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**Article**

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## ABSTRACT

***This paper critically assesses the implications of contract design and risk transfer on the provision of public services under public-private partnerships (PPPs).*** *Two results stand out. First, the alleged strength of PPPs in delivering infrastructure projects on budget more often than traditional public procurement could be illusory. This is – to put it simply – because there are costs of avoiding cost overruns and, indeed, cost overruns can be viewed as equilibrium phenomena. Second, the use of external (i.e., third-party) finance in PPPs, while bringing discipline to project appraisal and implementation, implies that part of the return on efforts exerted by the private-sector partner accrues to outside investors; this may undo whatever beneficial effects arise from 'bundling' the construction and operation of infrastructure projects, which is a hallmark of PPPs.*



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# Public-private partnerships: contract design and risk transfer


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## 1. Introduction

The financing and development of large projects, for example to provide physical infrastructure (roads, water supply, dams and the like) or public goods (schools, jails, information networks), often span many years, involve a variety of economic and political participants, and depend for their success on the efforts and investments of these participants. The main purpose of this paper is to argue that the risk assessment of such projects cannot be separated from the contracting terms that will be established between the parties. We should not consider the risk of these projects as purely exogenous and assess only the risk before contracting. This does not mean that exogenous risk is absent – for instance, a storm may destroy a bridge. But there are also endogenous risks, i.e., risks that are influenced by the contracting terms – for instance, if the contractor is paid just for the completion of the bridge, he may use sub-performing cement, with the consequences of this choice appearing only after many years, possibly at the same time as an event like the storm we alluded to before.

Endogenous risk can be due to a host of imperfections in the economic environment, but two are especially relevant. First, the sponsor of the project, the oversight committees, the builder, and the operator of the project usually have conflicting preferences about the quality that should be achieved and the costs that should be incurred: the builder wants to minimise the cost of building, but this may increase the cost of operating the project; if the sponsor is subject to budgetary approval, he may want the best quality for the project while the oversight committee may want to minimise costs. Because of exogenous risk or imperfect monitoring, the outcome of the actions taken by the different parties may not be perfectly verifiable. Second, given the complexities of the technologies involved and the difficulty to audit, participants have private information about contractual variables (for example, the costs for the builder and operator, information about budgetary or monetary policies for the sponsor) and cannot identify all possible contingencies that could affect the timely delivery of the project or the cost of building and operating it.

Disentangling exogenous and endogenous risk is the objective of the economics of regulation under asymmetric information and the theory of incomplete contracts, which we review in Section 2. Both literatures stress that – in addition to the standard cost-benefit analysis that could be applied if the environment were of perfect and symmetric information – it is necessary to consider endogenous contracting costs linked to the agency problems generated by asymmetric and incomplete information. Despite the natural application of this literature to public-private partnerships (PPPs), there is, somewhat surprisingly, a paucity of papers on the topic. Obviously, whether endogenous costs of contracting are important will depend on the extent of the agency problems and on the institutional possibilities to correct for them, for example, whether the sponsor can perform *ex ante* and *ex post* audits, whether contracts can include enough contingencies, and whether the result of the audits can be used as contingencies in contracts. In recent years, there have been applications of this theory to public-private partnerships. These applications have focused on the costs and benefits of bundling the building and operation of infrastructure, as also surveyed in Section 2.

In Sections 3 and 4 we turn to analysing two key aspects of PPPs that have hardly been touched upon in the literature. First, many PPP projects are by essence exposed to political risks due to changing objectives, which often manifest themselves in cost overruns. In Section 3 we assess the potential of PPPs to remedy such soft objectives and to help avoid cost overruns. Second, although PPPs are also called PFI (for Private Finance Initiative), the financial dimension of contracting has – somewhat

surprisingly – been missing. We introduce financing in Section 4, borrowing insights from the recent financial contracting literature. We analyse the consequences of shifting the investment risk of public projects to private parties, and we look at the pros and cons of involving external (i.e., third-party) investors in the financing of PPPs.

## 2. New economics of regulation and contract theory: overview and applications to PPPs

### 2.1 Insights from the new economics of regulation and contract theory

The purpose of this section is to sketch insights from two strands of literature relevant for the analysis of contract design and risk transfer in PPPs. We will use these insights in subsequent sections.

***The new economics of regulation stress the trade-off between efficiency and rent extraction.***

One strand of literature is the 'new economics of regulation' associated in particular with the book by Laffont and Tirole (1993). This literature stresses the trade-off between efficiency and rent extraction when the regulated firm has an informational advantage. This advantage has two components. One is that the firm is better informed about itself than the regulator; the firm has thus information that is hidden from the regulator. The other is that the firm knows its actions but the regulator may not; in other words, the firm can take actions that are hidden from the regulator. Box 1 describes a simple version of this trade-off between rent extraction and efficiency in the presence of hidden information and hidden action.

This model can be extended to a dynamic setting and be used to analyse the consequences of limited commitment of the government, a topic to which we will return later on. Schmidt (1996) considers regulation with asymmetric information in a model *à la* Laffont-Tirole. Its starting point is that of a government owning a firm and being plagued by a commitment problem: the government cannot commit not to expropriate (public) managerial investment by lowering the price it offers the firm for its service.

Schmidt (1996) considers that the public firm is run by a utility-maximising manager, just as a privately owned firm would be. The manager may invest to improve efficiency, or in the notation of Box 1, the intrinsic efficiency parameter $\beta$ (that is taken as an exogenous random variable in Box 1). The key aspect of public ownership is that the government has access to all information about the firm after the efficiency-enhancing investment has been made (or not), so there is no asymmetric information**.** This is good in terms of short-term incentives because the trade-off between efficiency and rent extraction is avoided. But it means that the government completely appropriates any surplus generated *ex post* by managerial investment.

In this context, privatisation reduces the information the government can access about the firm. This allows the firm to appropriate an informational rent and induces it to underprovide effort $e$ compared to a situation where its intrinsic efficiency $\beta$ is known. Privatisation is thus bad for short-term or *ex post* incentives. However, a lower $\beta$ means a higher informational rent, so that privatisation and the asymmetry of information it induces raise the firm's incentives to invest in lowering $\beta$ (when it is possible to influence one's intrinsic efficiency), which is good from an *ex ante* incentive point of view.

The other strand of literature relevant for the analysis of contract design and risk transfer in PPPs is on 'incomplete contracting'. This literature is associated in particular with the papers by Grossman and Hart (1986) and Hart and Moore (1990) and also the book by Hart (1995). Its starting point is the work of Williamson (1975, 1985), which stresses that market relations are problematic when they require

**Box 1. The trade-off between rent extraction and efficiency**

Assume that the firm has an intrinsic productivity parameter $\beta$ and reports an accounting cost level $C$ such that:

$$C = \beta - e.$$

The cost level $C$ is thus influenced not only by the firm's intrinsic productivity parameter $\beta$ but also by a level of effort $e$, costly for the firm and which it privately chooses (the firm's choice of $e$ is a hidden action). To be specific, define $\psi(e)$ (increasing and convex in $e$) to be the cost of effort for the firm. In this simple example, productive efficiency requires:

$$\psi'(e) = 1.$$

Such an outcome can be achieved through a fixed-price contract, whereby the firm gets a fixed amount of money for its services and therefore is residual claimant on its cost savings. Such a high-powered incentive scheme, while good in terms of efficiency, does imply a potential problem when the regulated firm has private and, thus, hidden information on the parameter $\beta$. In this case, an excessively generous price allows a 'low-$\beta$ firm' (i.e., a firm with a high intrinsic productivity) to keep any productivity advantage $\Delta\beta$ (which is then the informational rent of the firm) while a lower price runs the risk of inducing a 'high-$\beta$ firm' (i.e., a firm with a low intrinsic productivity) to shut down.

As Laffont and Tirole (1993) have shown, one way to get around this challenge and limit rents while making sure the service is always provided is to offer a not-too-generous price, but with an option to move (partly) to a cost-plus contract (which is a low-powered incentive scheme) in case the firm claims to have a relatively high $\beta$. In essence, what is offered to firms is a menu of contracts designed so that firms with a high intrinsic productivity choose high-powered incentive schemes whereas those with a lower productivity choose a low-powered incentive scheme. The advantage of such an approach is that it lowers the rents to be conceded to the 'low-$\beta$ firm' while guaranteeing that the service is provided. Its disadvantage is that when less intrinsically productive, the firm reduces its effort since it knows that part of the cost saving is shared with the regulator through the partial cost-plus scheme.

relation-specific investments while taking place in a complex environment. This complexity makes contractual incompleteness unavoidable, leading to underinvestment in the relationship due to the fear of *ex post* 'hold-up'. Specifically, higher investment by one party can trigger tougher *ex post* bargaining by the other party, which is tempted to grab a share of the surplus generated by the investment. Incomplete contracts typically fail to fully protect the parties against such opportunistic behaviour when it is difficult for a court to distinguish good-faith renegotiation demands (for example, when exogenous market conditions have changed) from bad-faith ones (those specifically triggered to take advantage of higher investment by the other party).

