Initiative in public-private partnerships

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Abstract

We formalize the argument that increased contractor initiative may provide one justification for the use of public-private partnerships. Such partnerships usually combine multiple sequential subprojects, e.g., development and operation, into a single large and long-term project. Opportunities and risks for future subprojects then have to be assessed early on, right upon granting the contract. This inflates assessment costs, even if only due to discounting, and may lead to weaker government monitoring. In an initiative model, the contractor then obtains greater real authority (effective control over decisions), which enhances his incentives.

Keywords: Public-private partnerships, Initiative model, Authority.
JEL classification: D8, H11, H5, L33.

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1 Introduction

One important aspect of public services is that of contracting out to the private sector (see, e.g., Levin and Tadelis, 2010). Since the nineties, this issue is accompanied by the question whether contracting out should be done at the level of individual projects, or whether multiple sequential projects should be bundled. For example, traditionally a government setting up a facility such as a hospital would arrange (and possibly contract out) infrastructure, financing, managing, and maintaining the facility as separate projects. More recently, there has been a shift towards bundling different stages into a single, large project to be contracted out as a whole in a public-private partnership. The government (either at the central or local level) then engages in a long-term relationship with a private party (often a consortium of firms) for the delivery of the facility as a whole.

Public-private partnerships illustrate the trend of increasing involvement of private parties in public good provision (Armstrong and Sappington, 2006). They were originally used for facilities such as transportation, energy and water. More recently, more and more public services have been developed in such partnerships, including for example hospitals, prisons, schools, leisure facilities, accommodation and IT services (Iossa and Martimort, 2008, and the references therein). One early form of the approach is the private finance initiative, where private capital is used to fund public projects in return for part-privatization. Another well-known form is the DBFMO contract, where the different stages or subprojects design, build, finance, maintain, and operate (or a subset of these) are combined in a single contract. Such a contract may easily cover a period of 20 or 30 years. For a comprehensive, practical discussion of public-private partnerships, see Yescombe (2007).

The main characteristics of public-private partnerships are bundling, the transfer of risk to the private party, and the long-term nature of the relationship (Iossa and Martimort, 2008). These features distinguish partnerships from privatization (for an overview of the literature on privatization see Shleifer, 1998, or Martimort, 2006). In this paper, we focus on the bundling of sequential projects and the long-term perspective. The type of public-private partnership we have in mind can most easily be interpreted as the DB(F)MO form. Bundling may allow the government to internalize externalities, for example when building greater quality infrastructure lowers operating costs (positive externality) or when a novel infrastructure design requires more advanced operating techniques (negative externality), see Martimort and Pouyet (2008). We acknowledge this aspect, but ignore it here. Instead we focus on the sequential nature of the bundled projects and argue that bundling implies an *earlier assessment* of opportunities and risks for all but the first project, and therefore an earlier decision on how to carry out a project based on the available information. We consider the agency problem between the government and the contractor, and show how early assessment may induce greater assessment effort by the contractor and less by the government. Indeed, one advantage of public-private partnerships that is often put forward in the popular literature is that they enhance initiative, creativity, and innovation of the private party by giving them greater freedom (see, e.g., Yescombe, 2007). This comes at a cost: the government faces a loss of control over how the projects are executed. But in the end, it may well benefit social value.

In procurement of a public service to a private party, before granting a contract both the government and the candidate contractors will perform a costly assessment. This assessment can be interpreted as collecting some amount of information on many alternative ways to potentially carry out the project. On some issues the government may have specific demands ex ante that need to be satisfied (e.g., the number of classrooms in a school). Various contractors may submit their plans and prices in the procurement stage, satisfying these requirements. The government then investigates the most attractive plan(s) further in collaboration with the contractor(s), and eventually a contract is drawn up. In this assessment, with competition among contractors the government essentially has formal authority in the sense that she can 'overrule' suggestions of the contractor in writing the contract. But she can of course only do so if she has the necessary information. If she does not, usually she will have to rely on the contractor's suggestion (who may not have the information either, or may even strategically choose to leave it open). In that case, the contractor has real authority as he has effective control over the decision.

With public-private partnerships, such a contract regularly is an elaborate document (measuring several centimeters thickness is no exception) specifying all kinds of details on how to exert the subprojects. So even though public-private partnerships leave more freedom to the contractor, this does not mean that everything is left open in the contract. An important share of the decisions is made based on the assessment and is included in the contract. Of course, given the long-term and complex nature of a public-private partnerships project, many other practical issues remain to be decided (by the contractor) during the execution. Clearly, the further a project is in the future, the more difficult it is to specify details in the contract, given the fact that earlier projects or stages have not yet been realized. Upon realization of a project, one has a clear starting point for collecting information on the next stage. But as long as earlier projects have not been realized, many options must be kept open, which diffuses information search. Furthermore, future innovations may be relevant for the project, but these too have not yet been realized.

