Government Opportunism in Public-Private Partnerships*

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Abstract

This paper analyzes the contracting out of public services through Public-Private Partnerships (PPPs) subject to government opportunism. The government delegates the construction and management operations to a private sector consortium. The bundling of project stages induces the consortium to invest at the construction stage to achieve long-run cost savings. However, the consortium's incentive to invest is affected by the government's lack of commitment. We characterize the optimal PPP contract when the government is opportunistic, i.e., when it fails to commit not to revise the contract. We compare this result to the optimal concession contract, in which the construction and management activities are provided by two different firms. We show that the PPP contract can be more costly than the concession contract. This is contrarily to the widespread view that PPPs are the most efficient mechanisms for the provision of public services.

JEL classification: D8, H41, H57, L33, L51.
Keywords: Public Private Partnership, Concession, No Commitment.

1 Introduction

The last three decades have witnessed a trend towards privatization of provision of public services and infrastructure. Increasingly governments are turning to the private sector to build and operate public facilities such as roads, schools, prisons, hospitals and water. This state withdrawal from the organization of public services resulted in the use of partnerships between the public and the private sectors, used as an alternative to full-scale privatization. These partnerships refer to contractual arrangements between a government and a private

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party for the provision of assets and the delivery of services traditionally provided by the public sector. They take place through a variety of contracts from the traditional form of public procurement, concession, to the modern form, Public-Private Partnership (PPP). Most features of this new procurement method have been drawn out from the practices of the english Private Finance Initiative policy, often presented as a success. Consequently, the french government introduced this PPP contract adopting the new legal framework set out in the June 2004 Ordinance.

The aim of this paper is to compare the relative efficiency of PPPs with respect to concessions accounting for government opportunism. A PPP refers to a single contract where a private consortium builds a public service facility and operates it for the government. Under a concession, these two tasks are undertaken by different private firms. PPPs find their particularity in the length of the contract induced by the bundling of tasks. This allows the possibility of opportunistic behavior from government. A party acts opportunistically when it exploits any revealed information by the execution of the agreement to modify the initial contract.

We start our analysis by developing a two-period model of procurement in which a government must procure a public utility project involving the construction of a specific asset and its operation. At each period, a private entity realizes a piece of this project. At the first period, she can invest to reduce operation cost. Only the bundling of tasks allows the internalisation of any positive externalities that may exist between the construction and operational stages. With two different firms, such externalities are not taken into account by the builder and productive efficiency of the project is diminished. So, PPPs are the optimal mode of public utility delivery. The private consortium adopts a whole-life costing approach of the project. This provides an incentive to realize construction investments to minimize the cost of providing the public service. But the benefits from bundling can be mitigated when the government is tempted to behave opportunistically. Indeed, the key factor governing PPPs is whether the contractual partners are able to commit themselves to execute the initial contract. The incentive to exploit any information arising at the first period limits the ability to make credible commitments. So, observing building costs, the government may update his beliefs about the consortium's efficiency. She recognizes that her revealed information will be fully exploited. She thus takes this into account in her response to the policies established at the beginning of the relationship. Internalization will be imperfect, thus the under-investment problem may be acute. It results that the whole life cost of the project is higher with an opportunistic government than under full commitment.

We compare PPPs run by short-term contracts with concessions. These latter are seen as two different static schemes. From this comparison, we show that PPPs are only preferred to concessions as long as the parties are sufficiently patient, the impact of investment on operation cost saving is important and the probality to face a efficient private entity is high.

We provide an extension of model to complete our analysis. It consists to add a moral hazard problem at the construction stage. In this framework, the consortium may exert an effort after contracting but before learning her type. Under no commitment, she chooses a level of effort taking into account both the effect on the first period reward and on the regulator's inference about her efficiency. She thus will be reluctant to convey favorable information early in the relationship. We show that this undereffort will undermine the efficiency of PPPs. This conclusions are contrarily to the widespread view that the PPPs are the most efficient mechanisms for public good provision.

Debate about the alternative contracts for private provision of public services, PPPs and concessions, has been initiated by Hart (2003). He considered the bundling of building and management operations as the key feature of PPPs. To study the desirability of bundling this tasks, he used a simple incomplete contracting model. Contrary to this autor, we do not postulate the incompleteness of contracts. We consider that all eventualities can be specified in the contract. So, we use a complete contracting approach, as Bentz, Grout and Halonen (2005). They show that PPPs are the optimal mode of delivery when efficiency-enhancing investments at the build stage are relatively cheap and set up costs at the service provision stage. Although our setting is quite similar, we do not deal with the problem of biais in favour of the PPPs. Martimort and Pouyet (2006) also show that the building of the facility and its operating should be managed altogether when an investment at the construction stage helps to save on operating costs. They encompass the effects of the ownership pattern. We abstract from the role of ownership, this problem has been sufficiently analyzed. As this previous papers, we define PPP as a simple bundling inducing the parties to adopt a long term approach of the project. Our paper considers the impact the institutional commitment on these contractual arrangements, often omitted by the bundling/unbundling literature.

Some early papers have already addressed the problem of commitment in the partnership contracts such as Guasch, Laffont and Straub (2006). They constructed a regulation model in which renegotiation occurs due to the imperfect enforcement of concession contract. We reach similar conclusion that the government's temptation to behave opportunistically discourages investments. However, our analysis differs from their work which concentrates on the long-term renegotiation proof optimal concession contract. We rather consider that the PPP relationship entirely run by short term contracts. Our paper is linked to the literature on dynamic regulatory contracts under asymmetric information. Laffont and Tirole (1988) investigated a two-period model of a principal-agent relationship run by short-term contracts. A main focus of their paper is the ratchet effect. Anticipating opportunism from government, firm wants to hide her private information to protect future rent. Conversely, in our setting, the firm does not reveal her efficiency. We set up a moral hazard model in which the private entity's investment is subject to moral hazard. Our paper is quite close to the Iossa and Martimort (2008). We also conclude that, with an opportunistic government, investment is reduced. They show that the degree of information revelation in the first period will be strategically determined to affect the governement beliefs. Due to our particular contractual setting, the firm can not lead astray the government about her efficiency. Our extention provides a means to affect the government beliefs without using screening.