***The theory of incomplete contracting suggests that market relations can result in too little relation-specific investment.***

Without considering the details of intra-firm relations, Williamson stressed that a way out of the underinvestment trap was to resort to integration. Grossman, Hart and Moore (hereinafter GHM) take a more symmetric view of inter-firm and intra-firm relations by considering two (or more) individuals who each have to make relation-specific investments in a situation where the firm structure is defined by asset ownership. Asset ownership is assumed to confer residual rights of control over the asset, and it motivates individuals to invest by giving them bargaining power *ex post* (since they retain control over the asset they own in case of disagreement) and thus higher returns on their investments.

Integration is not a panacea, however: while being a 'boss' and owning one's asset as well as the other party's asset raises one's incentives to invest, *mutatis mutandis*, having a 'boss' reduces one's incentives to invest.

The literature therefore stresses that in a simple two-party world when (i) one party's investment is much more important than the other's, integration is the optimum with the former party as boss, whereas when (ii) both parties' investments are roughly equally important, separation is the desirable outcome. These results assume that both parties have large levels of wealth and can optimally trade ownership of assets *ex ante*. With limited liability or wealth, the transfer of ownership may not be efficient in the sense of maximising the total expected surplus from the relationship.

***The new economics of regulation and incomplete contract theory provide important lessons for contract design and risk transfer in PPPs.***

To conclude, the new economics of regulation and incomplete contract theory provide four lessons relevant for the analysis of contract design and risk transfer in PPPs. First, when information is asymmetric, the regulator faces a trade-off between the goal of reaching an efficient supply of the regulated economic activity and the goal of extracting part of the regulated industry's informational advantage. As we will see in the next section, the government faces a similar trade-off when procuring public services under a PPP. Second, as contracts are incomplete, there is a trade-off between *ex post* decisions rights and *ex ante* effort choices, implying that if economic agents have *ex post* decisions rights, they will exert greater efforts *ex ante*. Third, as public owners of an asset cannot commit not to expropriate the returns on managerial effort, private ownership may be best. Fourth, the choice of contracts modifies project returns or their distribution and, thus, impacts on endogenous project risks.

While the literature reviewed so far captures important dimensions of the constraints in contracting for public-private relationships, two important dimensions are missing: (i) the bundling of decision rights for building and operating an asset and (ii) the shifting of investment risk from the public to the private sector. We will address the first issue in the next sub-section and the second issue in Section 4.

### 2.2 Application to PPPs: bundling decision rights

Abstracting from short-term political motives, the value for the public sponsor of a PPP lies in the cost and the quality of the service produced, with cost and quality depending on the financing, building, and operation of the project infrastructure used for delivering the service. There are clear links between financing, building, and operating the infrastructure. To illustrate, building determines the quality of the infrastructure, which – in turn – influences positively or negatively the cost of operating and maintaining it: a high-quality infrastructure may make its maintenance technically challenging and costly – for instance requiring skilled workers – or it may ease maintenance by lowering the likelihood of failure; on the other hand, a poorly designed bridge or a poor cement quality may raise the risk that the bridge collapses during a storm.

Unless the party responsible for building is induced to internalise possible externalities on the operating phase of the infrastructure, inefficiencies may arise. The potential cost of these inefficiencies can be large, for instance, when poor construction raises the risk of a bridge collapsing during a storm. As recent work has shown the builder has an incentive to internalise externalities if he also has the right to operate and maintain the infrastructure.

There are two strands in the literature on the bundling of decision rights that echo the two approaches reviewed in Section 2. One focuses on the role of asymmetric information and analyses how informational rents and incentives to undertake efficiency-enhancing efforts change if building

and operating decisions are separated. The other strand focuses on the role of contract incompleteness for the efficient allocation of decision rights. In what follows we will discuss both strands of literature. In addition, we investigate the role of PPPs in limiting cost overruns and ask to what extent avoiding cost overruns is desirable in the first place.

### 2.2.1 The role of asymmetric information

***PPPs can mitigate or exacerbate inefficiencies arising from asymmetric information.***

There can be two types of information asymmetries: hidden information and hidden action. In the former, an economic agent has superior information compared to other agents. In the context of PPPs, we could think of a situation where the government agency procuring a service has private information about service delivery costs that the firms bidding for this PPP do not have. With hidden action, an economic agent can take actions that are not observable by other agents. A case in point is an effort by a builder to cut construction costs even if this leads to higher operating costs. It should be added that hidden information and hidden action are closely related to the possibility of adverse selection and moral hazard, respectively. In what follows we look at two papers (Iossa and Legros 2004 and Bentz *et al.* 2002) that consider adverse selection and moral hazard in a world where complete contracts can be written. Both papers consider a sequential contracting setting in which effort in the first period is valuable for operation in the second period; both papers also stress private information about operating costs.

Iossa and Legros (2004) present a general model of regulation under soft audit information, but it can be easily applied to PPPs. There are two periods, and one can think of the first one as the building stage and the second one as the operating stage of an infrastructure project. The public sponsor of the project can allocate the right to operate to the builder or another agent (call this an entrant). An entrant does not have information about building effort in the first period but may acquire it by doing costly auditing.

In these circumstances, it is optimal to give the potential entrant the option to buy the right to operate the project in the second period and to have the builder (i.e., the first-period agent) receive the monetary payment from the operator in this case. If the entrant does not exercise his option, the builder continues to operate the asset. The entrant exercises his option if auditing shows that the underlying asset is in a good state: this solves both the problem of revelation in the second period and also induces the entrant to exert audit effort. Because the builder collects a high monetary payoff when the entrant exercises his option to operate, this contract provides incentives for effort in the first period. The model therefore suggests that creating competition for the right to operate the asset dominates contracts where one party both builds and operates the asset and contracts where one party builds and the other operates the asset. Key assumptions of this model are that information about the outcome of the building stage of the project can be obtained only through third-party audit and that information about the outcome of the operating stage is hard to verify.

In Bentz *et al.* (2002), the operator learns – without incurring costs – whether operating costs will be low or high; in the latter case, he can exert effort during the building phase with a view to cutting operating cost. For instance, the builder of a bridge may learn during the building phase of a new technology that will reduce the stress on the beams and therefore decrease maintenance costs. This leads to two types of inefficiencies in contracting. First, since the operator privately knows whether operating costs are high or low, even an optimal operating contract will leave an informational rent with the operator (as in the model of Box 1). Second, since there is moral hazard at the building stage with positive probability, the builder needs to be given incentives to invest in the reduction of operating cost; note that such incentives may be inefficient if the increase in the probability of lowering operating cost is small relative to the required investment.

Bentz *et al.* define a PPP as the ability to contract with only one agent, the consortium, who builds and operates the infrastructure. Without a PPP, the (risk-neutral) builder contracts without private information and, as a result, has to be paid only for the expected cost of the investment; but the informed operator gets an informational rent to reveal operating cost, enabling him to give incentives to the builder. Under a PPP, the builder-operator consortium knows at the contracting stage whether investing in the new technology can be helpful or not; this raises the informational rent to be conceded. On the other hand, an advantage of a PPP is that the consortium will invest 'for free' to obtain this informational rent. The main result is that when the cost of investment is low, a PPP is better (because the first effect dominates); otherwise it is worse (because the second effect dominates).

### 2.2.2 The role of incomplete contracting

***PPPs can mitigate or exacerbate inefficiencies arising from incomplete contracts.***

We now change perspectives by looking at two papers (Hart 2003 and Bennett and Iossa 2004) that assume symmetric information but account for the fact that contracts are incomplete. Both papers use the GHM paradigm to investigate the effects that the bundling of decision rights has on the incentives for investment in cost savings and quality improvements. The public sponsor (the government), the builder, and the operator have conflicting preferences for these investments: the private parties tend to consider mainly the cost effects of these investments while the sponsor also cares about the social benefits they bring. For instance, adding a traffic lane on a bridge may reduce congestion, but will increase significantly the cost of building the bridge.

Box 2 summarises Hart's model. In his model, the builder can make two types of non-contractible investments that would result in lower operating costs: one investment ($e$) not only lowers operating costs but also leads to an increase in the social quality of the service, another ($i$) cuts operating costs at the expense of service quality. Therefore, while both investments reduce operating costs, only $e$ brings social benefits. For instance, in the bridge example, $e$ can be the use of a new technology that reduces the stress on the beams, which is socially valuable since it lowers the frequency of repairs and, thus, of traffic interruptions; $i$ can be the use of a design with fewer traffic lanes, which lowers the cost of cleaning, painting, and maintaining the bridge but increases traffic congestion.

Hart chooses a parameterisation that makes investment $i$ socially wasteful independent of its cost. However, such an investment may not be wasteful for the contractor if the cost of investment is small enough. The benefit of bundling construction and operation of an infrastructure asset under a PPP is to induce the builder to internalise the savings in operating cost. But this comes at the expense of service quality, which – in Hart's model – outweighs operating cost savings. In these circumstances, traditional public procurement results in the socially optimal level of this type of investment ($i = 0$). That said, bundling also induces the builder to internalise the positive effect of $e$ on operating cost; and as this investment improves the quality of the service, it is socially beneficial. In other words, bundling construction and operation under a PPP contract leads to a higher level of the socially beneficial, quality-improving investment than traditional public procurement.