We present an initiative model, which assumes some congruence of interest among the government (principal; she) and the contractor (agent; he). However, the preferences of the government and the contractor are not fully in line. We assume the government to have formal control. Therefore, the government essentially monitors the contractor. As is standard in initiative models, this implies that the contractor's decision is overruled with some (strictly positive) probability, which reduces his real authority and decreases his effort level (or initiative). In this setting we show how public-private partnerships can, at least in some cases, alleviate the agency problem by shifting assessment effort backward in time. This implicitly increases the cost of monitoring due to discounting or simply because such an early assessment is more difficult (i.e., more costly), thereby decreasing the government's incentive to monitor. As public-private partnerships usually cover long time spans this effect may be rather large even if it is due to discounting only. As an illustration, with an interest rate of 4%, by moving assessment effort costs back in time 10 years, they are increased by almost fifty percent (note that $(1.04)^{10} \approx 1.48$). We show that the reduction in government monitoring facilitates the contractor's participation and may result in a greater social value and greater (net) return for the government. This result formalizes the idea that public-private partnerships imply a loss of government control but foster contractor initiative.

Our initiative model is a simplification of that of Aghion and Tirole (1997). In their model, they assume an incomplete contracting setting where alternative projects (or, in our terms, alternative ways to carry out a project) cannot be contracted on ex ante. In public-private partnerships contracts are written, so this may seem to conflict. However, this contract is written ex post, after information has been collected in a way similar to that in Aghion and Tirole (1997). The initiative model does nicely describe what happens in the assessment process at the beginning of a public-private partnership, as described above. Our model should therefore be interpreted as representing that stage of the partnership, i.e., the assessment of how to execute the (sub)project(s) by both government and contractor and the possible ‘overruling’ by the government in this stage, which eventually results in the writing of a contract and execution of the project.

This paper proceeds as follows. In Section 2 we present the initiative model and explain how to interpret public-private partnerships in this context. Section 3 derives the equilibrium of the model, both for the traditional method where the two subprojects are separated and for the case of PPP. Section 4 presents our main results, which are illustrated with a numerical example in Section 5. Section 6 concludes.

2 The model

We take outsourcing as given and focus on the decision whether or not to combine sequential projects into a long-term public-private partnership. We have a three stage model which describes the assessment preceding the writing of the actual contract(s). At $t = 0$, the government decides on the payments to be made to the contractor(s) upon completion of the project(s). We focus on fixed payments and ignore the possibility of an incentive contract. At each time $t = 1, 2$ a (sub)project – say, development ($t = 1$) and operation ($t = 2$) – is implemented. For each project, the contractor and the government simultaneously select effort levels, which drive their returns in a way described below.

For the comparison between the traditional method and a public-private partnership (henceforth PPP) we use an approach similar to that of Martimort and Pouyet (2008). As in Martimort and Pouyet (2008) we ignore the procurement stage where multiple contractors can bid on the projects, and focus on two sequential subprojects. Under the traditional method the two subprojects are carried out separately (likely but not necessarily by different contractors), whereas with PPP they are integrated into a single, long-term project which starts at $t = 1$ and continues at $t = 2$. The main difference between PPP and the traditional model is that with PPP assessment effort for *both* subprojects needs to be exerted (and the corresponding contract written) at the beginning, i.e., at $t = 1$. That is, for the second subproject the work itself (say, operation) is carried out and the payoff is realized at $t = 2$ just like with the traditional method, but the way the project will be carried out has to be assessed and decided early on with PPP, at $t = 1$. Such an early assessment is likely to be much more difficult and therefore more costly. In fact, time discounting itself implies that an early assessment is more costly, and in our analysis we focus on this aspect only for expositional convenience. Introducing an inflated cost function for early assessment under PPP would only strengthen our result.

For each of the two stages $t = 1$ and $t = 2$ we have an agency problem which we interpret as an initiative model. This uses a simplified version of the Aghion and Tirole (1997) initiative model. Aghion and Tirole (1997, henceforth AT) consider a setting where one out of many projects must be selected and implemented. They assume that these projects cannot be explicitly contracted on ex ante and model project choice and its dependence on formal authority (the right to decide), which in their model rests either with the principal or with the agent. Without any further information, both agent and principal prefer the same project. However, by exerting effort they may obtain more information with a probability that is increasing in effort. If informed, the preferences of the agent and the principal diverge to some extent. In the case where formal authority rests with the principal, this means that if the agent selects his preferred project, the principal will overrule this decision if she is informed too. Clearly, this possibility decreases the agent's incentive to exert effort. Thus, for given effort of the agent monitoring increases the principal's expected payoff. But monitoring reduces the agent's expected payoff and thus reduces the agent's initiative, which decreases expected payoff. (Note that the interpretation of the word 'project' in AT is quite different from that in our paper. For that reason, we will refer to the AT-type of project as 'AT-project' in the remainder of this paper.) We use a different modelling structure which captures essentially the same trade-off. In order to keep the analysis tractable we simplify by not modelling AT-project choice explicitly, but rather imposing a payoff structure which implicitly describes the monitoring trade-off. The reader may interpret this as describing a situation similar to that in AT, where there are various ways to carry out a (sub)project and government and contractor have preferences over these which are to some extent diverging. The payoffs in our model should thus be interpreted as *expected* payoffs, where the actual payoff depends on the way the project is carried out eventually.

