP - which provides higher rent - rather than through a traditional model of procurement.

3 The Model

Overview. Consider a public authority (thereafter PA) willing to procure the provision of a public service to a private contractor. The provision of the service requires to build and design an infrastructure. Examples of such delegation include of course transportation, water production and sanitation, waste disposal, clinical and educational services etc. Although different in details, contracting modes in those settings share a common timeline. The time horizon consists of three stages: the contract-design stage, the building stage and the operational stage. In the contract-design stage, the contractor submits a project, and there is uncertainty about how to write the contract, given the realizations that may occur during the project implementation. Different contingencies may realize: For example, the legal standards of service may change due to a new legislation or macroeconomic conditions may change, affecting the future revenues from the service. Including these contingencies in the contract is costly. This cost is privately observable by the public official (thereafter PO) after the project is submitted. The public official reports this cost to the PA who finalizes the contract design, choosing between a complete or an incomplete contract.

In the second stage, the infrastructure is built, and exogenous shocks may realize which affects the revenues of the service. When a complete contract has been signed at the contract-design stage, the payment to the contractor and the revenue sharing rule are then adjusted according to the realized contingency. When instead parties have only agreed upon an incomplete contract earlier on, the payment and the revenue sharing rule remain unchanged.\footnote{We assume that in this case, either because of legal rules or because of high transaction costs, renegotiation cannot occur.}

The third stage is the operational stage, where the provision of the service begins. The contractor exerts operational effort which affects realized revenues. Nonverifiable exogenous shocks may occur at this stage.

In this setting, we analyze the optimal degree of contract completeness, studying how the optimal payment and revenue sharing rule should be designed under different...
assumptions on the verifiability of revenue shocks and on the benevolence of PO.

3.1 The Set-Up

We now present the model in more details.

Production technology. For services where users pay (concession model), the revenues from the service are stochastic and defined as:

\[ R = R_0 + e + \theta + \zeta. \]

Only revenues can be verified and revenues-sharing rules are thus the only possible contracts available in our environment.

Various variables impact on revenues beyond a baseline level \( R_0 \) that can be obtained even in the absence of effort.

- First, \( e \) is an effort exerted by the operator at the operating stage. The positive effect of \( e \) on \( R \) captures for example the higher demand from users of transport services when service reliability, on-the-train services, or the efficiency of the ticketing system are higher. The cost of effort counted in monetary terms is \( e^2 \).

- Second, \( \theta \) represents a shock that occurs at building stage. In transport concessions, building excavation may reveal archeological sites delaying construction, oil prices may vary, macroeconomic conditions may change affecting future demand, and so on. For simplicity we assume that the revenue shock \( \theta \) has zero mean and can only take two values \( \bar{\theta} = (1 - \nu)\Delta \theta > 0 \) and \( \theta = -\nu \Delta \theta < 0 \) with respective probabilities \( \nu \) and \( 1 - \nu \). The corresponding variance is \( \chi^2 = \nu(1 - \nu)(\Delta \theta)^2 \).

- Third, \( \zeta \) is a random variable that represents a demand or productivity shock that occurs during the operational stage and whose occurrence involves prohibitive verifiability costs. In transport concessions, demand can be affected unpredictably by competition from other modes or facilities, from the conditions affecting the

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8Following Iossa and Martimort (2013), \( R \) can be used interchangeably to denote also the benefit from the service, for those services where users do not pay (PFI model). In this case, the contractor does not appropriate these benefits directly but it receives a payment linked to an index of \( R \).

9The costs of providing the service and assume that these are nonverifiable. Contractors in PPP projects are often involved in a variety of service provisions and there are large common costs which make it is difficult to attribute to a particular project. This is especially true in developing countries as noticed by Laffont (2005) and Estache and Wren-Lewis (2009). For the same reason we assume that the contractor’s profits on the specific projects are also nonverifiable. Also, the non-verifiability of operating costs is a key feature of complex projects like PPPs.

10For essential services with rigid demand or where the contractor operates in a condition of monopoly, \( R_\infty \) is high.
wider network, such as economic activity levels or tourism demand, and it is difficult to disentangle the effect of each of these factors. We further assume that $\zeta$ is normally distributed with zero mean and variance $\sigma^2$.

**Information.** Our model entails both elements of adverse selection and moral hazard.

- The revenue $R$ is verifiable and can be contracted upon.$^{11}$
- The realization of $\theta$ is unknown to all parties at the contracting stage. This creates a motive for insurance. Later on, the contractor learns the value of this shock and thus gets an informational advantage that affect the design/building stages. Truth telling constraints have to be satisfied at this stage.
- The contractor’s effort $e$ is nonverifiable. The operator chooses the effort $e$ ex post, i.e., once he already knows $\theta$. This simple formulation allows us to capture how the contractor can adapt his second-stage efforts to productivity shocks in the environment. Contracts must induce effort provision.

**Contracts and contracting technology.** As revenues are verifiable, a revenue-sharing agreement between the public authority and the contractor can be written down. Following Holmström and Milgrom (1987, 1991), we assume for simplicity that those contracts are linear. We adopt the accounting convention that the government keeps all the revenues $R$ and then gives back a transfer

$$t(R) = \alpha + \beta R$$

to the contractor. The parameter $\beta$ represents the share of revenues kept by the firm while $\alpha$ is a fixed fee.

In the sequel, we will distinguish between complete and incomplete contracts.

- With **complete contracts**, the PA can offer a full menu of options $\left\{ (\alpha(\hat{\theta}), \beta(\hat{\theta})) \right\}_{\hat{\theta} \in \Theta}$ contingent on the report $\hat{\theta}$ made by the operator on the realization of the productivity shock. The payment schemes then write as:

$$t(\hat{\theta}, R) = \alpha(\hat{\theta}) + \beta(\hat{\theta}) R.$$

From the Revelation Principle,$^{12}$ there is of course no loss of generality in restricting the analysis to such direct and truthful mechanisms.

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$^{11}$In transport projects, for example, revenues can be verified through electronic ticketing systems, whilst in energy projects they can be specified through computerized billing systems.

$^{12}$Myerson (1982).
• With incomplete contracts, the PA is restricted to offer a rigid option \( \{ \alpha_\infty, \beta_\infty \} \) that applies under all circumstances. The payment schemes becomes:

\[
t_\infty(\theta, R) = \alpha_\infty + \beta_\infty R.
\]

Observe that, under incomplete contracting, extracting the operator’s private information is useless, as the contract is rigid and inflexible with respect to the realized state. Separating allocations can only be offered if the contract is complete. As we shall see below, the value of such state-contingent clauses is that they allow to improve on both insurance and incentives.