The paper is organized as follows. Section 2 describes the benchmark characterizing optimal PPP contract under full commitment. Section 3 derives this contract under no commiment. Section 4 analyzes the efficiency of the PPP contract relatively to the concession. Section 5 provides an extension of this model. Section 6 concludes.

2 The Benchmark

We consider a two-period model of procurement in which a government[1] must procure a public utility project involving the construction of a specific asset and its operation. The value for the principal of this production, which is common knowledge, is exogenously fixed at S. We assume that S is large enough so that the project is always desirable[2]. Each task of this project, infrastruture construction and service provision, is carried out by a risk neutral firm for the principal. We assume that the firm's efficiency is constant over time, i.e. the firm's type θ is drawn once and remains fixed in both periods of the model. This agent can be either efficient ($\overline{\theta}$) or inefficient ($\underline{\theta}$) with respective probabilities v and $1-v$. We let $\Delta\theta \equiv \overline{\theta} - \underline{\theta} > 0$. To be efficient (inefficient) increases the probability that the cost of the project is low C_l (high C_h). This efficiency parameter is unknown by the two parties at the beginning of the game. Only the firm discovers it after contracting. Then, when she accepts or refuses the project, she is not informed about her type θ. Although at the first period, the cost depends only on the firm's efficiency such that $Prob(C^1 = C_l^1/\theta) = \theta$, the cost of the second period depends on several others parameters. Indeed, at the second period, the firm can exert a positive and costly effort e where $e \in \left[0, e^{Max}\right]$. Exerting effort e increases the probability that the cost of the project is low but incurs a disutility (in monetary units) of $\Psi(e)$ where $\Psi(e) = \frac{e^2}{2}$ which is a quadratic cost function. This disutility increases with effort $\Psi' > 0$ for $e > 0$, at an increasing rate $\Psi'' > 0$, and satisfies $\Psi(0) = 0$. This action is supposed to be non-observable so that the principal faces a moral hazard problem when delegating production to the agent. It is extremely valuable for the government, who always wants to implement a high level of effort from both types of firm. Effort is characterized as a continuous variable. A manager may not choose between working or not working on a project but may be able to fine-tune the exact effort spent on his project. Then, the project's cost at the second period depends on the time-invariant type, on the cost-reducing effort and on an other inobservable paramater which is the investment.

In this dynamic framework, the firm can make a some quantity of investment I, after she discovers her type, which costs $g(I) = \frac{I^2}{2}$ at the first period. This investment increases the probability of βI to have a low cost C_l^2 at the second period. As it refers to a positive externality, then $\beta > 0$. We consider that a better design of infrastrusture may facilitate the operating task and then reduce its costs. Thereby, the probability to have a low cost at the second period will be such that $Prob(C^2 = C_l^2/\theta) = \theta + e + \beta I$.

The Timing of the game is the following:

- The government offers a contract to the firm.
- The firm accepts or refuses the contract. If she refuses, she gets her reservation utility.

[1] The government is also called the principal in this principal-agent model, and the firm is the agent.

[2] This assumption allows us to avoid problems of optimal cutoff.

- Only the firm learns the value of her type θ drawn from nature.
- The firm chooses her investment I.
- The first part of the contract is executed and transfers take place.
- The firm chooses the contract corresponding to her efficiency parameter and she exerts her effort e.
- The second part of contract is executed and transfers take place.

The government designs a procurement contract on the only observable variable which is the realized costs. We take accounting convention that to accept to work for him, the firm must be compensated by a net monetary transfer t in addition to the reimbursement of her cost. The transfers of the first period t^1 is the same whatever the state of nature because the realized cost C^1 depend only on the unknown firm's type θ. It is only used to incentive her to invest. At the second period, this reward takes account cost and her announcement about her type such that $\left\{\left(C_l^2, \bar{t}_l^2\right), \left(C_h^2, \bar{t}_h^2\right), \left(C_l^2, \underline{t}_l^2\right), \left(C_h^2, \underline{t}_h^2\right)\right\}$. The principal offers a long-term contract to the agent which stipulates transfers in each period. Then, his objective function which corresponds to the consumer's welfare writes as:

$$S - \left[t^1 + \theta C_l^1 + (1-\theta) C_h^1\right] - \delta \left[(\theta + e + \beta I)\left(t_l^2 + C_l^2\right) + (1 - \theta - e - \beta I)\left(t_h^2 + C_h^2\right)\right]$$

We let δ, be the common discount factor used by the government and the firm.

The firm's utilities on each phase of project are such that:

$$\begin{aligned} U^1 &= t^1 - g(I) \\ U^2 &= (\theta + e + \beta I)\, t_l^2 + (1 - \theta - e - \beta I)\, t_h^2 - \Psi(e) \end{aligned}$$

Note that to obtain her participation, she must receive at least as much utility as outside opportunity level which is zero here.

$$U^1 \geq 0 \tag{1}$$
$$U^2 \geq 0 \tag{2}$$

At this stage, the agent knows her type θ and chooses her investment I such that:

$$I^{FB} = \arg\max_I \{-g(I) + \delta U^2\} \tag{3}$$

Faced with an incentive contract $\left\{(t_l^2,\ t_h^2\right\}$, the firm chooses an effort e, such that:

$$e^{FB} = \arg\max_e \{U^2\} \tag{4}$$

The principal recommends that the agent chooses a particular level of effort corresponding at her type.