For expositional convenience we assume the two subprojects ($t = 1, 2$) to be identical. Of course, this is an unrealistic assumption, but one which simplifies the notation without affecting any of the qualitative results. The model can easily be extended to the general case with different subprojects. Although under the traditional method, the two projects may well be contracted out to different contractors, we will from now on assume them to be identical and refer to 'the contractor' which should be interpreted as the relevant contractor for the (sub)project currently discussed.

We assume risk neutrality of all players and impose the following payoffs at times $t = 1, 2$. The government's expected payoff at time t is given by

$$\pi\left(e_t, E_t\right) - w_t - C\left(E_t\right),$$

where π denotes (expected) social value, w_t is the payment to the contractor at time t, and C denotes the effort cost function. Social value π is a function of the contractor's effort e_t and the government's effort E_t, and the government's effort cost C is a function of E_t only. Effort can be interpreted as effort to find information on the best way to carry out the subproject as in AT (see above), and in line with this the effort of the government can be interpreted as monitoring effort. We assume that social value $\pi(e_t, E_t)$ satisfies $\pi_1 > 0$ and $\pi_{11} < 0$, where subscripts denote partial derivatives. This means that the contractor's effort increases social value, but to a decreasing extent. Similarly, we assume $\pi_2 > 0$ and $\pi_{22} < 0$, i.e., the government's effort increases social value but to a decreasing extent. We assume $C' > 0$, $C'' > 0$: cost of effort is increasing at an increasing rate. Note that the payoff is expressed in terms of time-t money. For discounting we use a discount factor $\delta \in (0, 1)$.

The expected payoff for the contractor at time t is given by

$$b(e_t, E_t) + w_t - c(e_t),$$

where $b(e_t, E_t)$ can be interpreted as private benefits (perks) and 'corporate' benefits such as acquisition of (human) capital[1] and the possibility of signalling ability (reputation). The payoff b is a net return, i.e., net of any development or operating costs. We assume that $b_1 > 0$ and $b_{11} < 0$: the contractor's effort increases his return from the subproject, but to a decreasing extent. We also assume $b_{12} < 0$. This is a crucial assumption for our analysis and can be interpreted as follows. For the contractor, the marginal return to effort is decreasing in the government's effort. That is, from the point of view of the contractor, e_t and E_t are strategic substitutes. This reflects the basic conflict of interest of the initiative model: monitoring by the government in itself increases social value, but it will reduce the contractor's initiative. The term $c(e_t)$ denotes effort cost for the contractor. Due to their different roles and expertise, the effort cost functions of the contractor and the government are likely to be different. Again we assume that effort cost is increasing at an increasing rate: $c' > 0$, $c'' > 0$.

[1] Note that acquisition of human capital can be considered social value. In that case, it should also enter the function π. We ignore this.

At time $t = 0$ the government sets the fixed payment to the constructor. We assume that the government has all the bargaining power in this stage. This implies that the payment is set in such a way that in equilibrium, in each period the contractor is indifferent between this contract and the expected payoff from his outside option, denoted b^0. Since the payment is set at $t = 0$, from the point of view of the contractor who determines his effort at time 1 or 2 his payoff does depend on his effort level. Note that in reality, with the traditional method the second-period payment w_2 is more likely to be determined shortly before the start of period 2 (instead of before period 1, as we assume). Our simplification of the timing does not affect the results.

As a final technicality, consider again the payment by the government to the contractor. Under the traditional model, the assumption of identical subprojects implies that in equilibrium effort levels will be identical ($e_t = e$ and $E_t = E$ in equilibrium), and so will payments: $w_t = w$ in equilibrium. With PPP there is a single contract with a single contractor, so we could impose a single payment there. In practice, due to the long-term nature of PPP contracts contractors are usually paid in installments. These installments could be determined in such a way that they make the contractor indifferent between this contract and his outside option in each period, i.e., for each subproject, and this is what we will assume in the analysis below. But of course, payments can be shifted back or forth by correcting for discounting.

3 Solution

We solve the model using backward induction.

Traditional method First, we consider the traditional method, where the two subprojects are carried out separately. At time t, $t = 1, 2$, w_t is given.

The government and the contractor simultaneously set their effort levels, maximizing their expected payoff. The first-order conditions (FOCs) are given by

$$\begin{aligned} \pi_2 (e_t, E_t) &= C' (E_t) , \\ b_1 (e_t, E_t) &= c' (e_t) . \end{aligned}$$

The second-order conditions (SOCs) are satisfied by assumption. Each player chooses the effort level which equalizes marginal return to marginal cost of effort, taking into account the other player's effort. This results in equilibrium effort levels which are independent of time $t = 1, 2$ and which are denoted e^* and E^*. The payments w_t play no role here since at times $t = 1, 2$, these are taken as given.