To justify that incomplete contracts may emerge as optimal responses to contractual frictions, we simply assume that the PO in charge incurs an exogenous cost \( z \geq 0 \) of writing a complete contract. The cost \( z \) of writing a complete contract is privately observed by the public official in charge. This assumption captures the decentralization of power that inevitably occurs in public organizations.

This parameter \( z \) can also be thought as the communication cost of processing and understanding messages over the state of the world, especially when the latter is particularly complex to describe. This cost can also be interpreted as a cognitive cost\(^{13}\) or as the opportunity cost of not devoting time to more directly productive activities.

This cost is a random variable distributed on \( \mathbb{R}_+ \) according a positive density function \( g(z) \) and a cumulative (atomless) distribution function \( G(z) \) (with \( G'(z) = g(z) \)).

**Remark 1** Our contracting technology assumes that all costs of contracting comes from processing messages on nonverifiable states. We model thus the cost of verifying messages and not the cost of writing different contingencies that would also arise even if the state of nature were verifiable but different contracting clauses were written under different realizations of this shock. Yet, Section 4 below shows that, had the productivity shock and the operating effort been both verifiable, the optimal contract would be independent of the state of nature. Hence, even if the contracting cost was bearing on contingencies per se (and not messages on those contingencies), there would be no reason to incur that cost to complete the contract.

**Objectives.** Let us describe the three players’ objective functions in details.

• PA is risk neutral and maximizes the share of revenues it gets net of the costs of paying for the services and the infrastructure and net of the cost \( z \) of writing

\(^{13}\) See Tirole (2009) and Bolton and Faure-Grimaud (2009) for some more micro-founded models along these lines. Cognitive costs have a broad range of interpretations, including the managers’ psychic cost of focusing on issues they are unfamiliar with, or the fees paid to lawyers and consultants for advice on contracting.
complete contract if he chooses so. Formally, with complete contracts this objective writes as:

\[ W = E_{\theta, \xi} ((1 - \beta(\theta)) R - \alpha(\theta)) - z. \]

Instead, with an incomplete contract, PA can save on contracting costs and his objective becomes:

\[ W_\infty = E_{\theta, \xi} ((1 - \beta_\infty) R - \alpha_\infty). \]

- The contractor is risk averse with constant degree of risk aversion \( r \geq 0 \), and we denote \( v(V) = 1 - exp(-rV) \) his utility function, where \( V \) denotes its payoff. The assumption of risk aversion captures the fact that a PPP project might represent a large share of the contractor’s activities so that there is little scope for diversification. The contractor cares about the certainty equivalent of his payoffs from running the service. With a complete contract, he thus gets

\[ v(V) = E_{\theta, R} \left( v \left( \alpha(\theta) + \beta(\theta) R - \frac{e^2}{2} \right) \right), \]

while, with incomplete contract, he gets

\[ v(V_\infty) = E_{\theta, R} \left( v \left( \alpha_\infty + \beta_\infty R - \frac{e^2}{2} \right) \right), \]

where \( E_x(\cdot) \) is the expectation operator with respect to any random variable \( x \).

The contractor’s outside opportunity yields an exogenous payoff normalized at zero so that contracts are accepted whenever

\[ V \geq 0 \text{ or } V_\infty \geq 0 \]

depending on contracting possibilities.

- A benevolent PO has preferences aligned with those of PA. Instead, a corrupt PO also cares about and the monetary benefits he withdraws from being in charge and possibly corrupted. We leave to Section 6 the details of this formulation.

\[ ^{14} \text{The assumption of risk neutrality for the public authority might certainly be questioned in the case of small local authorities whose PPP projects may represent a significant share of their overall budget. For a large country, the existing deadweight loss in the cost of taxation may as well introduce a behavior towards risk, if the PPP project were to represent a large share of the budget. We make this assumption as it gives a simple benchmark: in the absence of moral hazard, the optimal risk allocation requires the public sector to bear all risks. Lewis and Sappington (1995) and Martimort and Sand-Zantman (2007) analyze the consequences of having risk averse governments in various procurement settings.} \]
4 Benchmarks

4.1 Verifiable Effort and Productivity Shocks

When the effort and the productivity shock $\theta$ are both verifiable, $PA$ can easily provide full insurance against productivity shocks to the risk averse operator, impose an effort target at the operating stage and use the fixed fee to reap all surplus from the operator.

The first-best effort level is independent of $\theta$:

$$e^* = \underset{e}{\arg\max} e - \frac{e^2}{2} \equiv 1.$$ 

The contractor bears no revenue risk and receives a constant payment in all states of nature:

$$\beta(\theta) = 0 \text{ and } \alpha(\theta) = \frac{e^*^2}{2} \forall \theta.$$ 

That fixed fee just covers the cost of exerting the first-best effort level.

4.2 Nonverifiable Effort but Verifiable Productivity Shocks

We now characterize the optimal contract when productivity shocks are verifiable and thus complete contracting is costless. This benchmark will allow us to identify the value of writing complete contracts. We shall disregard the possibility of collusion between the contractor and the public official, and assume that $PO$ is benevolent and has thus the same objective as $PA$.

The contract now has to be designed with the dual objective of providing insurance to the operator against the shocks that can occur during the project implementation and inducing operational effort. When the productivity shock $\theta$ is observable, the contract provides state-contingent clauses that specify a compensation $\alpha(\theta)$ and a revenue sharing formula $\beta(\theta)$ for each realized contingency $\theta$. These state-contingent clauses facilitate both insurance and incentives provision. The payment scheme then writes as:

$$t(\theta, R) = \alpha(\theta) + \beta(\theta)R.$$ 

When shocks that occur during the construction phase are verifiable, $PA$ does not need to extract the information from the contractor. However, since the contractor’s effort is nonverifiable, a few conditions must be satisfied to induce operational effort. Thanks to the CARA specification and the normality of shocks, we can write the certainty equivalent of the contractor’s payoff when $\theta$ is observed as:

$$U(\theta) \equiv \underset{e}{\arg\max} \alpha(\theta) + \beta(\theta)(R_0 + \theta + e) - \frac{e^2}{2} - \frac{r\sigma^2\beta^2(\theta)}{2}. \quad (1)$$

The quantity $\frac{r\sigma^2\beta^2(\theta)}{2}$ is the risk premium that needs to be paid to the contractor to compensate him for bearing the risk of exogenous shocks $\zeta$ during operations. As the
shocks $\zeta$ at operational stage cannot be verified, there is no way to provide insurance to the contractor, who will then bear revenue risk whenever $\beta > 0$. The risk premium that must be paid to compensate the contractor increases with the degree of risk aversion of the contractor $r$, with uncertainty at the operational stage $\sigma^2$, and with the share of revenues $\beta(\theta)$ he keeps in state $\theta$.