So, if a PPP stimulates both the socially desirable and the undesirable investment, when is a PPP better than traditional public procurement? Hart concludes as follows: (i) if the cost-cutting, quality-improving investment $e$ can be verified, traditional procurement is better than a PPP because $i = 0$ is optimal and $e$ can be set at the efficient level by contracting with the builder; (ii) instead, if the cost-cutting though potentially quality-shading investment $i$ can be verified, PPP dominates traditional procurement since the contractor has better incentives to carry out the quality-improving investment ($e = 1$).

**Box 2. Public-private partnerships – insights from Hart (2003)**

At the operating stage of an infrastructure asset, the benefits ($B$) of the service to society and operating costs ($C$) incurred by the operator are as follows:

$$B = B_0 + e - i$$
$$C = C_0 - e - i$$

$B_0$ and $C_0$ are the normalised benefits and costs when none of the two investments are realised. Assume that $e$ and $i$ take values in {0,1}, a value of 1 meaning that the investment is made. Further assume that the costs of carrying out the non-contractible investments are $c_e$ and $c_i$. The optimal outcome involves choosing $e$ and $i$ so that social benefits are maximised, with social benefits being the difference between the benefits of the service, on the one hand, and operating cost and the cost of investing in a reduction of operating cost on the other hand. In other words, the optimal outcome involves choosing $e$ and $i$ to solve:

$$max\ B - C - (e\,c_e + i\,c_i)$$

This means choosing $i = 0$ for all $c_i$ (because the cost-reducing investment is costly and its net social value is 0). On the other hand, $e$ (i.e., the investment that lowers operating cost and raises the quality of the service) does improve social benefit if it is not too costly. Specifically, we should have: $e = 1$ if $c_e < 2$.

How does contracting for a PPP (under which the right to build and operate the asset is given to one party) and traditional public procurement (under which the public sponsor contracts first with a builder and then with an operator) fare in comparison with this optimal outcome?

Under traditional procurement, the builder does not internalise the impact of $e$ and $i$ on operating cost and service quality and, thus, chooses $e = i = 0$. He therefore chooses the right level for $i$ but underinvests in $e$. The government ends up paying $C_0$ at the operating stage, and society obtains a surplus of $B_0 - C_0$.

Under a PPP instead, at stage 1, the contractor internalises the effect of $e$ and $i$ on operating cost and, therefore, chooses $e$ and $i$ to minimise $C + ec_e + ic_i$. Consequently, he chooses $i = 1$ if $c_i < 1$ and $e = 1$ if $c_e < 1$. Under a PPP, one may thus end up with the optimal level of $e$ but too much of the quality-shading investment $i$.

***PPP introduces a long-run profit motive, which can lead to good or bad results.***

Hart's setting is thus similar to that of Hart *et al.* (1997) on privatisation: by giving ownership of the second stage (i.e., the operating stage) to the first-stage contractor (i.e., the builder), PPP introduces a long-run profit motive. This is what makes it attractive for the first-stage contractor to potentially invest in quality improvement and cost savings. Of course, this is good only insofar as private and social interests are aligned. In fact, Hart *et al.* show that the profit motive can lead to good or bad results. To make this point they consider a multitask model *à la* Holmström and Milgrom (1991), namely the government cares not only about cost efficiency but also about quality provision. Privatisation strengthens incentives, which means that cost efficiency is improved, but if quality is non-contractible (or if not all aspects of quality can be contracted on), it may be sacrificed as a result. Hart *et al.* argue that the optimal ownership outcome depends on the nature of contract incompleteness: private ownership is better if cost efficiency is key and quality can be more or less controlled by the contract. In the opposite circumstances, public ownership may be preferred.

The main contribution of Bennett and Iossa (2004) to the literature on the allocation of ownership rights and to the literature on PPP is the observation that in the presence of externalities (for example when actions at the building stage affect the operating stage of a project or when actions at the building/operating stage affect service quality), giving ownership rights to an agent may decrease his bargaining power if the outside option of the other party is high because of the externality. Bennett and Iossa emphasise the role of renegotiation and the right of the owner to accept or refuse implementing a cost-cutting improvement.

The gist of the Bennett-Iossa model can be summarised as follows. Let us first recall that under a PPP the builder and the operator are the same entity – they form a consortium. By contrast, in the case of traditional procurement, the builder (first-period contractor) and the operator (second-period contractor) are two different entities. The builder suggests an innovation that reduces his cost and that is also socially beneficial – for instance the use of beams made of new alloy that lower the probability of them breaking. Furthermore, the innovation affects operating costs. In this regard, Bennett and Iossa distinguish two cases: in one the innovation at the building stage raises operating costs, in the other it lowers them; to illustrate, the new alloy may require more frequent painting than regular alloy, thus raising operating costs.

With bundling, the consortium (consisting of the builder and operator) will consider the overall effect of the innovation on costs. If the innovation at the building stage raises operating cost, the consortium will have lower incentives to innovate than a builder under traditional procurement since he can realise a larger cost reduction than the consortium. In these circumstances, traditional public procurement may be the better choice from society's viewpoint. By contrast, if the innovation at the building stage lowers operating cost, bundling dominates traditional procurement because the consortium internalises the effect of an innovation that reduces operating cost and, at the same time, is socially beneficial; it is worth adding that this result holds irrespective of whether the public or the private sector owns the infrastructure.

## 3. Can PPPs remedy soft objectives and cost overruns?

***Transferring ownership to the contractor under a PPP could provide protection against political risk.***

Another source of contractual incompleteness that may influence the choice of procurement is a possible change in the objectives of the parties. To illustrate: a highway from point *A* to point *B* could be viewed as the right design when the sponsor invites contractors to bid for the project, but large migration or relocation of industries may make a highway from *B* to *C* the better design when project implementation starts. This could suggest that transferring ownership to the contractor reduces the risk associated with a change in objective of the sponsor. In that sense, transferring ownership to the contractor under a PPP could provide protection against political risk or 'soft objectives'.

However, this view assumes that there is no way to protect *ex ante* the contractor under traditional procurement against such a change in objectives. Furthermore, since protection has to be provided when ownership rights are allocated, it is not clear that PPP is the best contract. As the example in Box 3 illustrates, a PPP also creates a hold-up problem: the contractor may choose to start working on a design that will maximise his expected payoff in case the sponsor changes his mind and enters into a renegotiation with the contractor. The free-rider problem makes it too costly for the sponsor to protect the contractor against changes in design, and traditional procurement is preferred.

That said, PPPs have potential to help avoid cost overruns resulting from soft objectives. We will now turn to examining how and under what circumstances this can be the case.

**Box 3. PPP is not a foolproof protection against 'soft objectives'**

Consider a highway that can be designed in two ways: design *A* and design *B*. The public sponsor will prefer design *B* with probability $\pi$, with $\pi < 0.5$ (this is without loss of generality). The sponsor has an additional utility of *v* if his preferred design is implemented. The initial contract specifies the price *p* for delivery of a highway whose design will be decided 'along the way'. After the contract is signed, the contractor starts working towards a specific design. While the total cost is the same for each design, there is an adjustment cost *a* (with $a<v$) if the contractor has to adapt his work to a new design. The contractor would have to bear the adjustment cost unless there are contractual provisions to the contrary.

Under traditional procurement, the sponsor has decision rights. If the contractor invests in design *A*, and the sponsor learns that he would like design *B*, the contractor suffers a cost of *a* and his expected payoff is

$$U^{trad}(p) = (1 - \pi)\, p + \pi\, (p - a).$$

Since $\pi < 0.5$, it is never optimal for the contractor to start working towards design *B*.

Under a PPP, the contractor has decision rights and is only obliged to deliver the highway while the sponsor is obliged to pay a price *p*. Suppose the contractor does preparatory works on design *B*. If the sponsor learns that his preferred design is *A*, the contractor can extract *v* from the sponsor for changing the design and his expected payoff is

$$U^{PPP}(p) = (1 - \pi)\, (p + v - a) + \pi\, p.$$

The contractor does not want to start work on design *A* since he will extract *v* from the sponsor with a lower probability ($\pi$ rather than $1 - \pi$).

Suppose that the competitive payoff to the contractor is $\underline{u}$. Under traditional procurement, the price will be $U^{trad}(p^{trad}) = \underline{u}$ for highway delivery, and the contractor will start work on design *A*. Expected payoffs are then $\underline{u}$ for the contractor and $v - p^{trad} = v - \underline{u} - \pi a$ for the sponsor (recall that the sponsor does not have to pay the contractor for a change in design).