At time $t = 0$, the government decides on payments w_t. The government maximizes her expected payoff by setting w_t such that at time t the contractor receives exactly his reservation utility:

$$w^* = b^0 - b (e^*, E^*) + c (e^*) .$$

PPP Now consider PPP. With the two subprojects integrated to a single project, both the government and the contractor have to decide at time $t = 1$ on their effort levels for *both* periods. That is, the government now maximizes at $t = 1$:

$$[\pi (e_1, E_1) - w_1] + \delta [\pi (e_2, E_2) - w_2] - C (E_1) - C (E_2)$$

over E_1 and E_2, and the contractor maximizes

$$[b (e_1, E_1) + w_1] + \delta [b (e_2, E_2) + w_2] - c (e_1) - c (e_2)$$

over e_1 and e_2. It is crucial to note that in these maximization problems the effort cost for the second subproject is *not* multiplied by the discount factor δ, and that this is essentially the only difference as compared to the traditional method. Again, the payments w_t are taken as given at this stage.

The resulting FOCs are now given by

$$\begin{aligned} \pi_2(e_1, E_1) &= C'(E_1), \\ \delta\pi_2(e_2, E_2) &= C'(E_2), \\ b_1(e_1, E_1) &= c'(e_1), \\ \delta b_1(e_2, E_2) &= c'(e_2). \end{aligned}$$

Again, the SOCs are satisfied by assumption. For the first subproject ($t = 1$) the FOCs are exactly the same as with the traditional method, but for the second subproject ($t = 2$) they are different now. Consider the second subproject. Under the traditional method, both effort cost and project return materialize at $t = 2$, which implies that both cost and benefit are multiplied by the same discount factor δ. With PPP however, effort cost moves backward in time. This implies that (marginal) benefit is now multiplied by the discount factor δ whereas (marginal) effort cost is not. Effectively, this increases the marginal cost of effort for the second subproject.

From the FOCs it is easy to see that the equilibrium effort levels under PPP do depend on time $t = 1, 2$. We denote the equilibrium effort levels by e_t^{*P} and E_t^{*P}. Note that $e_1^{*P} = e^*$ and $E_1^{*P} = E^*$.

At time $t = 0$, the government decides on payments w_t. The government maximizes her expected payoff by setting w_1 and w_2 such that the contractor receives exactly his reservation utility:

$$\begin{aligned} w_1^{*P} &= b^0 - b\left(e_1^{*P}, E_1^{*P}\right) + c\left(e_1^{*P}\right) = w^*. \\ w_2^{*P} &= b^0 - b\left(e_2^{*P}, E_2^{*P}\right) + \frac{1}{\delta}c\left(e_2^{*P}\right). \end{aligned}$$

Recall that with PPP payments can be shifted back or forth by correcting for discounting. The installments presented here are mainly intended as an illustration of how payments compare to those for the traditional method.

4 Results

First note that PPP affects effort levels of both government and contractor for the second subproject only. By shifting effort cost backward for the government, for given effort of the contractor the government now has weaker incentives to monitor. In itself, this increases initiative of the contractor. The contractor however faces the same problem of effort cost being shifted backward. We have assumed that reduced monitoring increases the marginal return of effort for the contractor. We will show that if the latter effect is sufficiently strong, it will dominate the effect of backward shifting effort cost and the contractor will increase his effort as a response to weaker monitoring with PPP. In the end, this may result in greater equilibrium social value than under the traditional method.

In order to show that PPP may indeed result in greater contractor initiative in this setting, we focus on period $t = 2$. We consider the effects of a change in δ on effort levels e_2 and E_2, since by substituting in the 'artificial' value $\delta = 1$ into the FOC for PPP we obtain the FOC for the traditional method. Clearly, the comparison between the two methods is a comparison between two discrete values for δ. In the analysis we consider the derivative of effort with respect to δ as a useful approximation. Note that this approximation weakens the result as we now consider when the two effort levels are changing in the desired direction for the entire range of discount factors in the interval $[\delta, 1]$.

Totally differentiation of the $t = 2$ FOCs for PPP yields (omitting the arguments of the functions b and π)

$$\begin{aligned}\mathrm{d}e_2\left[\delta\pi_{21}\right]+\mathrm{d}E_2\left[\delta\pi_{22}-C''\left(E_2\right)\right]+\mathrm{d}\delta\left[\pi_2\right] &= 0,\\ \mathrm{d}e_2\left[\delta b_{11}-c''\left(e_2\right)\right]+\mathrm{d}E_2\left[\delta b_{12}\right]+\mathrm{d}\delta\left[b_1\right] &= 0.\end{aligned}$$

Solving using Cramer's method we obtain

$$\begin{aligned}\frac{\mathrm{d}e_2}{\mathrm{d}\delta} &= \frac{1}{\Delta}\left\{-\delta\pi_2 b_{12}+\left[\delta\pi_{22}-C''\left(E_2\right)\right]b_1\right\},\\ \frac{\mathrm{d}E_2}{\mathrm{d}\delta} &= \frac{1}{\Delta}\left\{-\delta\pi_{21}b_1+\pi_2\left[\delta b_{11}-c''\left(e_2\right)\right]\right\},\end{aligned}$$

where

$$\Delta\equiv\delta^2\pi_{21}b_{12}-\left[\delta\pi_{22}-C''\left(E_2\right)\right]\left[\delta b_{11}-c''\left(e_2\right)\right].$$

Provided that π_{21} is not too negative, the denominator Δ is negative.