2.1 Complete information

We suppose that there is no asymmetry of information between the government and the firm. Then, both parties know θ before contracting and the principal observes agent's investment and her effort.

The value of the production for the government S being constant, he looks for to minimize the costs of the project. This program (P) writes as:

$$\begin{aligned}&\min_{\{I,e\}}\left\{\left[t^1+\theta C_l^1+(1-\theta)\,C_h^1\right]\right.\\&+\delta\left[(\theta+e+\beta I)\left(t_l^2+C_l^2\right)+(1-\theta-e-\beta I)\left(t_h^2+C_h^2\right)\right]\}\\&\text{subject to (1) to (4).}\end{aligned}$$

Under complete information, the government maintains all firm's types at their zero status quo utility level. Then, at the first best, the firm's rents are:

$$U^{iFB}=0,\ \ i=1,2.$$

As investment and effort are both verifiable, the principal can thus use forcing contracts to implement any investment and effort pair such that:

$$I^{FB}=\delta\beta\left(C_h^2-C_l^2\right),$$

$$e^{FB}=C_h^2-C_l^2.$$

This first best outcomes involve that the agent's actions depend on the difference between costs. We remark that the firm's investment depends also on the degree of the positive externality between design and operation and her preference about the second period. To invest increases building costs but, it improves the probability to lower the long-run cost of the service. The agent is incentivized by being rewarded for low cost levels and penalized otherwise. Since the agent is risk neutral, she is ready to accept this transfers scheme as long as the expected payment she receives satisfies her ex ante participation constraint.

2.2 Incomplete Information

In such environment, the principal observes the agent's cost but not its efficiency parameter, its effort or its investment. The optimal contract in complete information are no longer implementable under asymmetric information. Hereafter, he must incentive the agent $\overline{\theta}$ (resp.$\underline{\theta}$) to realize actions $\overline{I}$ and $\overline{e}$ (resp.$\underline{I}$ and $\underline{e}$), according to her type. Allocations must satisfy the following adverse selection incentive constraints :

$$\begin{aligned}-g(\overline{I})+\delta\overline{U}^2 &\geq \underset{e,I}{Max}\left\{-g(I)+\delta[\left(\overline{\theta}+e+\beta I\right)\underline{t}_l^2+\left(1-\overline{\theta}-e-\beta I\right)\underline{t}_h^2-\Psi(e)]\right\},\\-g(\underline{I})+\delta\underline{U}^2 &\geq \underset{e,I}{Max}\{-g(I)+\delta[(\underline{\theta}+e+\beta I)\,\overline{t}_l^2+(1-\underline{\theta}-e-\beta I)\,\overline{t}_h^2-\Psi(e)]\}.\end{aligned}$$

At the second period, the contract $\left(\underline{t}_l^2, \underline{e}\right)$ must be weakly preferred to $\left(\overline{t}_l^2, \overline{e}\right)$ by agent $\underline{\theta}$ and $\left(\overline{t}_l^2, \overline{e}\right)$ by $\overline{\theta}$ rather than $\left(\underline{t}_l^2, \underline{e}\right)$. We could rewrite this incentive constraints focusing on rents to highlight the distributive impact of asymmetric information:

$$\overline{U}^2 \geq \underline{U}^2 + \underline{e}\Delta\theta + \frac{g(\overline{I})}{\delta} - \frac{g(\underline{I})}{\delta}, \tag{5}$$

$$\underline{U}^2 \geq \overline{U}^2 - \overline{e}\Delta\theta + \frac{g(\underline{I})}{\delta} - \frac{g(\overline{I})}{\delta}. \tag{6}$$

As mentionned above, the principal and the agent contract at the ex ante stage, i.e., before the agent learns her type. So, the firm is willing to participate in the regulatory process if and only if:

$$E(U^1) + \delta E(U^2) \geq 0. \tag{7}$$

The principal will solve problem (P) subject to (3) to (7). The simplification in the number of relevant constraints leaves us with only two remaining constraints, the agent's participation constraint (7) and the efficient agent's incentive constraint (5) which are binding at the optimum of the principal's problem (P). Since the rents are costly to the principal[3], then he will minimize its in such a way that he imposes a zero expected utility to the agent and (7) will be binding. Note that the neglected constraint (6) is satisfied by this solution. Furthermore, adding up (5) and (6), we obtain the *monotonicity constraint* that yields

$$\overline{e} \geq \underline{e},$$

in such a way that we check that is always the efficient type who has incentive to mimic the ineffcient one's effort and not the reverse.

Hence, we obtain

$$E(U^1) + \delta\left[\underline{U}^2 + v[\underline{e}\Delta\theta + \frac{g(\overline{I})}{\delta} - \frac{g(\underline{I})}{\delta}]\right] = 0.$$

At the second period, only the efficient firm may get a positive rent. This rent is obtained by adding up the respective rents due to adverse selection and moral hazard. Indeed, the ability of the efficient firm to mimic the inefficient firm's effort forces the regulator to give up a information rent to the efficient type. In addition, a part of this rent is used to incentive the efficient agent to invest at the construction stage.

The optimal menu of contracts entails:

$$\widehat{\overline{I}} = \delta\beta\left(C_h^2 - C_l^2\right),$$
$$\widehat{\underline{I}} = \delta\beta\left(C_h^2 - C_l^2\right).$$

[3] We checked that the principal's objective function is increasing in the agent's transfers.

$$\widehat{\overline{e}} = C_h^2 - C_l^2,$$
$$\widehat{\underline{e}} = C_h^2 - C_l^2.$$

The optimal incentive contract implements the first-best outcome. In this context, the risk in the distribution of information rents to induce information revelation is costless for the principal because of the agent's risk neutrality. We conclude that the PPPs are efficient mechanisms for public good provision in commitment framework.