Under a PPP, the price will be such that $U^{PPP}(p^{PPP}) = \underline{u}$ and the contractor will start work on design *B*. The final payoff to the contractor under a PPP is still $\underline{u}$, but the sponsor has a payoff of $v - p^{PPP} - (1 - \pi)v = v - \underline{u} - (1 - \pi)a$ (note that the contractor will extract *v* when there is renegotiation, but this is compensated by a lower initial price). This is less than what the sponsor gets under traditional procurement, because here PPP leads to a strategic, but inefficient, choice of design *ex ante*. It follows that the sponsor chooses traditional procurement.

Large projects seem to be plagued by cost overruns (see for example Peck and Scherer 1962 and Flyvberg *et al.* 2003). When the initial contract specifies a cost target and when there is uncertainty about the performance of the technology that will be used for building and operating the project (or about other variables that affect the project), it is a tautology that *ex post* cost realisations will differ from the target. Against this background, one may ask why initial contracts do not specify finer contingencies and why the sharing of cost overruns is settled through *ex post* negotiation rather than *ex ante* refinement of the contract.

Some observers (Flyvberg *et al.* 2003, for instance) have suggested that cost overruns are due to the desire of firms to get the contract and, therefore, to bid well below what they expect the cost of delivering the project to be. We know from Laffont and Tirole (1993) and other work on auctioning procurement contracts that cost-plus contracts could correct for this problem and force the firms to bear the risk of too optimistic bids. However, that literature assumes that the parties can commit to the cost-plus contract; if firms are financially constrained or can hold up the sponsor at the stage of renegotiation,[1] cost-plus contracts may be sufficiently constrained with respect to the risk that can be shifted to the bidders and, thus, bids may turn out to be too optimistic.[2]

Another explanation for cost overruns could be that costs are not observable *ex post* and that cost-plus contracts depend on the willingness of the contractor to reveal his costs in a verifiable way, or on the efforts of the sponsor to audit. Without audit, the contractor has little incentives to report 'good' news and will only announce 'bad' news, i.e., cost overruns. Audit may modulate this conclusion, but since audit is costly, some of these effects may explain why we often see cost overruns in practice.

***Changes in the design of projects after awarding contracts often explain cost overruns.***

A third explanation is related to the endogenous choice by the sponsor of the objectives the project should fulfil, for instance, the design of a highway, its exact location, and the building material. Changes in objectives and, thus, the design of projects are often cited as a source of cost overruns in procurement. For example, Ganuza (2003) cites an empirical study on public works in Spain showing that close to two-thirds of cost overruns can be traced to changes in design during construction. One could argue that transferring decision rights to contractors under a PPP is a means of avoiding cost overruns that result from changes in objectives under traditional procurement. Indeed, the success of PPPs in delivering projects on time and budget more often than traditionally procured projects is frequently stressed as one of their main strengths (see NAO 2003, for instance). But what are the mechanisms that give PPPs an advantage in this respect, and is avoiding cost overruns an unmixed blessing?

To shed light on these questions, we start by noting that the literature on property rights emphasises the role of *ex ante* contracting on *ex post* outcomes and *ex ante* efficiency when renegotiation cannot be prevented. In the simplest models, renegotiation leads to an efficient decision independent of the bargaining power of the parties. However, despite this *ex post* efficiency, *ex ante* outcomes may be inefficient since the agents taking actions (the builder, for example) will consider their own marginal future benefits.

Besides this *ex ante* inefficiency, there will also be an *ex post* inefficiency if bargaining takes place under asymmetric information, a case of concern for PPPs. For instance, the sponsor may not know the quality of the investment made by the contractor before the bargaining starts, or the contractor may not be aware of future budgetary constraints that are known by the sponsor. In this case, the efficiency of bargaining will depend on the outside options of the parties, which are given by the initial contracting terms. There is then a trade-off between specifying many contingencies in the initial contract – which is usually positive in the absence of renegotiation – and modifying the outside options of parties – the effect of which is ambiguous when renegotiation cannot be prevented and when there is still asymmetric information.

The issues of transparency, specification of strict performance targets, and completeness of contracts are key elements of the European Directive for public work contracts (European Commission green

1 This may be so, for instance, if the project becomes 'too big to fail' from a political point of view.

2 This reasoning has been advanced in the recent auctions for wave spectrum, where bidders may have felt that they could submit an 'optimistic' (i.e., high) bid for spectrum because they reckoned that they did not bear the downward risk of no-payment.

paper 1986 and the 2004 Directive).[3] There, the main concerns are about the ability to increase competition for public work contracts. In the presence of agency costs and renegotiation, we want to point out that *ex ante* transparency is also subject to incentive problems. For instance, while a sponsor may learn about his preferred design for a highway by making the right surveys and developing models that will take into account the evolution of economic variables like the cost of petrol, the growth of urban population, and the effect of corporate taxes on the location of firms and industries, these studies are expensive and time consuming. The sponsor may then decide to wait and negotiate a change in design rather than invest *ex ante* with a view to giving more information to the potential contractors. Clearly, the decision to invest (or not) in acquiring information also depends on the benefits to the sponsor of having better-informed potential contractors. The main benefit are a lower probability of having to renegotiate the design after the contract has been awarded and the effect that information may have on the behaviour of contractors bidding for contracts, such as PPPs. As we show in Box 4 (based on Ganuza 2004), the effect of more information on bidding behaviour is a function of the competitiveness of the bidding process.

***Cost overruns are not necessarily bad.***

More specifically, the role of competition is to increase the probability that the winning bid is low, which implies – from an *ex ante* perspective – low rents captured by the winning firm. However, if the design is poorly specified, the surplus that has to be shared *ex post* – when the sponsor knows his preferred design – is large. Since the sponsor can avoid paying large *ex ante* rents when competition is stronger, he has an incentive to specify and commit to a design in order to avoid paying *ex post* rents to the contractor. Simple cost-benefit analysis may therefore explain why the design of projects – whether traditionally procured or launched as a PPP – may be renegotiated and lead to cost overruns even if such *ex post* costs could be avoided by investing *ex ante* in acquiring information. To put it differently, cost-benefit analyses of specifying a design and of keeping it suggest that observed cost overruns may be welfare-enhancing, equilibrium outcomes.

This example illustrates, first, that cost overruns should be expected in particular when *ex ante* competition is limited. In these circumstances, introducing a private monitor, such as outside shareholders and creditors, in PPPs may be particularly desirable. We will return to the role of external finance in PPPs in Section 4. Second, note that the possibility of private-public contracting may modify, for the reasons we developed above, the expectation of cost realisations but also their variance. Therefore, the sponsor's incentives to invest in specifying the design and to maintain it may be reduced, leading in the end to more observed cost overruns. This suggests that we should treat carefully the relationship between cost overruns and the efficiency of contracting. What matters is the *ex post* quality and costs of projects. A project of a given quality costing 200 without cost overruns is less desirable than a project with the same quality planned to cost initially 100 and experiencing a 50-percent cost overrun.

The analysis has so far assumed that the structure of costs is independent of contracting (PPP *vs.* traditional). However, as we will emphasise in the next section, traditional contracting modifies the claims to the financial returns of the project and often requires the contractor to use third-party finance. A potential benefit of traditional contracting may then be an increase in cost discipline: indeed, since the (private) financier does not internalise some of the social benefits – as the sponsor would do if he were financing directly the project – he has generally more incentives to engage into cost-monitoring or cost-saving initiatives.

3 The performance of contracts based on objective measures of performance or 'scores' is beginning to be analysed in the literature (for example, Cantillon and Asker 2003).

**Box 4. Project design, cost overruns, and competition**

Suppose there are two firms *A* and *B* that can bid for procurement of a public service. Like in Box 3, consider two potential designs for a highway: *A* and *B*. But now suppose that firm *k* (*A* or *B*) is specialised in design *k*: it has cost *c* of procuring design *k* and cost $c + a$ (where *a* stands for 'additional cost') for procuring the other design.

The sponsor has valuation *v* for having the right design and zero for the wrong one. *Ex ante*, there is an equal chance that the sponsor will prefer design *A*. The sponsor can invest *ex ante* to learn about his preferred design, for instance by doing macroeconomic simulations of labour demand, collecting information about the reliability of different designs, etc. We assume – to make the case most difficult for us – that this *ex ante* investment is not costly for the sponsor.

Contractors know whether the sponsor knows his best design and then bid for the contract. If the design is not specified and firm *A* is selected, there is a 50-percent chance that the sponsor learns that design *B* is best: we assume that renegotiation enables the firm to extract a compensation *r* from the sponsor (obviously $r \leq v$). If the sponsor knows his preferred design he specifies it prior to the bidding stage. We consider both situations in turn.

Suppose the design is not specified: the two firms are in fact in a symmetric situation since they each face renegotiation with probability ½. Competing for the contract leads them to offer a price $p = c + (a - r)/2$ and the sponsor obtains $v - r/2 - p = v - c - a/2$.

We now turn to the other situation. If the sponsor specifies the design prior to bidding, the two firms are no longer symmetric: for instance if design *A* is specified, firm *A* can bid slightly less than $p = c + a$ and gets the contract. Firm *A* obtains a rent of *a* while the sponsor has a payoff of $v - c - a$, which is strictly less than what he gets when the design is not specified.