Result 1 *The parameter δ decreases contractor effort and increases government effort for the second subproject, and thus the use of PPP in our setting will decrease government monitoring and increase contractor effort in equilibrium, (under the assumption that π_{21} is not too negative) if:*

- $\pi_2\left(e_2,E_2\right)$ *is sufficiently positive;*
- $b_{12}\left(e_2,E_2\right)$ *is sufficiently negative;*
- $\pi_{22}\left(e_2,E_2\right)$ *is not too negative;*
- *both $C''\left(e_2,E_2\right)$ and $b_1\left(e_2,E_2\right)$ are not too positive.*

The result that $b_{12}\left(e_2,E_2\right)$ should be sufficiently negative does not come as a surprise. This is a crucial aspect of the Aghion and Tirole (1997) initiative model, and states that the contractor's marginal return to effort is decreasing in government monitoring. Looking at the FOCs of our model, we see that the marginal returns to effort for the two players (π_2 and b_1) are multiplied by the discount factor $\delta < 1$ for the second project when PPP is used. For PPP to increase contractor effort in equilibrium, we require that this 'direct effect' of PPP is sufficiently strong for the government, but sufficiently weak for the contractor. Finally, for contractor effort to increase in the end, we need PPP to decrease government monitoring sufficiently, which requires both second derivatives π_{22} and C'' to be sufficiently small in absolute value.

Of course what matters in the end is the equilibrium payoff to the government. If this payoff is higher with PPP than it is with the traditional method, the government will impose a PPP structure. The total payoff for the government under the traditional method is given by

$$(1+\delta)\left[\pi\left(e^{*},E^{*}\right)-w^{*}-C\left(E^{*}\right)\right].$$

With PPP total government return is

$$\pi\left(e^{*},E^{*}\right)-w^{*}-C\left(E^{*}\right)+\delta\left[\pi\left(e_{2}^{*P},E_{2}^{*P}\right)-w_{2}^{*P}\right]-C\left(E_{2}^{*P}\right).$$

Subtracting the first from the latter we find that the 'excess' return from using PPP can be expressed as

$$\begin{aligned} & \delta\left[\pi\left(e_{2}^{*P},E_{2}^{*P}\right)-\pi\left(e^{*},E^{*}\right)-w_{2}^{*P}+w^{*}+C\left(E^{*}\right)\right]-C\left(E_{2}^{*P}\right) \\ = \; & \delta\left[\pi\left(e_{2}^{*P},E_{2}^{*P}\right)-\pi\left(e^{*},E^{*}\right)+b\left(e_{2}^{*P},E_{2}^{*P}\right)-b\left(e^{*},E^{*}\right)\right] \\ & +\delta C\left(E^{*}\right)-C\left(E_{2}^{*P}\right)+\delta c\left(e^{*}\right)-c\left(e_{2}^{*P}\right). \end{aligned}$$

Result 2 *The government will find it optimal to use a PPP structure in our setting if the resulting change in equilibrium effort levels:*

- *increases social value π and private benefits b sufficiently (or does not decrease these returns too much);*

- *decreases government monitoring cost C and contractor effort cost c sufficiently (or does not increase the latter too much).*

Note that for PPP to be optimal it does not necessarily need to increase social value. Alternatively, PPP may be desirable to the government because it increases private benefits for the contractor, and therefore requires a lower payment from the government.

5 Numerical example

So far, we have not formally proven that PPP may indeed result in a greater payoff to the government. For the general model described above, it is not straightforward to do so. Instead, we present a simple numerical example to show that PPP may not only result in greater contractor effort, but also in a larger payoff to the government.

Suppose that payoff and cost functions are given by:

$$\begin{aligned} \pi\left(e_t, E_t\right) &= 10e_t + E_t, \\ b\left(e_t, E_t\right) &= \left(9 - \frac{1}{2}e_t - 8E_t\right) e_t, \\ C\left(E_t\right) &= \frac{1}{2}E_t^2, \\ c\left(e_t\right) &= e_t^2. \end{aligned}$$

Note that in the discussion of the model we imposed the assumption that the function π is *strictly* concave both in e_t and in E_t. For a unique maximum of the government's objective function to exist, it is however sufficient to assume that this objective function is strictly concave. In this example, we simplify the analysis by using a linear social value function π, and use a convex monitoring cost function C to ensure concavity of the objective function. It can easily be verified that – apart from this exception – these functions satisfy the assumptions of our model:

$$\begin{aligned}
\pi_1(e_t, E_t) &= 10 > 0 \\
\pi_2(e_t, E_t) &= 1 > 0 \\
\pi_{11}(e_t, E_t) &= 0 \text{ (rather than } < 0) \\
\pi_{22}(e_t, E_t) &= 0 \text{ (rather than } < 0) \\
b_1(e_t, E_t) &= 9 - e_t - 8E_t > 0 \\
b_{11}(e_t, E_t) &= -1 < 0 \\
b_{12}(e_t, E_t) &= -8 < 0 \\
C'(E_t) &= E_t > 0 \\
C''(E_t) &= 1 > 0 \\
c'(e_t) &= 2e_t > 0 \\
c''(e_t) &= 2 > 0
\end{aligned}$$

Note that $\pi_{12} = 0$ which simplifies the analysis. The introduction of PPP has direct effect on both the government's and the contractor's effort through their FOCs, and there is also an indirect effect via the new government effort level on contractor effort. However, this assumption implies that there is *no* indirect effect of the change in contractor effort on government monitoring. This simplifies the analysis and allows us to illustrate graphically the effect of PPP on effort levels.