However, such an ex ante contract requires a strong ability of the court of law to enforce contracts that could possibly lead to a negative payoff at the second period. The firm may want to renege on a contract entailing a negative ex post utility level. Additionnally, the government may cause a breach in the contract using firm's revelation of information. This full commitment situation preventing the both parties from behaving opportunistically ex post and thus promotes efficient conduct ex ante is an idealized case. It is difficult to imagine a mechanism allowing the parties to commit ex ante never to reconsider the initial contract. The full commitment is a relevant concept only if the costs of renegotiating are high enough or if the parties must adhere to rigid policy, as it underlined by Salanié (1997). A PPP contract under no commitment should be more useful descriptive tool in procurement environment.

3 PPP under Government Opportunism

In this part, we account for the possiblity of opportunistic behavior by government. When commitment is not available, he can commit himself only to the current period. He is incentivized to exploit any information the firm reveals by revising its policy in future periods. So, observation of building costs, providing useful information on the underlying state of nature, may be used by the government to update his beliefs about the firm's efficiency. This revealed information is used by the principal as a signal to better design the second period optimal contract. This signal may take only two values which correspond to the costs C_l^1 and C_h^1. The process of beliefs revision takes place according to the bayes' rule. To simplify the writing of the program, we use σ such that:

$$\begin{aligned} \sigma &= P(\theta = \overline{\theta}/C^1) \text{ and } 1 - \sigma = P(\theta = \underline{\theta}/C^1) \\ \text{where } \sigma &= \lambda \text{ when } C^1 = C_l^1 \\ \text{and } \sigma &= \mu \text{ when } C^1 = C_h^1. \end{aligned}$$

In this no commitment framework, the PPP is run by short-term contracts.

Second period As the government cannot commit him to a second-period incentive scheme, he chooses the second-period incentive scheme optimally given his beliefs about the firm's type at that date. These beliefs depend on the realized first-period cost. We denote the anticipated level of investment $\widehat{I}$, corresponding to the optimal one. Then, the program of optimization is such that the principal minimizes the consumer's welfare at the second period $(P2)$:

$$\min_{\underline{e},\overline{e}}\{\sigma[\left(\overline{\theta}+\overline{e}+\beta\widehat{\overline{I}}\right)\left(\overline{t}_l^2+C_l^2\right)+\left(1-\overline{\theta}-\overline{e}-\beta\widehat{\overline{I}}\right)\left(\overline{t}_h^2+C_h^2\right)]$$
$$+(1-\sigma)[\left(\underline{\theta}+\underline{e}+\beta\widehat{\underline{I}}\right)\left(\underline{t}_l^2+C_l^2\right)+\left(1-\underline{\theta}-\underline{e}-\beta\widehat{\underline{I}}\right)\left(\underline{t}_h^2+C_h^2\right)]\}$$

with respect to:

$$\overline{e}^* = \arg\max_{\overline{e}}\{\left(\overline{\theta}+\overline{e}+\beta\widehat{\overline{I}}\right)\overline{t}_l^2+\left(1-\overline{\theta}-\overline{e}-\beta\widehat{\overline{I}}\right)\overline{t}_h^2-\Psi(\overline{e})\} \quad (8)$$
$$\underline{e}^* = \arg\max_{\underline{e}}\left\{\left(\underline{\theta}+\underline{e}+\beta\widehat{\underline{I}}\right)\underline{t}_l^2+\left(1-\underline{\theta}-\underline{e}-\beta\widehat{\underline{I}}\right)\underline{t}_h^2-\Psi(\underline{e})\right\} \quad (9)$$

$$\overline{U}^2 \geq \max_e\{\left(\overline{\theta}+e+\beta\widehat{\overline{I}}\right)\underline{t}_l^2+\left(1-\overline{\theta}-e-\beta\widehat{\overline{I}}\right)\underline{t}_h^2-\Psi(e)\}$$
$$\underline{U}^2 \geq \max_e\{\left(\underline{\theta}+e+\beta\widehat{\underline{I}}\right)\overline{t}_l^2+\left(1-\underline{\theta}-e-\beta\widehat{\underline{I}}\right)\overline{t}_h^2-\Psi(e)\}$$

$$\Leftrightarrow \overline{U}^2 \geq \underline{U}^2+\underline{e}(\Delta\theta+\beta\Delta\widehat{I}) \quad (10)$$

$$\Leftrightarrow \underline{U}^2 \geq \overline{U}^2-\overline{e}(\Delta\theta+\beta\Delta\widehat{I}) \quad (11)$$

We allow the firm to leave the project if it is in her best interests to do so. Then, the participation constraints are written in per period terms, such that:

$$\overline{U}^2 \geq 0 \quad (12)$$
$$\underline{U}^2 \geq 0 \quad (13)$$

Since the rents are costly to the principal, the contraints (13) is binding at the optimum. As explained above, (10) will be binding too. The only relevant constraints are the efficient's type incentive constraint (13) and the inefficient type's participation constraint (10). Of course, both constraints must be binding at the optimum of the principal's problem ($P2$). Indeed, (13) and (10) immediately imply (12). Note that the neglected constraints (11) are satisfied by this solution. This implies:

$$\underline{U}^2 = 0$$
$$\overline{U}^2 = \underline{e}(\Delta\theta+\beta\Delta\widehat{I}). \quad (14)$$

At the second period, the government chooses an optimal static incentive scheme relative to his posterior beliefs updated thanks to Bayes's rule. It entails:

$$\overline{e}^* = C_h^2-C_l^2$$
$$\underline{e}^* = C_h^2-C_l^2-\frac{\sigma}{(1-\sigma)}\left(\Delta\theta+\beta\Delta\widehat{I}\right)\geq 0 \quad (15)$$
$$iff\ C_h^2-C_l^2 \geq \frac{\sigma}{(1-\sigma)}\left(\Delta\theta+\beta\Delta\widehat{I}\right) \quad (16)$$

The efficient type's rent is positive and her level of effort is the first best one. In opposite way, the inefficient type obtains no rent. Furthermore, her undereffort is due to the fact that the principal has an incentive to reduce her level of effort to lower the efficient type's rent. Note that this downward distortion depends on the informativeness of the signal.