Hence, even if there are no cost of specifying the design, it is better for the sponsor to keep the firms in a symmetric situation: this increases competition for the contract between the firms, though the sponsor must accept an increase in the likelihood of renegotiation or cost overruns.

## 4. The financial side of PPPs

***The theoretical literature on PPPs has given little attention to the financial dimension of contracting.***

While the theoretical literature on PPPs discusses at length the incentive consequences of bundling the construction and operation stages of service provision, it is surprising that it does not deal more explicitly with the other key aspect of PPPs: that the government relies on private sector finance. This is indeed an important dimension of PPPs, which has led to the name used for them in the United Kingdom: Private Finance Initiative (PFI).

What are the economic consequences of private finance for providing public services? In political economy terms, it is clear that PPPs have been attractive for governments trying to make their accounts look good, thereby (ab)using public accounting rules that do not correctly capture government assets and liabilities. PPPs then create the impression that public debt has not grown as much following an investment project. We will abstract here from such public accounting motives since they do not alter the efficiency of PPPs (see for example the discussion in Välilä, this volume). We will instead analyse the real impact of financing modes on economic outcomes, with the analysis proceeding in two steps: Section 4.1 considers the rationale of risk sharing between the public

and the private sectors and the consequences of risk-bearing arrangements on incentives for PPP contractors; Section 4.2 examines how private finance affects these incentives.

### 4.1 Is it good to transfer risk to the private sector?

Can we justify the financing pattern of PPPs from a risk-sharing viewpoint? Note first that the total risk to be borne by society as a whole is given once the project has been identified and incentives are taken as given. Risk-sharing arrangements thus offer no 'free lunch': the total risk has to be borne.

***Pure risk-sharing considerations do not seem to offer a justification for PPPs.***

Having said this, we know that optimal risk sharing means it is efficient for less risk-averse parties to take a bigger proportion of the risk. One could argue that the government should be less risk averse than private operators, for which large infrastructure projects would potentially imply large risks that are not easy to diversify. This casts doubts on the government's ability to save money through PPP financing schemes. Instead, one should expect the private contractors to demand a higher remuneration from the government for having to bear significant risks. Moreover, private contractors will face less favourable financing conditions in capital markets because they are 'worse risks', having a higher default probability than the government, which benefits from its ability to tax. Pure risk-sharing considerations, therefore, do not seem to offer a justification for PPP.

It is worth adding a qualification, however. It is of course too simple to consider the government risk neutral. If we consider the cost of taxation to be convex in the tax rate (Barro 1990), the government is anxious to stabilise its tax rate across 'states of the world'. This idea has been used, for instance, to look at optimal public debt indexing policies as a function of the correlation between unexpected inflation and real GDP growth. With this perspective, it is reasonable to think of much of the random component of the returns of specific public projects as uncorrelated with macroeconomic performance, so that one could argue that risk neutrality of the government is not an unjustifiable assumption.

Classical agency theory then tells us how to think about the relationship between risk sharing and incentives in optimal contracting. From a pure risk-sharing perspective, a risk-neutral government should bear all the risk. This is the solution that maximises efficiency, but also the one giving the government the highest payoff. If the contractor can be limited to its competitive (i.e., 'individually rational') payoff, the government will end up paying the risk premium to the contractor for his risk bearing. It is thus in the interest of the government to insulate the contractor against exogenous risk.

In reality, the problem comes from the difficulty of disentangling exogenous risk from endogenous risk, that is, what the contractor can influence through his action. In Section 3, we have looked at endogenous risk but assumed for simplicity that the contractor was risk neutral; this allowed us to abstract from risk-sharing considerations. Classical agency theory instead focuses on the trade-off between risk sharing and incentive provision (see for example Mirrlees 1975 and Holmström 1979, 1982). It assumes that the outcome delivered by the agent (the contractor in our case), in terms of cost and quality for example, is a random variable, but with its distribution being a function of the effort exerted by the contractor. When setting up the contract, the government has to trade off risk-sharing and incentive-provision considerations. Indeed, when effort is not contractible, passing on no risk to the contractor will lead to zero effort.[4]

4 For completeness, note that we normalised to zero the effort level the contractor would choose in the absence of any financial reward. We thus concentrate on 'costly effort' or, equivalently, we focus on a situation where the government benefits from the effort exerted by the contractor and therefore induces him to exert more effort than he would 'naturally'.

***Optimal risk sharing implies that the marginal cost of shifting risk from the public to the private sector equals its marginal benefit.***

At the other extreme, having the contractor bear the whole risk induces him to fully internalise the benefits of his efforts since he is the residual claimant of these benefits. But this is disastrous in terms of risk sharing, and the government will have to pay a sizable risk premium if the contractor is very risk averse. The optimum is to find a middle ground, where the degree of risk sharing is such that the marginal loss incurred by shifting risk from the government to the contractor equals the marginal gain from increased effort by the contractor. Details of this trade-off between risk sharing and incentive provision are set out in Box 5. In the solution, we can see that the amount of risk borne by the contractor depends on three variables: the exogenous randomness of the contractor's performance (i.e., its variance $\sigma^2$), the contractor's degree of risk aversion ($\eta$), and his cost of effort ($c$).

More specifically, the risk borne by the contractor decreases as the exogenous randomness of performance rises. Indeed, a higher variance means that performance becomes less informative about the chosen effort level. Thus, a given rise in the variable component of the contractor's compensation, and his effort level, implies a proportionately higher risk bearing. Giving the contractor more incentives for effort provision is the more expensive, the higher the exogenous randomness in performance. And then, the risk borne by the contractor decreases with a rise in the contractor's risk aversion. Intuitively, giving the contractor more incentives to exert effort is the more expensive the higher his risk aversion is; this is because the higher his risk aversion, the higher the risk premium for each unit of risk. Finally, the risk borne by the contractor decreases with the contractor's cost of effort, which is again intuitive: a given increase in the contractor's effort involves a higher exposure to risk (and associated increase in the risk premium).

These results have other implications. First, any means of creating a more precise relationship between performance and effort is valuable. It is therefore a good idea to neutralise the effect on the contractor's compensation of purely random shocks that can be independently observed.[5] Independent observations are important, otherwise the government and/or the contractor would be inclined to temper with the observation to increase their own payoff at the other's expense.

Second, there may be indirect ways to improve performance measurement. A natural one is relative-performance evaluation, meaning that the contractor's pay is based not only on his absolute performance but also on his performance relative to a benchmark. In this respect, there is value in having competition in the market, because competitors provide a natural benchmark. To be specific, we could add to the setting presented in Box 5 another contractor whose performance is also linear in effort, with an additional error term that is normally distributed. It can then be shown[6] that each contractor's performance should enter negatively the other contractor's compensation scheme whenever the two performance levels, conditional on their respective efforts, are positively correlated. This is intuitive: one can think of this positive correlation as a common random shock that affects both performance levels. For a given performance of one contractor, the higher (lower) the performance of the other contractor, the more probable the common shock was positive (negative), so that it makes sense to neutralise the effect of the common shock – at least partly – rather than rewarding (punishing) the contractor for good (bad) luck. It is only when the two performance levels are conditionally independent that relative-performance evaluation is suboptimal because it would only add randomness to the contractor's compensation.

Relative-performance evaluation is thus about partly filtering out common shocks to lower the risk borne by each contractor for a given strength of incentive pay. Its goal is not primarily to induce contractors to work harder by pitting one against the other. But it is true that the availability of

5 On the other hand, it can be shown that optimal contracts typically should include all 'relevant' contingencies, namely all variables that improve the correlation between effort and performance, however meagre their contributions in this respect (see Holmström's classical 1979 and 1982 papers on the subject).

6 See for example Bolton and Dewatripont (2005, chapter 8).

another contractor's performance measure leads to higher effort at the optimum by strengthening the relation between individual effort and performance. Note a caveat, however: one should make sure to avoid collusion between contractors; when relative-performance evaluation is used,

**Box 5. The trade-off between risk sharing and incentive provision**

Consider the performance of the agent (a contractor in our case) to be $q = e + \varepsilon$, where $e$ is effort and $\varepsilon$ is a normally distributed error term with zero mean and variance $\sigma^2$. Assume effort $e$ costs the agent $ce^2/2$. Suppose the risk-neutral principal (the government in our case) offers the agent a linear contract, $w = t + sq$, where $t$ is the fixed compensation level and $s$ the variable, performance-related component of compensation. The agent is assumed to have a utility function of the constant absolute risk-aversion type, which means that the payoff he derives from the contract can be written as

$$E(w) - \eta Var(w)/2 - ce^2/2.$$

So the agent's payoff depends on his expected compensation, $E(w)$, minus a risk premium (which equals the variance of this compensation, $Var(w)$, times half of his coefficient of absolute risk aversion $\eta$) and the cost of effort $ce^2/2$. With the linear contract introduced above and the assumptions about $q$ and $\varepsilon$, the agent's payoff can be written as

$$t + se - \eta s^2\sigma^2/2 - ce^2/2.$$

The agent's optimisation problem is to choose his effort $e$ so that his payoff becomes as large as possible. It is easy to show that, faced with a variable compensation $s$, the agent's optimal effort will be $e = s/c$. The agent thus raises his effort with an increase in the performance-related pay, and he would exert no effort ($e = 0$) if the principal offered only a fixed payment $t$ and no performance-related reward ($s = 0$).