For the traditional method, we now have the FOCs

$$\begin{aligned}
1 &= E_t, \\
9 - e_t - 8E_t &= 2e_t.
\end{aligned}$$

Solving this we find effort levels $E^* = 1$ and $e^* = \frac{1}{3}$. For PPP the FOCs

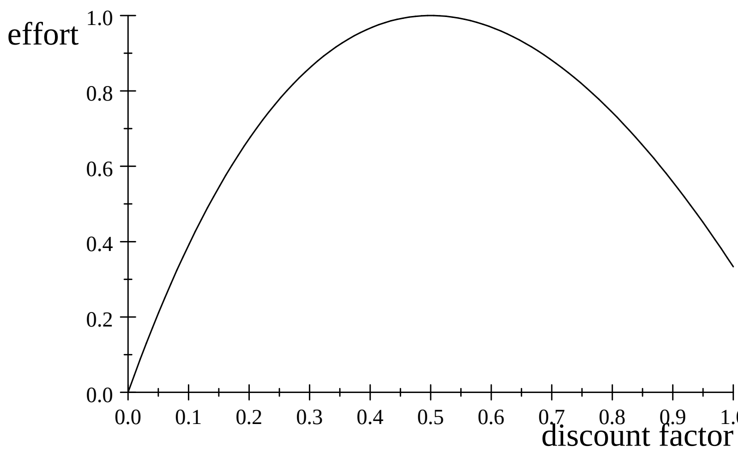

Figure 1: Second-period equilibrium contractor effort under PPP, e_2^{*P}, as a function of the discount factor δ.The traditional method corresponds to $\delta = 1$.

change to

$$\begin{aligned} \delta &= E_2, \\ \delta\left(9 - e_2 - 8E_2\right) &= 2e_2, \end{aligned}$$

which yields $E_2^{*P} = \delta < E^*$ and $e_2^{*P} = \frac{\delta}{\delta+2}\left(9 - 8\delta\right)$. Figure 1 shows this e_2^{*P} as a function of the discount factor δ. The traditional method corresponds to the (artificial) value $\delta = 1$. As the expression for e_2^{*P} is decreasing in δ for $\delta \in (\frac{1}{2}, 1]$, using PPP instead of the traditional method may indeed increase contractor effort. Note that usually, a discount factor of around 0.96 is considered a realistic value when the time period is one year. Here, the time span between $t = 1$ and $t = 2$ may be much larger. It could easily be ten years, and therefore a discount factor of for example $\left(\frac{1}{1.04}\right)^{10} \simeq 0.68$ may not be unusual.

In order to build some further intuition, let us consider again the equilibrium effort levels. In all cases, equilibrium effort is determined by the intersection

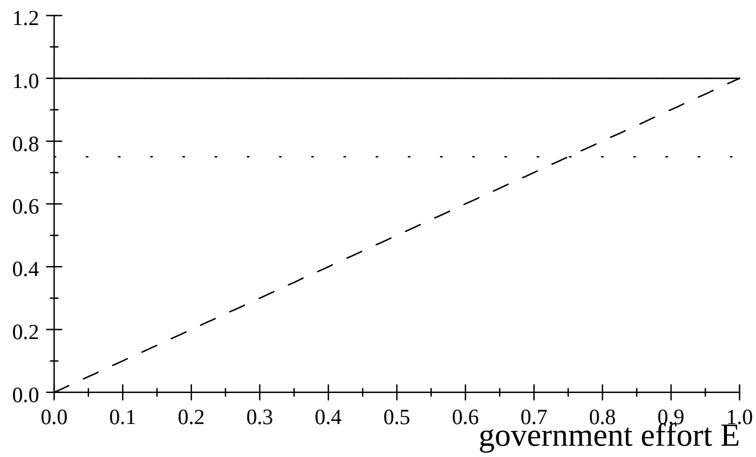

Figure 2: Effort choice of the government. The solid line represents marginal social value π_2, the dashed line marginal cost C', and the dotted line marginal social value under PPP (with discount factor $\delta = 3/4$).

of marginal return to effort and marginal cost of effort. Figure 2 shows effort choice for the government. Under the traditional method effort is determined by the intersection of the marginal increase in social value (π_2, solid line) and marginal cost C' (dashed line). Note that usually, marginal return will be decreasing, but in this particular example we let it be constant for simplicity. The two lines intersect at $E^* = 1$. Under PPP the marginal return is multiplied by a factor δ, which we fix on $\delta = 3/4$ in the figure (dotted line). This decreases the equilibrium government effort for $t = 2$ to $E_2^{*P} = 3/4$. Since in this example $\pi_{12} = 0$, all this is independent of the value of contractor effort e_t.For the contractor, however, effort choice does depend on the government's effort level. Let us first consider the government's equilibrium effort level under the traditional method, $E^* = 1$. Figure 3 graphs the effort choice for the contractor for that case. Under the traditional method contractor effort is determined by the intersection of the marginal increase in private benefits (b_1, solid line) and marginal cost c' (dashed line). The two lines intersect at