If the principal observes C_l^1, he will think that is more likely that the agent is efficient. He thus has an incentive to reduce strongly $\underline{e}^*$ to lower the efficient type's rent. On the contrary, if he observes C_h^1, he thinks he has a strong probability to face an inefficient firm, then, the distortion will be weaker. In this case, the efficient agent's compensation at the second period will depends on her performance in that period and her performance in the prior period. Due to timing of the game (backwards induction), the investment became only a parameter.

First Period Firstly, to obtain the firm's participation minimizing the rent, the principal will leave the first period rent such that:

$$E(U^1) = 0$$

Henceforth, it rests to firm to choose investment knowing that it could happen at the second period:

$$\overline{I}^* = \arg\max_{\widehat{\overline{I}}} \{-g(\widehat{\overline{I}}) + \delta[E(\theta)\overline{U}^{2*}_{C_l^1} + (1 - E(\theta))\overline{U}^{2*}_{C_h^1}\} \quad (17)$$

$$\underline{I}^* = \arg\max_{\widehat{\underline{I}}} \{-g(\widehat{\underline{I}}) + \delta[E(\theta)\underline{U}^{2*}_{C_l^1} + (1 - E(\theta))\underline{U}^{2*}_{C_h^1}\} \quad (18)$$

The solutions are:

$$\begin{aligned}
\underline{I}^* &= 0 \\
\overline{I}^* &= \delta\beta\frac{C_h^2 - C_l^2 - 2\Delta\theta A}{1 + 2\delta\beta^2 A} \geq 0 \; iff \; C_h^2 - C_l^2 \geq 2\Delta\theta A \\
where\ A &= \overline{\theta}\frac{\lambda}{(1-\lambda)} + (1-\overline{\theta})\frac{\mu}{(1-\mu)}
\end{aligned}$$

Under no commitment, the firm chooses her level of investment knowing that it will happen at the second period. The inefficient agent does not invest because she anticipates that the regulator will reap all the surplus at the second period. Actually, it is too costly for the regulator to get the inefficient firm invests at the first period. Contrary to this type, the efficient one will invest but it will be distorded downward from the first best level. This investment is firstly distorded downward to reduce the efficient type's rent (from (14)). But this distortion is minimized by the fact that this rent depends also on the inefficient type's effort and that the latter depends on the investment (from (15)). In this case, the principal has incentive to raise it to reduce effort and investment.

Furthermore, this sequential equilibriums'distortions depends on the informativeness of the signal. If the principal believes that it is more likely that the agent is efficient, he will reduce her information rent. On contrary, if he is likely to face an inefficient agent, he will reduce the effort distortion to tend toward the first best. Anticipating this situation, the firm will reduce her first period investment even until at zero for the inefficient one. The rent of the efficient firm is clearly lower when the distribution is more favorable. The perspective of a more likely efficient type leads the principal to a trade off that is less favorable to allocative efficiency.

The next proposition emerges directly from the previous reasoning.

Proposition 1 *Government opportunism affects investment incentive and induces higher cost of the project than under full commitment.*

Note that due to the contractual setting, the firm can not lead astray the government about her type. Indeed, she does not influence principal's beliefs, the firm's level of investment affecting only the second period costs.

We consider this no commitment assumption as more realistic than the full commitment. Allowing the government to exploit any information the firm reveals by revising its policy in future periods, modifies contract design and incentives. As it was suggested by Laffont and Tirole (1993), "by limiting the scope for ex post inefficiency, short-term contrats effectively reduce ex ante efficiency".

4 The relative efficiency of PPP

To evaluate the efficiency of this modern contract, we compare it with the traditional one, the concession.

4.1 The Concession Model

Under a concession, the government contracts with the builder to build the facility and then later with another firm to run it. In this way, there are two objective functions, one for the builder and an other for the operator. Note that to compare it with the PPP contract under no commitment, we must stay in the same framework and keep the same timing.

The Construction Stage The risk neutral builder must accept or reject the contract before knowing her type, so its participation constraint must be written ex ante as:

$$E(U^1) \geq 0. \tag{19}$$

In addition, once her type known, she must choose a level of investment such that

$$\widetilde{\overline{I}} = \arg\max_{\overline{I}} \{t^1 - g(\overline{I})\} \tag{20}$$

$$\widetilde{\underline{I}} = \arg\max_{\underline{I}} \{t^1 - g(\underline{I})\} \tag{21}$$

The incomplete information entails the same results than complete information structure, i.e., that the rent of the builder is null such that:

$$E(U^1) = 0.$$

It also entails that the builder has no incentive to invest in order to enhance the probalities to have a low operation costs run by another firm.