Turning to the principal's optimisation problem, it is obvious that he wants to maximise the difference between the performance of the agent $q$ and the compensation $w$ that he pays the agent. The choice variables of the principal are $t$ and $s$, but in choosing them he has to consider that the agent can get an outside certainty-equivalent compensation $w_0$, which implies that the agent's expected payoff under the contract has to be a least as high as $w_0$. The principal's optimisation problem is thus:

$$\begin{aligned} &Max_{\,t,s}\ E\,(q - w) \\ &s.t. \quad E(w) - \eta Var(w)/2 - ce^2/2 \geq w_0 \ \text{ and } \ e = s/c. \end{aligned}$$

With the notation introduced above and $e = s/c$, this can be rewritten as:

$$\begin{aligned} &Max_{\,t,s}\ s/c - (t + s^2/c) \\ &s.t. \quad t + s^2/c - \eta s^2\sigma^2/2 - cs^2/(2c^2) \geq w_0. \end{aligned}$$

Solving for this maximisation problem implies: $s = 1/(1 + \eta c\sigma^2)$. So the performance-related compensation and, thus, the risk borne by the agent should fall with a rise in $\eta$, $c$, and $\sigma$.

A caveat should be made: assuming a linear incentive scheme (here: $w = t + sq$) is typically not without loss of generality, even if Holmström and Milgrom (1987) have identified conditions where the optimal contract is indeed linear in performance.

it is in the interest of contractors to simultaneously reduce effort since each contractor exerts a negative externality on others by working harder.[7]

To conclude, we sketch the relevance of the insights derived here for risk allocation in PPPs. Consider a highway concession, for instance, where the government wants to align toll fees, at least in part, with the performance of the concessionaire. In this case, it would be bad to pass on risks to the concessionaire that are beyond his control – like GDP fluctuations, oil price variations, and changes in petrol taxes. It would be desirable to put in place a predictable regulatory regime of toll fees that controls for inflation and exerts relative-performance discipline by taking advantage of the potential multiplicity of concession owners.

### 4.2 Pros and cons of external finance for PPPs

Beyond pure risk sharing, it is important to think about the effects of the funding mechanism on incentives. While the literature surveyed above stresses incentives linked to allocating ownership rights under traditional service provision and PPP, it does not explicitly take into account that the contractor has to honour and remunerate external finance such as outside equity and debt.

***Large outside equity or debt can lower the incentives for PPP contractors to exert the socially optimal level of effort.***

Traditional corporate finance has stressed, however, that large outside equity or debt can lower incentives to exert effort (see, for example, Jensen and Meckling 1976 and Myers 1977) since effort partly benefits external investors (outside shareholders or creditors). One should therefore be aware of potential drawbacks of relying on highly leveraged private contractors to undertake public projects. To illustrate, consider a stylised infrastructure project with a building stage and an operating stage. Assume that building the project requires an investment $I$ and that total consumer willingness to pay for the service delivered at the operating stage of the project is a random variable, being either a low $V_0$ or a high $V_1$. Moreover, assume that the realisation of consumer willingness to pay depends on effort exerted at the building stage. Specifically, the realised willingness to pay will be $V_0$ with probability $1-k-e$ and $V_1$ with probability $k+e$, where $k$ is a positive constant and $e$ is the effort exerted at the building stage. Assume for simplicity that $e$ can only take two values: $0$ and $e^* > 0$. Let us normalise to $e$ the cost of exerting effort $e$; and to keep things simple, we normalise operating cost to zero, so that the profit generated by the project does not depend on operating costs**.** Assume finally that maximising profits implies that undertaking effort $e^*$ is desirable.

Traditional public procurement and service provision (i.e., building and operation are not bundled under one contract) do not yield effort $e^*$ since the builder does not internalise the effect of his effort on consumers' willingness to pay. By contrast, as stressed in Section 3.2, bundling the building and operating phases can deliver this desirable outcome provided $(V_1 - V_0)e^* > e^*$, or $V_1 - V_0 > 1$. Indeed, by giving the builder-operator consortium ownership of the asset and allowing it to extract consumers' willingness to pay, the consortium chooses its effort at the building stage to maximise $(1-k-e)V_0 + (k+e)V_1 - e$. In this case, effort $e^*$ (rather than $e=0$) is the preferred option. This result is not surprising: we are considering here the most favourable situation for a PPP, that is, the case where there is a positive externality of effort at the building stage on the operating stage and where – in contrast with Hart's model described in Box 2 – there are no 'multitask problems', for example a cost-cutting effort (at the building and/or operating stage) that has a quality-reducing effect not borne by the consortium**.** In this case, it is indeed an unmixed blessing to get the consortium to internalise the profit effect of its effort on consumers' willingness to pay.

Things may be different, however, if 'bundling' also concerns the financing of the project. Indeed, assume that bundling requires the consortium to buy and finance the asset. Typically, the consortium will have to seek external finance, unless it has enough funds: this implies that part of the return of

7 See, for example, Holmström and Milgrom (1990).

the project will accrue to outside investors, and not just to the consortium. This raises the incentive issues that have been the subject of much of the theoretical literature on corporate finance since Jensen and Meckling (1976)[8]. The first effect of external finance is that it introduces a new agency problem, that is one between the consortium and the external investor. Starting from a first-best outcome, like the one above where bundling without the need to bring in external investors results in $e^*$, this can be bad news, as we will see in the next sub-section. That said, adding a third partner in the relationship, besides the government and the consortium, may help some of the incentive problems. We will turn to the bright side of external finance in Section 4.2.2.

### 4.2.1 Negative effect of external finance

***A PPP consortium needing external finance may not choose the optimal level of effort.***

We will now argue that a consortium needing external finance may not choose the socially optimal effort $e^*$. To make the point as clear as possible, we assume that the consortium has no money to start with and has to raise the amount $I$ entirely from outsiders. This corresponds to the case where the government does not want to fund $I$ upfront but relies on the consortium to find the money on the capital market. Such money can be raised in different forms. We consider here the two most conventional forms: outside equity and debt.

With outside equity, the consortium offers outside shareholders a constant share of what it gets by extracting consumers' willingness to pay. If this share is $\beta$, the consortium keeps a share $1-\beta$ of the surplus generated by its effort. Having to share the returns on its efforts with outside shareholders, the consortium has less incentive to exert effort. In fact, the incentive for the consortium can be preserved only if the share accruing to outside equity is not too high. The problem is that the share accruing to outside shareholders must not be too low either, because if it is too low, outside shareholders would not find it worthwhile to supply the initial financing $I$. As shown in Box 6, which sets out the underlying model in greater detail, these two constraints can be incompatible, that is, outside shareholders cannot be convinced to finance the project for a profit share small enough to convince the consortium to exert effort.

This is a case where PPP backfires: on the one hand, the bundling of building and construction gives appropriate effort incentives to the consortium; on the other hand, since the consortium has to rely on outside equity to finance the asset, the positive incentive of bundling is undone because outside shareholders end up getting too much of the return on the consortium's effort.

In fact, outside equity is not the optimal external financing mode in this case: one can do better with debt, which maximises effort incentives for a given expected repayment to the outside financiers by maximising the difference between the consortium's payoff in 'good' states of the world ($V_1$) and 'bad' ones ($V_0$). Indeed, for a debt with face value $D$, the consortium gets a payoff of max $[0, V_i - D]$ when the return is $V_i$, since creditors receive min $[V_i, D]$. As shown in Box 6, all this implies that debt finance makes it easier than outside equity to simultaneously induce the consortium to exert effort and investors to supply finance.[9]

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8 See Tirole (2005), for example, for a synthesis of this literature.

9 The idea that debt maximises incentives to undertake effort has already been stressed by Jensen and Meckling (1976). The conditions for the optimality of debt in a moral hazard setting have been analysed more thoroughly by Innes (1990) and, more recently, by Matthews (2001) and Dewatripont *et al.* (2003). Innes (1990) shows that debt is the effort-maximising financing mechanism in a principal-agent relationship where: (i) both the principal-financier and the agent-entrepreneur are risk neutral; (ii) the agent is wealth-constrained; (iii) both parties' payoff are constrained to be monotonic in total performance. Allowing for a risk-averse agent would typically invalidate the optimality of debt, because it puts too much of the risk on the agent. As shown by Matthews (2001) and Dewatripont *et al.* (2003), this is not the case when one applies the Innes conditions to a modified principal-agent setting – put forward by Fudenberg and Tirole (1990) and Hermalin and Katz (1991) – where, after effort has been chosen but before performance is realised, the principal and the agent can renegotiate the contract to improve risk sharing. In such a case, starting from a debt contract initially is a good idea, knowing that the excessive risk it implies for the agent can be renegotiated away later on.