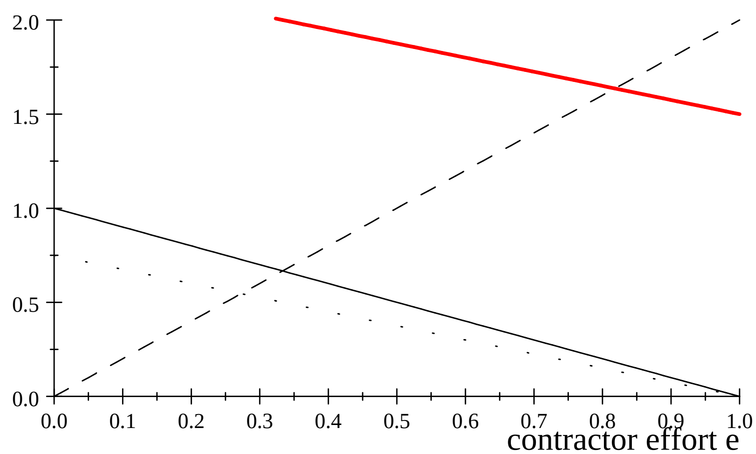

Figure 3: Effort choice of the contractor. The solid line represents marginal private benefit b_1 when the government selects $E^* = 1$, the dashed line marginal cost c', and the dotted line marginal private benefit when the government selects $E_2^{*P} = \delta$ (with discount factor $\delta = 3/4$).

$e^* = \frac{1}{3}$. Under PPP the marginal return is multiplied by the factor $\delta = 3/4$ in the figure (dotted line). Ceteris paribus, this decreases the equilibrium effort. However, as discussed above, PPP reduces government effort, which itself increases marginal private benefits ($b_{12} < 0$). In the figure, the red thick line describes the resulting marginal private benefit function. Clearly, the intersection of the resulting marginal private benefit function with the marginal cost function corresponds to a substantial increase in equilibrium contractor effort due to the use of PPP.

Next, we verify that the government's payoff may indeed be higher with PPP than with the traditional method in this example. The excess return of PPP

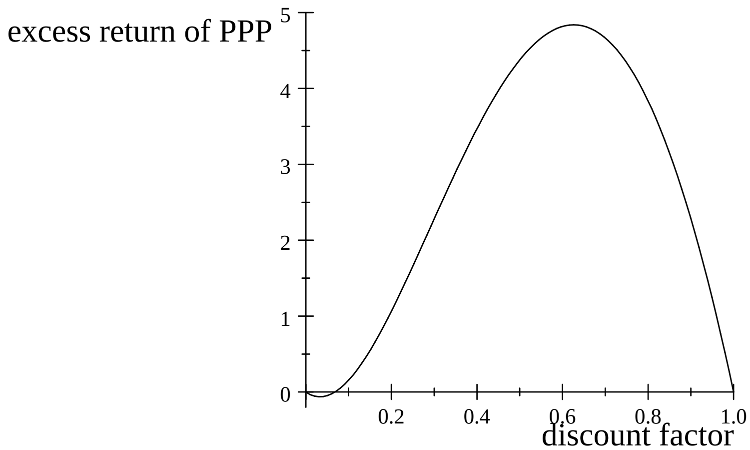

Figure 4: Government's excess return from PPP. The traditional method corresponds to $\delta = 1$.

to the government is given by

$$\begin{aligned} & \delta\left[\pi\left(\frac{\delta}{\delta+2}\left(9-8\delta\right),\delta\right)-\pi\left(\frac{1}{3},1\right)+b\left(\frac{\delta}{\delta+2}\left(9-8\delta\right),\delta\right)-b\left(\frac{1}{3},1\right)\right] \\ & +\delta C\left(1\right)-C\left(\delta\right)+\delta c\left(\frac{1}{3}\right)-c\left(\frac{\delta}{\delta+2}\left(9-8\delta\right)\right) \\ = & \frac{1}{2}\frac{\delta}{\delta+2}\left(64\delta^3-303\delta^2+255\delta-16\right). \end{aligned}$$

Figure 4 graphs this excess return as a function of the discount factor δ. Comparing this to Figure 1 we see that excess return is positive even for some values of δ for which contractor effort is an increasing function in Figure 1. As explained before, in order to see which method is optimal for the government, we should in fact compare the excess return for the actual value of δ to that under the traditional method ($\delta = 1$). Requiring contractor effort to be a decreasing function of δ for the entire range of discount factors in the interval $[\delta, 1]$ is in fact overly restrictive. From this figure it is clear that in this specific example, PPP increases the government's payoff for almost all values of δ.