$$\widetilde{\overline{I}} = \widetilde{\underline{I}} = 0$$

The Operating Stage Faced with an incentive contract $\{(t_l, t_h)\}$,this agent, knowing his type, chooses an effort $\underline{e}$ ($resp.\overline{e}$) for the efficient agent (resp.inefficient), such that:

$$\widetilde{\overline{e}} = \arg\max_{\overline{e}}\{\left(\overline{\theta}^2 + \overline{e}\right) t_l^2 + \left(1 - \overline{\theta}^2 - \overline{e}\right) t_h^2 - \Psi(\overline{e}^2)\} \tag{22}$$

$$\widetilde{\underline{e}} = \arg\max_{\underline{e}}\{\left(\underline{\theta}^2 + \underline{e}\right) t_l^2 + \left(1 - \underline{\theta}^2 - \underline{e}\right) t_h^2 - \Psi(\underline{e}^2)\} \tag{23}$$

$$\begin{aligned}
\overline{U}^2 &\geq \max_e \left\{\left(\overline{\theta} + e\right) \underline{t}_l^2 + \left(1 - \overline{\theta} - e\right) \underline{t}_h^2 - \Psi(e^2)\right\} \\
\underline{U}^2 &\geq \max_e \left\{(\underline{\theta} + e) \overline{t}_l^2 + (1 - \underline{\theta} - e) \overline{t}_h^2 - \Psi(e^2\right\}
\end{aligned}$$

$$\Leftrightarrow \quad \overline{U}^2 \geq \underline{U}^2 + \underline{e}\Delta\theta \tag{24}$$

$$\Leftrightarrow \quad \underline{U}^2 \geq \overline{U}^2 - \overline{e}\Delta\theta \tag{25}$$

$$\underline{U}^2 \geq 0 \tag{26}$$

$$\overline{U}^2 \geq 0 \tag{27}$$

The principal wishes to solve the following program without impact of investment on this stage:

$$\begin{aligned}
&\min_{\underline{e}^2, \overline{e}^2}\{v[\left(\overline{\theta}^2 + \overline{e}\right) \left(\overline{t}_l^2 + C_l^2\right) + \left(1 - \overline{\theta}^2 - \overline{e}\right) \left(\overline{t}_h^2 + C_h^2\right)] \\
&+(1 - v) \left[\left(\underline{\theta}^2 + \underline{e}\right) \left(\underline{t}_l^2 + C_l^2\right) + \left(1 - \underline{\theta}^2 - \underline{e}\right) \left(\underline{t}_h^2 + C_h^2\right)\right]\} \\
&\text{subject to (21) to (26).}
\end{aligned}$$

The optimal commitment solution under incomplete information is characterized by:

$$\begin{aligned}
\underline{U}^2 &= 0 \\
\overline{U}^2 &= \underline{e}\Delta\theta
\end{aligned}$$

$$\widetilde{\overline{e}} = C_h^2 - C_l^2$$
$$\widetilde{\underline{e}} = C_h^2 - C_l^2 - \frac{v}{(1-v)}\Delta\theta \; iff \; C_h^2 - C_l^2 > \frac{v}{(1-v)}\Delta\theta$$

Contrary to PPP, the builder does not exert any investment because it is not already integrated as a single entity with the operator. As investment was not realized at the second period, it implies a pure adverse selection model. It results as previously that the efficient type's effort is the first best one and her rent is positive. On the contrary, the inefficient type obtains no rent and her effort is distorted downward below the first-best effort due to the fact that the principal has an incentive to lower the efficient type's information rent.

This traditional public procurement is seen as two different static schemes. At the first period, the builder has no incitation to invest because he will not operate the asset to provide the service. For this same reason, commitment problem does not occur. At the second period, the optimal incentive scheme for the operator trades off only the two conflicting concerns of extracting the firm's informational rent and giving the latter appropriate incentives to reduce cost.

4.2 PPP versus Concession Contracts

The relative drawbacks and benefits of PPP are evaluated over the entire project lifecycle, from construction to operation stage. Actually, we intend to define if the building of an infrastructure and the management of public utilities should be undertaken by two different firms (unbundling) or by a consortium (bundling). As we showed, the bundling of construction and operation contracts in a PPP give the private partner greater incentives to make investments in the construction phase to lower subsequent operation and maintenance costs, contrary to the concession. However, this PPP advantage is mitigated by the distortion from the commitment problem which downward distord investments and efforts. We evaluate the relative efficiency of this contracts comparing their whole life cost of the project:

$$C^{PNC} - C^{C} = v\{A\beta\overline{I}^*(\frac{1}{2}\beta\overline{I}^* + \Delta\theta) - \frac{1}{2\delta}(\overline{I}^*)^2 + \frac{1}{2}(\Delta\theta)^2(A-1)\}.$$

To simplify analysis, we call the costs difference ΔC.

Proposition 2 *In a delegation context, the government should use PPP rather than concession contract only when:*

- the government is sufficiently patient, i.e., $\frac{\partial\Delta C}{\partial\delta} > 0$*,*

- the impact of investment on operation cost reduction is important, i.e., $\frac{\partial\Delta C}{\partial\beta} > 0$*,*

- the probality to face a efficient agent is high, i.e.,$\frac{\partial\Delta C}{\partial v} > 0$*.*

The intuition behind this proposition is direct.

Firstly, concerning the discount factor, the government has none incentive to bundle the building and management of an infrastructure if he has a strong preference for the present. Indeed, the PPP exhibit higher costs of construction because it give the private partner greater incentives to make investments in the construction phase to lower subsequent operation costs. Secondly, more the impact of the positive externality is important, more the government is incentived to contract with a PPP. Our analysis suggests that PPPs are more beneficial when an investment of the infrastructure can significantly reduce cost at the operational stage implying a lower whole life cost of the project. Finally, when the probability that the firm is efficient is important, the government prefers to bundle stages. Indeed, the firm's type in a PPP is determined at the first period for the whole duration of the relationship. We thus understand why, when the firm is more likely to be inefficient, the government could prefer the concession contract which offer an additional likelihood to face the firm with the good type at the second period.