**Box 6. Why outside finance may stifle the efforts of PPP contractors**

As sketched at the beginning of Section 4.2, we consider a stylised infrastructure project. The willingness of consumers to pay for the infrastructure service is a random variable being either a low $V_0$ or a high $V_1$. The realisation of consumer willingness to pay depends on effort exerted at the building stage. Specifically, the realised willingness to pay will be $V_0$ with probability $1 - k - e$ and $V_1$ with probability $k + e$, where $k$ is a positive constant and $e$ is the effort exerted at the building stage. Effort, $e$, can only take two values: 0 and $e^* > 0$, with $e^*$ indicating the profitmaximising level of effort.

With **outside equity**, the consortium keeps a share $1-\beta$ of profits and chooses $e$ to maximise:

$$(1 - \beta)(1 - k - e)\, V_0 + (1 - \beta)(k + e)V_1 - e.$$

This will lead to a choice of effort $e^*$ only if:

(1) $$(1 - \beta)\,(V_1 - V_0) \geq 1 \quad \text{or}$$

(2) $$\beta \leq 1 - 1/(V_1 - V_0).$$

The left-hand side and the right-hand side, respectively, of (*1*) show marginal benefit and marginal cost to the consortium of exerting effort. Condition (*1*) – which can be rewritten as condition (2) – thus says that the share of profits retained by the consortium ($1-\beta$) must be big enough to induce the consortium to exert effort.

At the same time, the share of profits accruing to outside shareholders has to be large enough to induce them to supply the initial financing $I$. Specifically, shareholders' participation constraint is:

(3) $$\beta\,(1 - k - e^*)\, V_0 + (k + e^*)V_1 \geq I \quad \text{or}$$

(4) $$\beta \geq I / (V_0 + (k + e^*)(V_1 - V_0))$$

***Debt is better than outside equity at preserving consortia's incentives to exert effort.***

Although debt is better than equity at preserving the consortium's incentive to exert effort, it is true nonetheless that there will be cases where it cannot be done while satisfying investors' participation constraint. The general lesson from this sub-section is that, by insisting on external finance, a PPP can undo the desirable incentive effect that bundling the construction and operation phases may achieve.

In discussing the downsides of external financing for PPPs we have so far attributed a minimalist role to outside equity and debt: we have stressed the income rights attached to these instruments, but we have abstracted from their associated control rights, an issue that has attracted the attention of the corporate finance literature since the work of Aghion and Bolton (1992)[10]. Here, this is not so much of a problem for debt: while creditors have control rights in case of default by borrowers, they will not be able to get more than the value of the firm in the bad state of nature (i.e., $V_0$ in our case).

By contrast, it must be said that we have considered completely passive outside shareholders, effectively holding non-voting equity. In reality, there are many debates about the various ways in which, in the parlance of Aghion and Tirole (1997), shareholders can transform their 'formal authority' – managers are by law instructed to pursue shareholder interests – into 'real authority' through the

10 See also the work summarised in Hart (1995).

For a sufficiently high investment level $I$ , conditions (2) and (4) are incompatible: any $\beta$ high enough to make the provision of equity profitable for outside shareholders is then too high to induce the consortium to exert the socially optimal level of effort $e^*$.

With **debt finance** $D$, the consortium's profit is zero if consumers' willingness to pay turns out to be $V_0$, with $V_0 < D$ being the payment to creditors in this state of the world. But the consortium will earn $V_1 - D$ if consumers' willingness to pay is $V_1$, with $D$ being the payment to creditors in this state of the world. Overall, the consortium chooses $e$ to maximise:

$$(k + e)(V_1 - D) - e.$$

This will lead to a choice of effort $e^*$ only if:

(1′) $$(V_1 - D) \geq 1$$

where the left-hand side and the right-hand side of (1′) shows, respectively, the marginal benefit and marginal cost to the consortium of exerting effort

With risky debt $D$, the participation constraint of lenders is:

(3′) $$(1 - k - e^*) V_0 + (k + e^*) D \geq I$$

As shown in the Annex, (1′) and (3′) are easier to satisfy than (1) and (3), implying that debt finance is more likely than outside equity to induce outside investors to provide finance and to encourage the consortium to exert the optimal level of effort $e^*$. Intuitively, debt provides more incentives to exert effort, for a given expected repayment to outside investors, than outside equity for the following reason: while outside equity gives the builder and the investor a constant fraction of the realised return, whether performance was good or bad, debt leaves the builder the minimum possible fraction of the return (that is, zero) after poor performance, and therefore a relatively high fraction after good performance. The reward for exerting effort is thus maximised under debt finance.

various mechanisms of corporate governance. The corporate finance literature has analysed the various safeguards against the divergence between managerial conduct and shareholder interests, for example the role of boards of directors, transparency of information, and the regulation of takeovers (these are discussed in much detail in the survey by Becht *et al.* 2002).

***The result that creditors may be better than outside shareholders in controlling managers is quite robust.***

Notice, however, that the above lesson – according to which creditors may be better in controlling managers than outside shareholders – may be quite robust, especially if one contrasts expert, concentrated debt investors (banks for instance) with small dispersed shareholders. Dispersion does indeed create a free-rider problem in monitoring, as we discuss in more detail next.

### 4.2.2 Positive effects of external finance

The contingencies of financial contracting can affect in a non-trivial way the performance of PPPs. Consider for instance how the rights are licensed when contractors face the risk of bankruptcy. If contractors are financially constrained, the risk of bankruptcy is not internalised when contracts are awarded. This is relevant, for example, at the auction stage: it can lead to aggressive bidding and success at the auction, with the government/sponsor paying the consequences later. Things are worse if, because of 'too important to fail' considerations, the sponsor finds it optimal *ex post* to intervene and rescue the project. The anticipation of such 'soft budget constraints' would contribute

to a further distortion of competition at the auction. This could provide an argument for the sponsor to contribute to the initial financing of the project, but could also justify PPPs in order to transfer decision rights in the case of bankruptcy to a third party – external investors – who is not subject to such soft budget constraints.

Softness of budget constraints is an illustration of a lack of commitment or lack of completeness of contracts, and the question is whether external finance can help in making budget constraints bind, thereby avoiding the opportunistic behaviour of contractors sketched above. For complex projects, auditing and monitoring could alleviate some of the problems posed by opportunistic behaviour of contractors. However, auditing and monitoring are effective when the auditors and monitors are experts in the area they control and when they have themselves the incentives to spend the resources needed to discover useful information. A result of external finance is that investors have the stake to incur monitoring costs and – if they specialise in financing large projects – the expertise and reputation for being credible monitors.

This is a central idea in the literature that views financial intermediation as delegated monitoring (Diamond 1984), or the recent literature on venture capital that models the active monitoring and sometimes executive role of the financial intermediary (see Kaplan and Stromberg (2003) for references and evidence). Whether finance is obtained through equity or debt, that literature underlines a trade-off between the benefits of risk diversification, which leads to a dilution of ownership of individual firms, and the benefits of monitoring resulting from a more concentrated ownership structure.[11] Indeed, as Berle and Means (1932) had pointed out, since monitoring has public good characteristics, firms with dispersed ownership generate a free-rider problem in monitoring. Intuitively, if a stakeholder can claim only 1 percent of a project's return, his incentives to invest in monitoring will be less than those of a creditor having a 10-percent claim; as long as there are economies of scale in monitoring, concentrating external finance on a few investors will lead to more investment in monitoring.

***PPPs financed through a few intermediaries are likely to perform better than others.***

This suggests that special attention should be paid to the way projects are financed when they are technically complex and when information on performance may be hard to obtain. A reasonable conjecture is that PPPs financed through a few intermediaries will tend to perform better than others.

Another illustration of the lack of commitment or lack of completeness of contracts is the problem arising from 'soft objectives' of the sponsor discussed in detail in Section 3.3. To recall, 'soft objectives' means that the sponsor may find it difficult to commit to a design or to make the initial contract contingent on later changes of design. The importance of external finance in this context is that the financial contract and the allocation of decision rights is a way for the contractor and the sponsor to share the risks associated with the later change in objectives by the sponsor**.**

## 5. Conclusion

The literature on the theory of contracts and its recent applications to PPPs has some clear implications.

11 Things are more complex since financial markets characterised by a dilution of ownership at the individual firm level are also associated with a higher liquidity of the market, which may enhance the disciplinary role of takeovers. For PPPs, takeovers seem less important and we thus ignore them.

First, PPP contracts enable the partners involved in developing infrastructure projects – whether financing, building or operating – to internalise the various costs associated with the choice of investments or the choice of contracts. For investments, the builder of a project will take into account the maintenance costs of the bridge in a PPP but not necessarily under traditional public sector procurement. For contracts, the builder will anticipate how his contract will affect the negotiation between the sponsor and the operator of the infrastructure under PPP but not necessarily under traditional procurement. For this reason, PPPs seem to be better at providing incentives for life-cycle cost savings; the builder and the operator have the right incentives to minimise life-cycle costs. However, there are concerns that such cost cutting may come at the expense of quality. There is therefore a need for controlling the quality of public services delivered through PPPs.