Now consider the various components of the excess return of PPP. For the traditional method we have in equilibrium $\pi\left(\frac{1}{3},1\right)=\frac{13}{3}$, $b\left(\frac{1}{3},1\right)=\frac{5}{18}$, $C\left(1\right)=\frac{1}{2}$, $c\left(\frac{1}{3}\right)=\frac{1}{9}$.For PPP the corresponding equilibrium values are (for $t=2$):

$$
\begin{aligned}
\pi\left(\frac{\delta}{\delta+2}\left(9-8\delta\right),\delta\right) &= 10\left(\frac{\delta}{\delta+2}\left(9-8\delta\right)\right)+\delta=-\frac{\delta}{\delta+2}\left(79\delta-92\right), \\
b\left(\frac{\delta}{\delta+2}\left(9-8\delta\right),\delta\right) &= \left(9-\frac{1}{2}\left(\frac{\delta}{\delta+2}\left(9-8\delta\right)\right)-8\delta\right)\left(\frac{\delta}{\delta+2}\left(9-8\delta\right)\right) \\
&= \frac{1}{2}\frac{\delta}{\left(\delta+2\right)^2}\left(8\delta-9\right)\left(8\delta^2+23\delta-36\right), \\
C\left(\delta\right) &= \frac{1}{2}\delta^2, \\
c\left(\frac{\delta}{\delta+2}\left(9-8\delta\right)\right) &= \left(\frac{\delta}{\delta+2}\left(9-8\delta\right)\right)^2.
\end{aligned}
$$

Again, the equilibrium values under the traditional method can be derived from these by substituting the artificial value $\delta=1$. Figure 5 plots these expressions. The black curve represents social value π, the red one contractor private benefits b, the blue dashed one government monitoring cost C and the cyan dashed one contractor assessment cost c. The figure illustrates the different components of the excess return of PPP. We see that as δ moves from its artificial value of 1 – corresponding to the traditional method – to some actual value, say, in the region $[\frac{1}{2},1)$, both social value and private benefits increase. Clearly, less government monitoring implies a decrease in monitoring cost, and greater contractor effort implies greater contractor assessment costs. Increased private benefits lead to a (ceteris paribus) lower required payment from the government to the contractor. Similarly, increased contractor effort cost leads to a (ceteris paribus) higher required payment. Overall, the benefits of PPP to the government (increased social value, lower payment due to increased private benefits, and lower monitoring cost) exceed the costs (in terms of higher payment due to increased contractor effort cost).

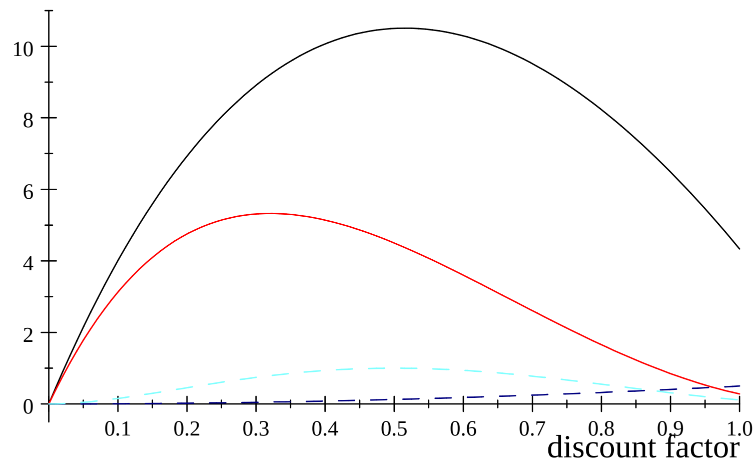

Figure 5: Components of the excess return of PPP. The black (top solid) curve represents social value π, the red (bottom solid) one contractor private benefits b, the blue (top dashed) one government monitoring cost C and the cyan (bottom dashed) one contractor assessment cost c. The traditional method corresponds to $\delta = 1$.

6 Conclusion

Clearly, there may be various reasons to engage in PPP. For example, bundling projects in a PPP may internalize externalities. Joint financing may allow risk sharing and greater investment. Private or shared ownership may provide incentives to the private party. This paper's contribution is to present one more justification for PPP by formalizing the argument that PPP may be associated with a loss of control for the government, which may eventually be beneficial by inducing greater contractor initiative.

We have shown that a government may indeed prefer PPP over the traditional method of outsourcing individual projects because it makes assessment relatively more costly. This will reduce government monitoring and may (under some conditions) increase the incentive of the contractor. This reduced monitoring and increased initiative are in line with the more popular literature on PPP which often states that PPP is associated with a loss of control for the government and a greater role – with more initiative, creativity, innovation and freedom – for the contractor. In terms of the initiative literature, PPP gives more real authority to the contractor because of less overruling by the government, who has formal authority. Note that in addition, effort costs may be higher with PPP because it is difficult to assess information early on. In the model we have ignored this, but this would only strengthen our results, in particular if this holds mainly for the government.

In our setup we focused on a fixed payment to the contractor upon realization of the project. That is, we ruled out by assumption the possibility to use an incentive payment to motivate the contractor to increase his effort. Our results show that by reducing monitoring PPP itself may yield high-powered incentives. We conjecture that in a setting where it is possible to write an incentive contract, the use of PPP and of an incentive contract may become substitute instruments in that respect. The question which of the two methods dominates in which situation is left for future research.

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