5 Extended model

An possible extension consists to add a moral hazard problem at the first period. The firm may exert an effort at the interim stage, i.e., after contracting but before learning her type. We firstly derive the PPP contract under the commitment assumption before to relax it and to envisage the no commitment situation.

5.1 Commitment framework

The government commits not to use against the firm in the second period any cost information he infers from the first-period observations. In this more sophisticated setting, the firm may exert an effort e^1 at the interim stage, i.e., after contracting but before learning her type. Therefore, the principal proposes a contract such that $\left\{\left(C_l^1, t_l^1\right), \left(C_h^1, t_h^1\right)\right\}$; $\left\{\left(C_l^2, \underline{t}_l^2\right), \left(C_h^2, \underline{t}_h^2\right), \left(C_l^2, \bar{t}_l^2\right), \left(C_h^2, \bar{t}_h^2\right)\right\}$. Note that the level of effort e^1 will be the same whatever her type in this model because at the moment of her choice, the firm don't know her type.

- The complete information entails the first best outcomes as in the previous setting, but determines this additional level of effort at the first period such that:

  $$e^{1FB} = C_h^1 - C_l^1.$$

  The structure of information does not change the previous optima.

- Under incomplete information, this effort is supposed to be non-observable so that the principal faces a moral hazard problem when delegating production to the agent. This effort is extremely valuable for the principal, who always wants to implement a high level of effort from both types. Effort is still caracterized as a continuous variable. To solve this new problem under incomplete information entails the same results about investment and second period effort than the previous setting. But it takes now into account the first period effort which is the first best.

5.2 No commitment framework

In this part, the second period incentive scheme will be chosen optimally given the beliefs'regulator about the firm's type at that date. These beliefs depend on the first period cost, and on the firm's equilibrium first period strategy (the firm's effort cannot be observed by the regulator). For any first period incentive scheme $t^1(C^1)$, the firm chooses a level of effort taking into account both effect on the first period reward and on the government's revision about her efficiency. Note that this effort does not depend on her type being unknown at this stage. But, the firm will be reluctant to exert effort which is supposed to entail low costs. Indeed, an agent with high performance today will tomorrow face a demanding incentive scheme. Lastly, the government chooses the first period incentive scheme knowing that the firm will take a dynamic perspective.

The principal is a bayesien expected utility maximizer. In designing the agent's payoff rule, he moves first as a Stackelberg leader anticipating the agent's behavior and optimizing accordingly within the set of available contracts.

Second period The results are the same than previously but now the probabilities σ take account of first period effort.

$$\begin{aligned} \overline{U}^2 &= 0 \\ \underline{U}^2 &= \overline{e}^2(\Delta\theta + \beta\Delta I^*). \end{aligned}$$

$$\begin{aligned} \underline{e}^{2*} &= C_h^2 - C_l^2 \\ \overline{e}^{2*} &= C_h^2 - C_l^2 - \frac{\sigma}{(1-\sigma)}(\Delta\theta + \beta\Delta I^*) \end{aligned}$$

First Period

$$\begin{aligned} \max_{e^1}\{ \quad & S^1 - \left[\left(E(\theta)+e^1\right)\left(t_l^1 + C_l^1\right) + \left(1 - E(\theta) - e^1\right)\left(t_h^1 + C_h^1\right)\right] \\ & +\delta\{S^2 - \sigma\left[\left(\underline{\theta} + \underline{e}^{2*} + \beta\underline{I}^*\right)\left(\underline{t}_l^{2*} + C_l^2\right) + \left(1 - \underline{\theta} - \underline{e}^{2*} - \beta\underline{I}^*\right)\left(\underline{t}_h^{2*} + C_h^2\right)\right] \\ & -(1-\sigma)\left[\left(\overline{\theta} + \overline{e}^{2*} + \beta\overline{I}^*\right)\left(\overline{t}_l^{2*} + C_l^2\right) + \left(1 - \overline{\theta} - \overline{e}^{2*} - \beta\underline{I}^*\right)\left(\overline{t}_h^{2*} + C_h^2\right)\right]\} \end{aligned}$$

The firm chooses a level of effort taking into account both effect on the first period reward and on the regulator's inference about its efficiency. Note as the firm does not know his type at the moment of choosing e^1, it will use the revised probabilities:

$$e^{1^*} = \arg\max_{e^1}\left\{E(U^1) + \delta\left[\sigma\underline{U}^{2*} + (1-\sigma)\overline{U}^{2*}\right]\right\} \tag{28}$$

$$\overline{I}^* = \arg\max_{\overline{I}}\{-g(\overline{I}) + \delta[E(\theta)\overline{U}^{2*}_{C_l^1} + (1-E(\theta))\overline{U}^{2*}_{C_h^1}\} \tag{29}$$

$$\underline{I}^* = \arg\max_{\underline{I}}\{-g(\underline{I}) + \delta[E(\theta)\underline{U}^{2*}_{C_l^1} + (1-E(\theta))\underline{U}^{2*}_{C_h^1}\} \tag{30}$$

$$E(U^1) \geq 0 \tag{31}$$

The solution is such that[4]:

$$e^{1*} < e^{1FB}$$

The first period effort is downward distorded from the first best as the investment level:

$$\begin{aligned} \underline{I}^* &= \delta\beta \frac{\left[C_h^2 - C_l^2 - 2\frac{\sigma}{(1-\sigma)}\Delta\theta\right]}{1 + 2\delta\beta^2 \frac{\sigma}{(1-\sigma)}} \\ \overline{I}^* &= 0. \end{aligned}$$

No commitment reduces the efficiency of PPP downward distording the firm's effort and investment. At the first period, the firm's effort affect the building cost C^1. So, the firm is reluctant to convey favorable information (i.e. high effort) early in the relationship. Whatever her type, she has an incentive to convince the principal that she is inefficient. About investment distortion, we reach the same conclusion than previuosly. It is too costly for the regulator to get the inefficient firm invests at the first period. Indeed, she can anticipate second period outcomes.