At operational stage, once he has observed $\theta$, the operator chooses his operational effort optimally. This leads to the following moral hazard incentive constraint:

$$e(\theta) = \beta(\theta) \forall \theta \in \Theta.$$  \hfill (2)

Substituting for the above value into (1) yields:

$$U(\theta) = \alpha(\theta) + \beta(\theta)(R_0 + \theta + e) + (1 - r\sigma^2)\frac{\beta^2(\theta)}{2} \forall \theta \in \Theta. \hfill (3)$$

Equipped with those notations, we can write the ex ante participation constraint that must be satisfied to induce the contractor’s participation when $\theta$ is verifiable as:

$$E_\theta(v(U(\theta))) \geq 0. \hfill (4)$$

As the contractor is risk averse, he must be compensated for any ex post risk that he bears, not just at operational stage but also at the building stage. This means that he should receive full insurance against the shock $\theta$ at the optimal contract. This fact together with other findings related to the optimal contract are summarized in Proposition 1.

**Proposition 1** Assume that $\theta$ is verifiable. The optimal complete contract is such that:

1. The contractor is fully insured by the public authority against exogenous events occurring at building stage:

$$U_{mh}(\bar{\theta}) = U_{mh}(\theta);$$

2. The contractor keeps a share of revenues $\beta_{mh}^{\theta} < 1$ that is independent of the realized shock

$$\beta_{mh}^{\theta} = \frac{1}{1 + r\sigma^2} < 1 \forall \theta \in \Theta;$$

3. Effort is suboptimal

$$e_{mh}^{\theta} = \frac{1}{1 + r\sigma^2} < 1.$$
Proposition 1 suggests that contracts between the public and private sectors should include state-contingent clauses providing for monetary payments to compensate the contractor for all the predicted exogenous events affecting his profits. When input prices increase, or there is a national strike slowing down production or there is a change in legislation that increases the cost of operations, the firm should receive a compensation by the authority. The contingent clauses should then provide for the fixed payment $\alpha_{mh}(\theta)$ to reflect external conditions so as to fully insure the firm:

$$\alpha_{mh}(\theta) - \alpha_{mh}(\bar{\theta}) = \Delta \theta \beta_{mh} > 0 \iff U_{mh}(\theta) = U_{mh}(\bar{\theta})$$

As revenue shocks are exogenous and thus outside the firm’s control, these contingent clauses provide insurance on shocks unrelated to the firm’s effort and thus do not weaken incentives.\(^{15}\)

Under a complete contract, for each realized contingency during the design stage, the contract specifies a revenue shares $\beta_{mh}$ that will be applied during the operational stage. The optimal share trades off the value of incentives with the risk premium that must be paid for bearing risk at operational stage, $\frac{\sigma_2^2 \beta}{2}$. On the one hand, a higher revenue share raises incentives for operational effort during operations: $e$ is indeed increasing in $\beta$. On the other hand, a higher revenue share raises the level of risk transfer to the contractor and thus the risk premium. The contractor always bears revenue risk on all those shocks $\zeta$ that may occur during the operations. The risk premium due to the contractor is then higher the higher is the share $\beta$ of revenues kept by the contractor. Because of this trade-off, the revenue share is lower than one.

The cost of contractual incompleteness. The principal of course gains from being able to write a complete contract as otherwise the optimal contract would be independent of the realized state and would not provide enough insurance, contrary to what is obtained in Proposition 1. To evaluate the cost of incompleteness and for future references, next Proposition derives such optimal incomplete contract.

Proposition 2 Suppose that effort is nonverifiable. The optimal incomplete contract has the following features.

1. The contractor fully bears the risk of exogenous shocks at the building stage:

$$U^\infty_{mh}(\bar{\theta}) = U^\infty_{mhi}(\theta) + \Delta \theta \beta^\infty_{mh}.$$  

\(^{15}\)This result arises because only the net revenues $R' = R - \theta_i = e + \zeta$ matter for incentives purposes. The marginal benefit of effort $\delta R/de$ is indeed independent of the revenue risk $\theta$. In practice, shocks in revenues, such as a change in macroeconomic conditions, do not affect the productivity of operational effort devoted for example to reduction in congestion or increase safety on a highway.
2. The contractor keeps a share of revenues that is independent of the realized shock, and lower than under complete contracting:

\[ \beta_{\infty}^{mhi} < \beta_{\infty}^{mh} < 1 \]

with

\[ \beta_{\infty}^{mhi} = \beta_{\infty}^{mh} (1 - \Delta \theta \varphi' (\Delta \theta \beta_{\infty}^{mhi})) . \]  

(7)

3. Effort is suboptimal and lower than under complete contracting

\[ e_{\infty}^{mhi} < e_{\infty}^{mh} < 1 . \]

An incomplete contract cannot provide for payments and revenue shares to be contingent on the realized state. This results in more revenue risk being transferred to the contractor, without this being compensated in terms of stronger incentives. In fact, the risk that the contractor keeps for events occurring at building stage is higher the greater the revenue share \( \beta_{\infty} \) that the contractor keeps at operational stage. Providing incentives is therefore more risky than under the optimal complete contract, and this makes it optimal to reduce revenue risk transfer under the incomplete contract, by setting \( \beta_{\infty}^{mhi} < \beta_{\infty}^{mh} \). Weaker incentives at operational stage then characterize the incomplete contract.

5 The Choice Between Complete and Incomplete Contracts with a Benevolent Public Official

In this section we characterize the optimal contract when both the effort and the productivity shock are nonverifiable, contracting is costly, but the PO has the same objective as PA. This benchmark allows us to understand how the contracting cost \( z \) affects the choice of contract and its design, when there is no risk of corruption.

When shocks that occur during the construction phase are nonverifiable, and PA wants to write a complete contract, it needs to extract the information from the contractor on the realized contingency. This entails two different kinds of contracting costs.

First, there is the direct cost of contracting \( z \) that is incurred to verify the reports on different contingencies. This cost is privately observed by PO and will be taken into account when he chooses between complete and incomplete contracting. An important question is whether delegating the task of designing such contract creates additional agency costs. As we shall see, there are no such costs with a benevolent PO. Agency costs will instead arise when PO is corrupted.