Second, while cost overruns are often viewed as illustrating the failure of traditional public procurement, we have pointed out that they can be equilibrium phenomena. There are costs associated with trying to make contracts complete and specifying a project in such a way that its characteristics will not change later on. These costs could be related to the difficulty of filtering out exogenous disturbances, like changes in macroeconomic conditions, or to the difficulty of anticipating changes in the objectives of the different parties. There is then a trade-off between the costs of making contracts complete and the benefits of minimising cost overruns, with these benefits resulting from better-specified contracts. Therefore, contract design and choice are also subject to incentive problems, sometimes on the part of the agencies in charge of allocating the public project. As we have pointed out, stiff competition among contractors may help, and opening the markets for public projects is a way to do so. Another option to avoid inefficiencies in the choice of contracts is to compel agencies to provide verifiable evidence on the steps they have followed to design the objectives of the project in a way that anticipates future economic shocks.

***There are costs of avoiding cost overruns and of engaging third-party finance in PPPs.***

A final lesson from the literature is that the quality of projects reflects both exogenous and endogenous uncertainty and that the purpose of contracts is to disentangle their effects. It is therefore important to identify, and find ways to filter out exogenous disturbances, e.g., by using indexing or – when possible – relative performance evaluation. Although the literature has insisted on the endogenous uncertainty linked to the bundling of property rights in PPPs, we have noted the importance of financial contracting and the use of external finance, which implies transferring financial risk to third parties. Such external financing may have negative effects, which have been emphasised in the corporate finance literature but are surprisingly absent in the economic literature on PPPs. The negative effect of financial contracting – namely that part of the return on effort accrues to outside investors – may also undo whatever beneficial effects arise from bundling the decision rights for building and operating the infrastructure project. That said, external finance may have the benefit of having expert and concentrated investors who will monitor projects. Since we have moreover shown the advantage of debt over equity in limiting underinvestment in effort, this pleads for relying on large, expert creditors when outside investors are relied upon in the context of PPPs.

## Annex

The purpose of this Annex is to show that equations (1') and (3') of Box 6 are easier to satisfy than equations (1) and (3).

Consider the level of $\beta$ such that (1) is binding, that is, $\beta = 1 - 1/(V_1 - V_0)$. This is the maximum level of outside equity compatible with effort $e^*$. For this $\beta$, compute now the level of $I$ such that (3) is binding. This is the maximum 'outside equity funding capacity' compatible with effort $e^*$. Its level is:

$$I^{equity} = V_0 + (k + e^*)(V_1 - V_0 - 1) - V_0/(V_1 - V_0).$$

As for debt, its level such that (1') is binding is $D = V_1 - 1$ and, for this level, the maximum 'debt funding capacity' (the level of $I$ which makes (3') binding) is:

$$I^{debt} = V_0 + (k + e^*)(V_1 - V_0 - 1),$$

which is higher than $I^{equity}$. The set of values of $I$ such that (1) and (3) are satisfied is thus a strict subset of the set of values of $I$ such that (1') and (3') are satisfied.

**References**


Aghion, P. and Tirole, J. (1997). "Formal and real authority in organizations". *Journal of Political Economy,* (105), pp. 1-29.

Aghion, P. and Bolton, P. (1992). "An incomplete contracts approach to financial contracting". *Review of Economic Studies*, (59), pp. 473-94.

Barro, R. (1990). "Government spending in a simple model of endogenous growth". *Journal of Political Economy*, (98), pp. 103-117.

Becht, M., Bolton, P. and Roell, A. (2002). "Corporate governance and control," ECGI Working Paper.

Bennett, J. and Iossa, E. (2004). "Building and managing facilities for public services". Brunel University and CMPO (University of Bristol) Working Paper.

Bentz, A., Grout, P., and Halonen, M. (2002). "What should the State buy?" CMPO (University of Bristol) Working Paper.

Berle, A. and Means, G. (1932). *The modern corporation and private property,* Transaction Publishers, revised edition 1964, Somerset, USA.

Bolton, P. and Dewatripont, M. (2005). *Contract Theory*, MIT Press, Cambridge, USA.

Cantillon, E. and Asker, J. (2003). "Equilibrium in scoring auctions," FEEM Working Paper No. 148.04.

Dewatripont, M., Legros, P. and Matthews, S. (2003). "Moral hazard and capital structure dynamics". *Journal of the European Economic Association,* (1), pp. 890-930.

Diamond, D.W. (1984). "Financial intermediation and delegated monitoring". *Review of Economic Studies,* (51), pp. 393–414.

European Commission (1996). "Public procurement in the European Union: Exploring the way forward," Green Paper, COM (96), p. 583.

European Commission (2004). "Coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors". Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004.

Flyvbjerg, B., Bruxelius, N., and Rothengatter, W. (2003). *Megaprojects and risk – An anatomy of ambition,* Cambridge University Press, Cambridge, UK:

Fudenberg, D. and Tirole, J. (1990). "Moral hazard and renegotiation in agency contracts". *Econometrica*, (58), pp. 1279-1320.

Ganuza, J-J. (2003). "Competition and cost overruns in procurement". Mimeo.

Ganuza, J-J. (2004). "Ignorance promotes competition: An auction model with endogenous private valuations". *Rand Journal of Economics*, (35), pp. 583-598.

Grossman, S. and Hart, O. (1986). "The costs and benefits of ownership: A theory of vertical and lateral integration.". *Journal of Political Economy*, (94), pp. 691-719.

Hart, O. (1995). *Firms, contracts and financial structure*, Oxford University, Press, Oxford, UK.

Hart, O. (2003). "Incomplete contracts and public ownership: Remarks and an application to public-private partnerships". *The Economic Journal*, (113), pp. 69-76.

Hart, O., Shleifer, A., and Vishny, R. (1997). "The proper scope of government: theory and an application to prisons". *Quarterly Journal of Economics* (112), pp. 1126-1161.

Hart, O. and Moore, J. (1990). "Property rights and the nature of the firm". *Journal of Political Economy*, (98), pp. 1119-1158.

Hermalin, B. and Katz, M.L. (1991). "Moral hazard and verifiability: The effects of renegotiation in agency". *Econometrica*, (59), pp. 1735-1754.

Holmström, B. (1979). "Moral hazard and observability". *Bell Journal of Economics*, (10), pp. 74-91.

Holmström, B. (1982). "Moral hazard in teams". *Bell Journal of Economics*, (13), pp. 324-342.

Holmström, B. and Milgrom, P. (1987). "Aggregation and linearity in the provision of intertemporal incentives". *Econometrica*, (55), pp. 303-28.

Holmström, B. and Milgrom, P. (1990). "Regulating trade among agents". *Journal of institutional and theoretical economics,* (146), pp. 85-105.

Holmström, B. and Milgrom, P. (1991). "Multitask principal-agent analyses: Incentive contracts, asset ownership and job design". *Journal of Law, Economics and Organization,* (7), pp. 24-52.

Innes, R. (1990). "Limited liability and incentive contracting with ex ante action choices". *Journal of Economic Theory*, (52), pp. 45-67.

Iossa, E. and Legros, P. (2004). "Auditing and property rights". *Rand Journal of Economics*, (35), pp. 356-72.

Jensen, M. and Meckling, W. (1976). "Theory of the firm: Managerial behavior, agency costs and ownership structure". *Journal of Financial Economics*, (3), pp. 305-360.

Kaplan, S. and Strömberg, P. (2003). "Financial contracting theory meets the real world: An empirical analysis of venture capital contracts". *Review of Economic Studies*, (70), pp. 1–35.

Laffont, J.J. and Tirole, J. (1993). *A theory of incentives in procurement and regulation*, MIT Press, Cambridge, USA.

Matthews, S.A. (2001). "Renegotiating moral hazard contracts under limited liability and monotonicity. *Journal of Economic Theory*, (97), pp. 1-29.

Mirrlees, J. (1975). "The theory of moral hazard and unobservable behaviour". Mimeo Nuffield. Reprinted in 1999 in *Review of Economic Studies*, (66), pp. 3-21.

Myers, S. (1977). "Determinants of corporate borrowing". *Journal of Financial Economics*, (5), pp. 147-175.

National Audit Office. (2003). "PFI: Construction performance". Report by the comptroller and Auditor General. HMSO London.

Peck, M.S. and Scherer, F.M. (1962). *The weapons acquisition process: An economic analysis,* The Harvard University Press, Boston, USA.

Schmidt, K. (1996). "The costs and benefits of privatization: An incomplete contract approach". *Journal of Law, Economics and Organization*, (12), pp. 1-24.

Tirole, J. (2005). *Topics in corporate finance*, Mimeo.

Williamson, O. (1975). *Markets and hierarchies*, Free Press, New York, USA.

Williamson, O. (1985). *The economic institutions of capitalism*, Free Press, New York, USA.