From this explanations, we can formulate the following proposition.

Proposition 3 *No commitment entails a downward distortion of investment and an undereffort affecting the probability that an efficient trade takes place in this extention case. It affects the efficiency of PPP.*

Government opportunism entails a downward distortion of investment and an undereffort affecting the probability that an efficient trade takes place in this extention case. From now on, the agent may hold back on revealing information that could be used against her in later stages of the relation.

6 Conclusion

Recent years have witnessed the state withdrawal from the organization of public services. It resulted in a growing use of PPPs in many developed and developing countries. In this paper, we focused on this modern procurement, and studied the rationale for delegating contracting to a PPP under government opportunism. We constructed a regulation model in which the revision of the initial contract occurs due to imperfect enforcement PPP contracts. We found that PPPs are no longer the optimal mode of delivery public services. Anticipating opportunistic governement behavior, the firms may be discouraged to invest and exert effort at the construction stage. This is contrarilty to the widespread view that the PPPs are more efficient and cost effective than traditional form of public procurement.

[4] The effort is put in appendix due this unconfortable form.

Appendix

- **PPP under Government Opportunism**: Decisons based on $P(\theta = \underline{\theta}/C^1)$ will be better than those based on $P(\theta = \underline{\theta})$ because they use the available information. This process of beliefs revision takes place according to the bayes' rule, and we obtain the following Bayesian Probabilities:

$$\begin{aligned}
P(\theta &= \overline{\theta}/C^1 = C_l^1) = \frac{v\overline{\theta}}{E(\theta)} = \lambda; \\
P(\theta &= \underline{\theta}/C^1 = C_l^1) = \frac{(1-v)\underline{\theta}}{E(\theta)} = 1-\lambda; \\
P(\theta &= \overline{\theta}/C^1 = C_h^1) = \frac{v(1-\overline{\theta})}{1-E(\theta)} = \mu; \\
P(\theta &= \underline{\theta}/C^1 = C_h^1) = \frac{(1-v)(1-\underline{\theta})}{1-E(\theta)} = 1-\mu.
\end{aligned}$$

To simplify the writing of the program, we use σ such that:

$$\begin{aligned}
\sigma &= P(\theta = \overline{\theta}/C^1) \text{ and } 1-\sigma = P(\theta = \underline{\theta}/C^1) \\
\text{where } \sigma &= \lambda \text{ when } C^1 = C_l^1 \\
\text{and } \sigma &= \mu \text{ when } C^1 = C_h^1
\end{aligned}$$

- **Extended Model**: Bayesian Probabilities are such that:

$$\begin{aligned}
P(\theta &= \underline{\theta}/C^1 = C_l^1) = \frac{v(\underline{\theta}+e^1)}{E(\theta)+e^1}; \\
P(\theta &= \underline{\theta}/C^1 = C_h^1) = \frac{v(1-\underline{\theta}-e^1)}{1-E(\theta)-e^1}; \\
P(\theta &= \overline{\theta}/C^1 = C_l^1) = \frac{(1-v)(\overline{\theta}+e^1)}{E(\theta)+e^1}; \\
P(\theta &= \overline{\theta}/C^1 = C_h^1) = \frac{(1-v)(1-\overline{\theta}-e^1)}{1-E(\theta)-e^1}.
\end{aligned}$$

The probabilty that the agent is efficient is equal to $P(\theta = \underline{\theta})$. However, after the execution of the first contract, he observes the cost C^1 that he can use as a signal to better design of the contract. The probability distribution become then $P(\theta = \underline{\theta}/C^1)$. Clearly, decisons based on $P(\theta = \underline{\theta}/C^1)$ are better than those based on $P(\theta = \underline{\theta})$ because they use the available information.This process of beliefs revision takes place according to the bayes' rule as previously, but this Bayesian probabilities integrate e^1.

The optimal firm's effort at the first period is such that:

$$
\begin{aligned}
e^{1*} &= C_h^1 - C_l^1 + \delta\left(E(\theta) + e^1\right) \\
&\left\{ \begin{array}{c} \left(C_h^2 - C_l^2\right)\left[\beta \underline{I}^{*\prime}\sigma' + (\Delta\theta + \beta\underline{I}^*)\sigma''\right] \\ -2\beta\underline{I}^{*\prime}\frac{\sigma}{(1-\sigma)}(\Delta\theta + \beta\underline{I}^*)\left(2\sigma' - \frac{\sigma}{(1-\sigma)}(1-\sigma)'\right) + (\Delta\theta + \beta\underline{I}^*)\frac{\sigma}{(1-\sigma)}[(1-\sigma)' + (1-\sigma)'' - 2\sigma''] \end{array} \right\} \\
&+\delta\left\{\frac{\sigma^2}{(1-\sigma)}\beta\underline{I}^{*\prime}(1 + \Delta\theta + \beta\underline{I}^*) - \frac{2\sigma\sigma'(1-\sigma) + \sigma^2(1-\sigma)'}{(1-\sigma)^2}(\Delta\theta + \beta\underline{I}^*)\left[1 - \frac{1}{2}(\Delta\theta + \beta\underline{I}^*)\right]\right\} \\
&-\sigma'\frac{(\underline{I}^*)^2}{2} - \sigma\underline{I}^*\underline{I}^{*\prime}
\end{aligned}
$$

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