Second, asymmetric information on \( \theta \) implies that the contractor can no longer be fully insured. Allocations have to satisfy incentive compatibility constraints that induce some endogenous risk on the contractor. This results in a costly risk premium paid to the contractor, which in turns triggers reduced incentives to exert effort.
5.1 Complete Contracting

To see how the different contracting costs articulate, let us first consider the design of a complete contract. To this purpose, it is convenient to redefine the contractor’s net returns as:

\[ U(\theta) = \max_{(e,\hat{\theta})} \alpha(\hat{\theta}) + \beta(\hat{\theta})(R_0 + \theta + e) - \frac{e^2}{2} - \frac{r\sigma^2\beta^2(\hat{\theta})}{2} \]

Incentives at the operating stage are entirely defined by the share of revenues kept by the operator, i.e.,

\[ e(\hat{\theta}) = \arg \max_e \alpha(\hat{\theta}) + \beta(\hat{\theta})(R_0 + \theta + e) - \frac{e^2}{2} - \frac{r\sigma^2\beta^2(\hat{\theta})}{2} \equiv \beta(\hat{\theta}) \quad \forall (\theta, \hat{\theta}) \in \Theta^2. \]

From this, we deduce the more compact expression of the contractor’s returns as:

\[ U(\theta) = \max_{\hat{\theta} \in \Theta} \alpha(\hat{\theta}) + \beta(\hat{\theta})\theta + (1 - r\sigma^2) \frac{\beta^2(\hat{\theta})}{2}. \]

This latter expression encompasses the usual incentive compatibility constraints that are both necessary and sufficient to induce truthful revelation once \( \theta \) is known. Any contract satisfying the above constraint prevents an operator having faced a shock \( \bar{\theta} \) to pretend having faced a more averse shock \( \theta \), and vice versa. As standard in screening environments,\(^{16}\) the contractor has an incentive to report a negative shock when instead a good shock was observed. The only relevant (binding) incentive compatibility constraint in our framework with two productivity shocks is thus:

\[ U(\bar{\theta}) - U(\theta) \geq \Delta \theta \beta(\theta). \quad (8) \]

By underreporting his productivity, the operator offers a lower estimate of revenues at the operational stage and receives a greater monetary payment (i.e., \( \alpha(\hat{\theta}) > \alpha(\bar{\theta}) \)). With such strategy, the contractor appropriates an extra rent worth \( \Delta \theta \beta(\theta) \). This rent is strictly positive unless \( \beta(\theta) = 0 \). Setting \( \beta(\theta) = 0 \) would of course remove the incentives to lie, which is good on the adverse selection side, but it would also destroy all incentives to exert effort at the operating stage following a bad revenue shock at construction stage. Now, the operator must face a risky allocation of returns to satisfy the incentive compatibility constraint.

To put it differently, if \( \beta(\theta) > 0 \), the incentive compatibility constraint implies that when external events hit construction, the contractor will now have to receive only a partial compensation for the lost revenues. If the contractor were fully compensated \( (U(\bar{\theta}) - U(\theta) = 0) \), then he would always report a negative shock to receive that compensation. The important insight here is then that leaving some revenue risk to

\(^{16}\)See Laffont and Martimort (2002, Chapter 2) for instance.
the contractor is indeed necessary to solve the asymmetric information problem on the
events that occur during the building stage. This type of risk is endogenous. As the
contractor is risk averse, leaving this endogenous risk to the contractor is costly: the
contractor now needs to receive an additional risk premium.

The shape of this risk premium is described in the following Lemma.

Lemma 1 Let \( \theta \) be nonverifiable. The risk premium that must be paid to the contractor
for inducing truthful revelation of the realized state is:

\[
\varphi(\Delta \theta \beta(\theta)) = \nu \Delta \theta \beta(\theta) + \frac{1}{r} \ln (1 - \nu + \nu \exp(-r \Delta \theta \beta(\theta))),
\]

where \( \varphi(0) = \varphi'(0) = 0 \) and \( \varphi'(\Delta \theta \beta(\theta)) > 0 \) if \( \beta(\theta) > 0 \).

There is now a trade-off between insurance and truth-telling: full insurance becomes
too costly, as the contractor would always report that a negative shock hit the proect
during construction, to maximize his compensation. Expression (8) tells us that to in
order to ensure truth-telling, the contract needs to provide for a gap in returns between
the good and the bad states. This gap increases with the share of additional revenues
that the contractor can appropriate by underreporting the shock, \( \Delta \theta \beta(\theta) \). The greater
this share \( \beta(\theta) \), the greater the incentives to report a negative shock. This explains
why the risk premium is increasing with \( \beta(\theta) \).

Equipped with Lemma 1, we may rewrite the certainty equivalent of the firm’s
payoff as (with obvious notations):

\[
V(\beta(\overline{\theta}), \beta(\overline{\theta})) = E_\theta(U(\theta)) - \varphi(\Delta \theta \beta(\theta)).
\]

Taking into account the expression of effort in terms of revenue shares, the PA’s
expected payoff with complete contracting (and contracting costs have value \( z \geq 0 \))
can in turn be written as:

\[
W(\beta(\overline{\theta}), \beta(\overline{\theta}), z) = E_\theta \left( \beta(\theta) - \frac{(1 + r \sigma^2)}{2} \beta^2(\theta) - U(\theta) \right) - z
\]
or

\[
W(\beta(\overline{\theta}), \beta(\overline{\theta}), z) = E_\theta \left( \beta(\theta) - \frac{(1 + r \sigma^2)}{2} \beta^2(\theta) \right) - \varphi(\Delta \theta \beta(\theta)) - V(\beta(\overline{\theta}), \beta(\overline{\theta})) - z.
\]

As a benchmark for the subsequent analysis, consider the case where it is always
costless to write down a complete contract (i.e., \( G(\cdot) \) has just a unit mass point at
\( z = 0 \)). The optimal contracting problem consists in solving:

\[
(P_\infty): \max_{(\beta(\overline{\theta}), \beta(\overline{\theta}))} W(\beta(\overline{\theta}), \beta(\overline{\theta}), 0) \text{ subject to } V(\beta(\overline{\theta}), \beta(\overline{\theta})) \geq 0.
\]

The solution for this problem is immediate. The operator’s participation constraint
is of course binding. Inserting into the maximand and optimizing pointwise yields the
following Proposition.
Proposition 3 Suppose that revenue shocks are nonverifiable, PO is benevolent and contracting is costless. The optimal complete contract is such that:

1. The contractor is only partially compensated for revenue shocks occurring during construction

\[ U^{nv}(\bar{\theta}) - U^{nv}(\theta) = \Delta \theta \beta^{nv}(\theta) > 0. \]  \hspace{1cm} (9)

2. The contractor keeps a lower share of the revenues when a negative revenue shock is reported

\[ 0 < \beta^{nv}(\bar{\theta}) < \beta^{nv}(\theta) = \beta^{mh} < 1 \]

where

\[ \beta^{nv}(\theta) = \beta^{mh} \left( 1 - \frac{\Delta \theta}{1 - \nu \varphi^{nv}(\theta)} \right). \]  \hspace{1cm} (10)

Since the contractor has incentives to underreport revenues, he must receive only a partial compensation for adverse events. Leaving some ex post risk to the contractor then becomes optimal but this comes at the cost of the risk premium \( \varphi(\Delta \theta \beta^{nv}(\theta)) > 0. \) To reduce this risk premium, PA reduces the revenues share when negative shocks are reported, \( \beta^{nv}(\theta). \) This reflects a standard “no-distortion at the top” result which is familiar from the screening literature. However, this effect in turn dampens incentives to exert effort at the operational stage.

5.2 Incomplete Contracting

Consider now the case where the contract is left incomplete. As previously, we define the operator’s return in state \( \theta \) as:

\[ U_{\infty}(\theta) = \max_{e} \alpha_{\infty} + \beta_{\infty}(\theta + e) - \frac{e^2}{2} - \frac{r \sigma^2 \beta^2_{\infty}}{2}. \]

Incentives at the operating stage are again entirely defined by the share of revenues kept by the operator, i.e.,

\[ e(\theta) = \beta_{\infty} \quad \forall \theta \in \Theta. \]

With an incomplete contract, the payment scheme does not change when the state \( \theta \) realizes. Thus, for any given revenue share \( \beta_{\infty}, \) the occurrence of \( \theta \) imposes a risk on the contractor given by

\[ U_{\infty}(\bar{\theta}) - U_{\infty}(\theta) = \Delta \theta \beta_{\infty}. \]

This risk is of course very similar to that arising with complete contracting. To compensate for this risk, a risk premium of \( \varphi(\Delta \theta \beta_{\infty}) \) must now be paid. A rigid contract

\[ ^{17} \text{We index this case with a superscript } nv \text{ in the sequel.} \]
that does not adjust with the realized contingencies imposes an exogenous risk on the contractor which is proportional to the contractor’s share $\beta_\infty$ of revenues.

We may now rewrite the operator’s and the $PA$’s payoff respectively as:

$$V_\infty(\beta_\infty) = E_\theta(U_\infty(\theta)) - \varphi(\Delta \theta \beta_\infty)$$

and

$$W_\infty(\beta_\infty) = \beta_\infty - \frac{(1 + r \sigma^2)}{2} \beta_\infty^2 - E_\theta(U_\infty(\theta)) \equiv \beta_\infty - \frac{(1 + r \sigma^2)}{2} \beta_\infty^2 - \varphi(\Delta \theta \beta_\infty) - V_\infty(\beta_\infty).$$

As another benchmark for the subsequent analysis, consider the case where it is infinitely costly to write down a complete contract. The optimal contracting problem consists in solving:

$$(P_\infty) : \max_{\beta_\infty} W_\infty(\beta_\infty) \text{ subject to } V_\infty(\beta_\infty) \geq 0.$$  

It should be clear that the optimal incomplete contract is again characterized as in Proposition 2. With an incomplete contract, the fixed payment $\alpha_\infty$ and the revenue sharing rule $\beta_\infty$ are both independent of the realized contingency. This imposes additional risk on the contractor, as he cannot be insured in states that are not contracted upon. The cost of providing incentives is therefore higher in this case. This explains why the revenue share is lower in those states: $\beta_{mhi}^\infty < \beta_{mh}^\infty$.

### 5.3 The Optimal Degree of Incompleteness

Consider the choice of a benevolent $PO$ as to when to use a complete contract. Such $PO$ only cares about the $PA$’s payoff, and thus chooses a complete contract whenever the $PA$ would find it optimal ex post to do so, i.e., if and only if the following condition holds:

$$z \leq z^* = W(\beta(\theta), \beta(\theta), 0) - W_\infty(\beta_\infty).$$  

Excluding corner solutions, this condition identifies a cut-off value $z^*$ such that for all $z \leq z^*$ a complete contract contingent on the realized state will be written, whilst for all $z > z^*$ an incomplete contract is preferred.

To illustrate, suppose that the principal commits to offer the optimal complete and incomplete contracts described in Sections 5.1 and 5.2 above. The corresponding cut-off $z^{nv}$ would then be strictly positive:

$$z^{nv} = W(\beta_{mh}, \beta^{nv}(\theta), 0) - W_\infty(\beta_{mhi}^\infty) > 0.$$  

The right-hand side can be interpreted as the value of writing a complete contract when the shock is verifiable. The cut-off defined through (12) turns out to be optimal when $PO$ is benevolent as we will see below.
Intuitively, the contracting problem lies somewhere “in between” the outcomes achieved when there are no contracting costs and when those costs are infinite. Formally, we write:

\[
(\mathcal{P}) : \max_{(z^*, \beta_\infty, \beta(\theta), \beta(\bar{\theta}))} \int_0^{z^*} W(\beta(\bar{\theta}), \beta(\theta), z) dG(z) + W_\infty(\beta_\infty)(1 - G(z^*)) \\
\text{subject to (11) and} \\
(1 - G(z^*))V(\beta(\theta), \beta(\bar{\theta})) + (1 - G(z^*))V_\infty(\beta_\infty) \geq 0. \tag{13}
\]

This latter condition is indeed an ex ante participation constraint that applies to the contractor. This agent must be willing to operate before knowing whether a complete or an incomplete contract will regulate the relationship. Of course, the operator is able to anticipate the payoffs consequences of this choice.

Remark 2 Observe that a pointwise optimization of the maximand with respect to \(z^*\) would give us a first-order condition that is nothing else that (11). In other words, the PA would like to commit ex ante to a cut-off rule that is indeed ex post optimal when the PO in charge of this delegated choice has similar preferences. This suggests that the Lagrange multiplier of (11) is zero at the optimum of (\(P\)) and that this condition is redundant. Yet, in view of preparing for the analysis to come when PO is corrupted, we keep this general formulation.

The following Proposition then derives the optimal contracts, both in case a complete one is chosen and when an incomplete one is preferred, and the optimal level of contractual incompleteness.

**Proposition 4** Suppose that \(\theta\) is nonverifiable and PO is benevolent. The optimal contractual arrangement has the following features.

1. A complete contract is chosen whenever
   \[z \leq z^{nv} = W(\beta^{mh}, \beta^{nv}(\theta), 0) - W_\infty(\beta^\text{mhi}).\]

2. The incomplete contract which is chosen when \(z \geq z^{nv}\) is characterized in Proposition 2.

3. The complete contract which is chosen when \(z \leq z^{nv}\) is characterized in Proposition 3.

4. The operator always gets zero expected payoff whether a complete or an incomplete contract is chosen:
   \[V(\beta^{mh}, \beta^{nv}(\theta)) = V_\infty(\beta^\text{mhi}) = 0. \tag{14}\]
Depending on the realized level of contracting costs $z$, a different contract may be chosen. For $z$ sufficiently high, an incomplete contract is optimal. For $z$ low instead the benefit of better insurance and higher incentives that the complete contract provides justifies incurring contracting costs. Proposition 4 further shows that there is a complete dichotomy between finding the characteristics of the contracts (whether it remains incomplete or not) and finding the set contingencies under which either contractual mode is chosen. There is no risk transfers between these two sets of contingencies and both the complete and the incomplete contracts allow the operator to break even in expectations.

Yet, sometimes an incomplete contract is implemented. The level of contractual completeness is captured by $z^{nv}$. Since the interests or $PA$ and $PO$ are aligned, there are no agency costs of delegating the contract choice. The incomplete contract saves on contracting costs but also has the operator bears more risk than with a more complete contract.\textsuperscript{18}

6 The Choice Between Complete and Incomplete Contracts with a Corrupted Public Official

In practice, institutions in place at a given point in time can be highly corrupted, with corruption present at different levels of the hierarchy. This is the ‘grabbing end of corruption’.\textsuperscript{19} Within this view, distortionary policies may be introduced they may be respond more easily to the threat of corrupted behavior.

To take into account the possibility of corruption, in this section we remove the assumption that $PO$ and $PA$ have the same objectives, and we allow for the possibility that he may accept a bribe to favor the contractor in the contract negotiations. As we shall see, this discretion delegated to $PO$ may create agency costs and distort contractual arrangements when those preferences differ.

6.1 $PO$’s Preferences and the Stake For Corruption

We have seen in the previous section that for $z$ sufficiently high, an incomplete contract is optimal, whilst for $z$ low the benefit of better insurance and higher incentives that

\textsuperscript{18}This insight goes in the same direction of what has been suggested by other scholars considering the cost of incompleteness of contracts due to ex post adaptations. In Bajari and Tadelis (2001), the contractor is risk neutral so the insurance motive is irrelevant. More complete contracts are instead valuable because they reduce the need of renegotiation in case adaptations are needed. Since renegotiation is shown to be more costly with fixed price contracts than with cost plus, high powered incentives (fixed price contracts in their paper) will go one to now with more complete contracts. In our setting, instead, renegotiation is not an issue, and complete contracts are more high powered because the cost of risk transfer is lower.

\textsuperscript{19}See e.g. Shleifer and Vishney (1993).
the complete contract provides justifies incurring contracting costs.

A PO with preferences imperfectly aligned with those of PA may receive a bribe from the contractor in order to bias the selection towards one mode over the other. With conflicting preferences, agency costs of delegated contract negotiations arise and distort contractual arrangements. We will model corruption with a simple reduced form. PO now gives also an extra weight $\gamma \in [0,1)$ on the firm’s payoff in state $\theta$ in his objective function.20 Formally, PO’s preferences under complete contracting can be written as:

$$W + \gamma E_\theta(U(\theta)) = E_{\theta, \zeta}((1 - \beta(\theta)) R - \alpha(\theta)) - z + \gamma E_\theta(U(\theta)).$$

While under incomplete contracting, those preferences accordingly become:

$$W_\infty + \gamma E_\theta(U_\infty(\theta)) = E_{\theta, \zeta}((1 - \beta_\infty) R - \alpha_\infty) + \gamma E_\theta(U_\infty(\theta)).$$

The optimal contractual arrangement found in Proposition 4 has some important features. Gathering (14), (6) and (9), we find the following expressions of the expected profits under both contracting scenarios:

- Under complete contracting

$$E_\theta(U_{nv}(\theta)) = \varphi(\Delta_\theta \beta_{nv}(\theta));$$

20Those preferences could be micro-founded. Suppose that the public official and the contractor jointly observe the realized value of $z$ and will share knowledge on the realization of $\theta$ with some probability $q$. Under those circumstances, information sharing triggers collusive behavior. With probability $1 - q$, there is no information sharing, collusion fails and PO’s objective is aligned with that of PA.

Whenever a collusive deal is reached, it stipulates bribes $(\tau(\theta), \tau(\bar{\theta}))$ to maximize PO’s expected utility subject to the constraint that the expected payoff of the contractor under incomplete contracting is at least as high as his expected utility with a complete contract, that is:

$$\max_{(\tau(\theta), \tau(\bar{\theta}))} k E_\theta(\tau(\theta)) \quad \text{subject to} \quad E_\theta(v(U_{\infty}(\theta)) - \tau(\theta)) \geq E_\theta(v(U(\theta))) = 0.$$

The parameter $k < 1$ captures the cost of transferring bribes including possibly the cost that contractors may bear in organizing corruptible activities, the fact that side-contracts are not easily enforceable (on this issue see Tirole 1992, and Martimort 1999), the risk of being caught for briberies, or the psychological costs that the public official may incur when being involved in some illegal activities (Khalil and Lawarrée, 2006). More broadly, the existence of such transaction costs is a standard assumption in the public choice and regulation literatures. See Congleton (1984), Laffont and Tirole (1993), Faure-Grimaud, Laffont and Martimort (2002) and Faure-Grimaud and Martimort (2003) among others.

This side-contract gives full insurance to the operator. The public official extracts the whole stake from corruption, and obtains an expected benefit from corruption worth the risk premium.

Overall, PO’s objective is as stipulated in the text with $\gamma = \frac{q}{1 - q}$. 

22
• Under incomplete contracting

\[ E_{\theta}(U_{mhi}^{\infty}(\theta)) = \varphi(\Delta \theta \beta_{mhi}^{\infty}). \]

From comparing (7) and (10) and the fact that \( \varphi' > 0 \), it immediately follows that \( \beta_{mhi}^{\infty} > \beta_{nv}(\theta) \) and thus

\[ E_{\theta}(U_{nv}(\theta)) > E_{\theta}(U_{mhi}^{\infty}(\theta)). \]

Under incomplete contracting, the risk left on the operator is greater and the risk-premium needed to ensure his participation increases. This creates a bias for the pro-firm PO towards choosing too often an incomplete contract compared to what a benevolent PO (or the PA) would do.

Formally, for any arbitrary contracts with revenues shares \( (\beta_{\infty}, \beta(\theta), \beta(\bar{\theta})) \) and corresponding risk-premiums \( \varphi(\Delta \theta \beta(\theta)) \) and \( \varphi(\Delta \theta \beta_{\infty}) \), a biased PO will choose a complete contract whenever:

\[ z \leq z^* = W(\beta(\bar{\theta}), \beta(\theta), 0) - W_{\infty}(\beta_{\infty}) + \gamma(\varphi(\Delta \theta \beta(\theta)) - \varphi(\Delta \theta \beta_{\infty})). \tag{15} \]

This condition that what will drive the decision rule of PO is his own payoff under the contracts designed by PA. PO chooses a complete contract if the difference in expected welfare compared to the case of an incomplete contract is at least as high as the value of the bribe he can secure via the higher risk premium that a complete contract generate. He chooses an incomplete contract otherwise.

**Remark 3** Our analysis implicitly focuses on the case where the choice between incomplete and complete contracting is always delegated to PO. An alternative would be for PA to always control this choice himself even if he has no information on contracting costs. This would mean either committing ex ante to always implement a complete contract whatever the level of contracting costs will be or to always focusing on an incomplete one irrespectively of the realized contracting costs that he does not observe ex ante, although later on he will bear and learn that cost if he is committed to.\(^{21}\) In full generality, PA could thus commit to a mechanism that, on top of the requested revenues sharing parameters for both complete and incomplete contracts, would also stipulate a probability \( x(\hat{z}) \) of implementing a complete contract as a function of PO’s report on the contracting costs \( z \) he has observed.\(^{22}\) This delegation mechanism is certainly in line with Holmström (1984) and the more recent literature on mechanism design without incentive transfers and especially Alonso and Matoushek (2008) and Martimort

\(^{21}\)The implicit assumption here is that those costs may be ex post observable although not verifiable ex ante; a standard assumption in the incomplete contracts literature.

\(^{22}\)It can be easily checked that there is no benefits for PA to make the revenues sharing parameters depend on PO’s announcement \( \hat{z} \).
and Semenov (2006). Following the machinery developed by that literature, incentive compatibility for PO requires:

\[ z \in \arg \max_{\tilde{z} \geq 0} x(\tilde{z})(W(\beta(\theta), \beta(\bar{\theta}), z) + \gamma \phi(\Delta \theta \beta(\bar{\theta}))) + (1 - x(\tilde{z}))(W_\infty(\beta) + \gamma \phi(\Delta \theta \beta_\infty)). \]

Because \( W(\beta(\theta), \beta(\bar{\theta}), z) \) is monotonically decreasing in \( z \), those conditions also imply that \( x(z) \) is weakly decreasing in \( z \) and thus almost everywhere differentiable. At any point of differentiability \( z \), incentive compatibility amounts to:

\[ \dot{x}(z)(W(\beta(\theta), \beta(\bar{\theta}), z) - W_\infty(\beta_\infty) + \gamma(\phi(\Delta \theta \beta(\bar{\theta})) - \phi(\Delta \theta \beta_\infty))) = 0. \]

From this, it follows that \( x(z) \) is constant on the intervals \([0, z^*] \) and \((z^*, +\infty)\). Denote by \( x_0 \) and \( x_1 \) those constants, with the monotonicity requirement \( x_0 \leq x_1 \). Finally, observe that the principal’s objective is linear in the probability \( x(z) \) so that any mechanism with non-trivial delegation (i.e., where \( PA \) does not keep full control on contractual choice) should have:

\[ 0 = x_0 < x_1 = 1 \]

as requested when delegated contractual choice follows the cut-off rule (15).

### 6.2 Optimal Contracts and Levels of Incompleteness under Corruption

When the contractual choice is delegated to a biased PO, the contracting problem may be rewritten as:

\[
(P^{co}) : \max_{(z^*, \beta_\infty, \beta(\bar{\theta}), \beta(\theta))} \int_0^{z^*} \left[ W(\beta(\bar{\theta}), \beta(\theta), z) dG(z) + W_\infty(\beta_\infty)(1 - G(z^*)) \right] + (1 - G(z^*)) v(\mathcal{V}(\beta)) \geq 0.
\]

Remember that (15) defines a decision rule that is ex post suboptimal from \( PA \)'s viewpoint since it is too favorable to contractual incompleteness. When facing such distortion, \( PA \) has two options: First, he could choose to leave the contracts as they are, and simply accept that an incomplete contract will be selected too often. Second, he may choose to modify the shape of the complete and incomplete options so as to affect indirectly the choice of \( PO \) as to which contract applies, making a complete contract more attractive.
In this respect, constraint (15) could be eased in one of three ways: (i) by increasing the expected welfare \( W(\beta(\bar{\theta}), \beta(\bar{\theta}), 0) \) under complete contracting, (ii) by reducing the expected welfare \( W_\infty(\beta_\infty) \) under incomplete contracting, or by (iii) modifying the complete and incomplete contracts so as to reduce the difference in the risk premiums \( \varphi(\Delta \theta \beta(\bar{\theta})) - \varphi(\Delta \theta \beta_\infty) \). In the first two cases, PA would operate so as to increase the welfare cost of the distorted decision of the public official. In the last scenario case, he operates so as to decrease the stake of corruption.

The following Proposition derives the optimal contracting package in this environment with corruption.

**Proposition 5** The presence of corruption has three different effects on contracting.

1. A complete contract will be chosen whenever the contracting costs are below or equal to some threshold \( z^{co} \) with:
   \[
   z^{co} < z^{nv}.
   \]
   The incomplete contract is chosen too often.

2. The complete contract option is modified so that the contractor now bears more revenue risk when a negative revenue shock is reported:
   \[
   \beta^{co}(\bar{\theta}) = \beta^{mh} > \beta^{co}(\bar{\theta}) > \beta^{nv}(\bar{\theta}).
   \]

3. The incomplete contract option is modified so that the contractor now bears less revenue risk:
   \[
   \beta^{nv}_\infty > \beta^{co}_\infty.
   \]

4. The operator gets a negative (resp. positive) expected payoff under complete (resp. incomplete) contracting:
   \[
   \mathcal{V}(\beta^{mh}, \beta^{co}(\bar{\theta})) < 0 < \mathcal{V}_\infty(\beta^{co}_\infty). \tag{17}
   \]

The contracts designed for the case of a benevolent PO are now no longer optimal, as they would induce a biased PO to select an incomplete contract too often. The optimal contracts now trade off the agency costs of delegated contracting with the agency costs of delegated public service provision. Their design reduces the distortion in the decision rule by introducing a distortion in the allocation rule.

In particular, the design of the complete and incomplete options are no longer disentangled. To better align PO’s choice with PA’s objectives, expected returns are made lower under complete contracting.
The particular shape of the optimal contracts that result from this trade off can then be understood by inspecting the decision rule (15). Consider the three potential instruments. (i) First, increasing the expected welfare $W(\beta(\theta), \beta(\theta), z)$ under complete contracting is undoable, as the optimal contract under honest public official already maximizes welfare. (ii) Second, reducing the expected welfare $W_\infty(\beta_\infty)$ under incomplete contracting is a valuable option, as we shall see in point (iii) below. (iii) Third, reducing the difference in the risk premiums $[\varphi(\Delta \theta \beta_\infty) - \varphi(\Delta \theta \beta(\theta))]$, by decreasing $\beta_\infty$, which decreases $\varphi(\Delta \theta \beta_\infty)$ and $EW(\theta, \alpha_\infty, \beta_\infty)$, and by increasing $\beta(\theta)$, which increases the risk premium under the complete contract, although it has a partially offsetting effect of reducing the expected welfare in that scenario.

7 Conclusion

Numerous regulations already exist across countries so as to limit the scope for post-contractual renegotiation of concession contracts by, for example, imposing legal limits on the percentage of the contract value that can be renegotiated, or by requiring the authorization of an independent third party. These provisions were initially designed to help increase the commitment power of public authorities and thus to reduce the potential abuse of bargaining power by contractors locked in important public service contracts. These provisions however were also clearly helpful to fight post-tender stage corruption as they increase monitoring of the contract execution stage and reduce contract flexibility. There is indeed strong evidence that corruption explained the widespread use of post-contractual renegotiations in Latin America concessions (Guasch 2004, Guasch and Straub 2009). Guasch (2004) in particular warns that informational asymmetries on costs between the operator and the regulator provide incentives for opportunistic demands for renegotiation and increases in tariffs to restore that equilibrium.\footnote{As noted by Engel, Fisher and Galetovic (2009), existing accounting standards allow governments to renegotiate PPP contracts and elude spending limits. Here renegotiations occur to favour re-election of current governments by increasing spending in politically sensitive projects. The evidence from Chilean renegotiations of PPP contracts confirm their predictions.} \footnote{Bajari and Tadelis (2006) also provide insights along this line. They discuss how post-tender corruption may affect the choice of price-only versus cost-plus contractual mechanisms. Fixed-price contracts awarded competitively, especially in the case of complex projects, provide an incentive to enter into a corrupt agreement where the winner will deliver at no penalty substandard quality. The corrupt contractor wins the tender with the lowest price offer thanks to the information advantage the briber has with respect to the other participants.}

The suggestion of our paper is to make use of similar principles when dealing with the design of the initial contract. Corrupted public officials may purposefully leave contingent clauses vague so as to create greater scope for rogue deals with the contractor. Badly designed contracts that leave too many contingencies unspecified can indeed be
a source of rent for contractors, and this creates a scope for corruption. Incomplete contracts do not need a contract redrafting or the authorization of a third party, and therefore they even more at risk of corruption than renegotiation clauses.

The inefficiency created by the suboptimal contract choice explains why in many countries contracting is not totally left to the public authority: a greater use of standardized contracts is made. In practice, the planning and design of most PPP contracts involves two different layers of the governmental hierarchy: the central government (for example the national Department of Transport) and the local government (a local authority). The former typically coordinates the national PPP program and provides information and guidelines. The latter instead implements and monitors specific projects. With the public official’s discretion being confined to a choice of contract, rather than a choice on how to draft contract clauses, the scope for corruption is reduced. An implication of our paper is that when the risk of corruption at local level is particularly high, using standardized contracts which set boundaries on the discretion of local public officials is particularly valuable.

Further, we did not question in the paper whether decentralization of contracting is optimal. An interesting extension of our model would allow for an explicit comparison between centralized and decentralized contracting, so as to identify the conditions under which the loss of local information that occurs under centralized contracting is more than compensated by the increase in allocative efficiency that a more benevolent contract negotiator would ensure. We conjecture, that in countries where the risk of corruption is high the benefit of decentralization will be small. With no flexibility on the contract design, we expect complete contracts to be used as the standardized contract for PPP programs in sectors where project complexity is high (e.g. waste management or complex IT) and uncertainty is high (as captured by a higher $\Delta \theta$). Vice versa, incomplete contracts may be used for simple projects with relatively stable returns (e.g. parking units and cemeteries). However, how complexity and uncertainty affect the choice of decentralizing contracting deserves further research.

Two issues have been left out of our analysis. First, we have not made an explicit distinction between the concession model (where users pay) and the Private Finance Initiative (PFI) model (where the contractor recoups his revenues from the government since users do not pay), and it would be interesting to explore the cost of corruption in PFI models as concession contracts. In the PFI model, the compensation paid to the contractor takes the form of an increase in the unitary payment paid by the authority which is financed through public funds. In the latter, which are self-financed, the compensation paid to the contractor takes the form of an increase in users’ fees which is financed by users. Being the users the residual claimant of the tariff increase, the concession contracts will typically receive more ex post monitoring than the PFI model, making the deal more transparent. And since transparency helps monitoring, it is reasonable to expect that concession contracts will suffer less from post-tendering corruption than PFI contracts. This insight however needs further investigation.
Second, we have taken a reduced form approach and assumed that only one contingency may realize. In practice, projects may be of different complexity and more complex projects may exhibit more relevant contingencies. Studying which contingency to regulate in the contract and which not, taking into account of the contracting costs of different contingencies and the risk of corruption, may constitute an interesting scope for further research.

References


[34] Laffont, J.J. (2005), Regulation and Development, Cambridge University Press.


Appendix

To be written.