The Value of Public Private Partnerships in Infrastructure[1]

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Abstract: This paper makes three claims. First, and possibly in contrast to Public-Private Partnerships in other industries, infrastructure PPP contracts can be conditioned on the delivery of roads and railways of appropriate user quality. Secondly, the bundling of investment and maintenance into one single, rather than several separate contracts may provide a way to bypass rigidities and contract incompleteness in PPP contracts. Third, having a private concessionaire organising funding of a PPP project's investment costs may increase financing costs. This is, however, balanced by that it also enhances the agent's commitment in long-term incomplete contracts.

Keywords: PPP projects, asymmetric and incomplete contracting, risk, commitment.

JEL code: D8, L9

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[1] A previous version of this paper has been circulated under the title "Designing Public-Private Contracts for the Efficient Provision of Infrastructure Services".

[*] The paper is based from the work done with OECD (2008). I am indebted to Colin Stacey and Urban Karlström for many interesting discussions during the preparation of that report.

1. Introduction

Large investment projects are costly to build while the subsequent spending on maintenance and operations the facility is comparatively small. In view of their often long service life, the aggregate (present) value of spending on maintenance may still be substantial. Furthermore, there is a link between the two cost components in that more spent during the construction phase to create an asset with higher quality may save on subsequent maintenance costs, and vice versa. In addition, the quality of the road or railway may affect future users since an investment which has been built to high standard will have greater chances to deliver high-quality services.

Infrastructure investment shares these qualities with costly projects in several other sectors of the economy. Once built, a road, railway, airport or port has low opportunity costs, i.e. it has no value for other uses than it is built for. In combination with other market failure problems, this means that the provision of infrastructure services is typically a responsibility of the public rather than the private sector. But although the public sector is ultimately responsible for service delivery, only few countries still use in-house resources to build new and maintain existing infrastructure. Rather, these services are provided by the private sector after a process of competitive procurement.

The present paper describes the standard way in which the procurement contract between a public sector principal and a private sector agent is designed. This is done to construct a framework for comparison with the increasingly common use of Public-Private Partnerships (PPP's) in infrastructure provision. PPP is here defined to be a contract where the agent raises the capital needed to undertake an investment and retains control over it for a number of years after completion where after it is handed over to the procuring agency; this is referred to as bundling of construction and operations. While construction costs may be covered by way of tolling users, focus is here on the government paying back the costs based on a down payment scheme established in the original contract.

The purpose of the paper is to demonstrate that a standard qualification for the efficiency potential of PPP projects – that bundling may jeopardise service quality – may not be a major issue for infrastructure projects. This is so since both ex ante specification and ex post monitoring of service quality is feasible. The merits of PPP contracts should also be seen against a background of the shortcomings of the standard approach for unbundled procurement, in particular the rigidities generated by their command-and-control nature.

The focus in considering the pros and cons of PPP's should therefore be directed towards issues related to risk and the inevitable challenges posed by incomplete contracts which cover long periods of time. It is demonstrated that the use of private financing in PPP's may serve as a device for disciplining the private partner into renegotiation contracts on an equal footing with the principal in case of external shocks. In particular, this will cap the contractor's incentives to shirk on quality in construction in the hope of winning favours in subsequent renegotiations.

The plan of the paper is to summarise some insights from the contracting literature in section 2. Section 3 establishes the welfare properties of optimal provision of infrastructure services. This provides some substance to the issue of service quality and the necessity to account for user costs in the optimal design of new, and maintenance of the finalised project. Section 4 describes four different ways to contract for infrastructure investment and maintenance. The standard procurement model is in the engineering literature referred to as Design-Bid-Build. Three alternative models, where PPP is the third, gradually shift control over the project from principal to agent. Section 5 concludes. Examples from road projects and one railway project will be used, but the analysis would probably generalise also to other infrastructure projects. The wider applicability of the conclusions hinges on the possibility to measure and monitor quality in future service delivery in other applications.

2. Literature review

The literature on Public Private Partnerships is growing fast. Iossa & Martimort (2008) seek to analyse PPP's from a both the perspectives of asymmetric and incomplete information, at the same time summarising the previous literature. Iossa et al. (2007) provide a best practice manual for a range of design aspects. The purpose of the present review is rather more modest than in these papers in that focus only is on some specific aspects of the literature with immediate implications for the present paper.

A common denominator of the complete contracting literature, summarised for instance in Laffont & Tirole (1993), is the focus on the choice between fixed price and cost plus contracts and its implications for incentives and profit sharing. Incentives are best provided – are high powered – if the agent bears a high fraction of project costs (C). A fixed price contract has this quality but will at the same time make it feasible for the firm to make a rent. Reimbursing the firm's cost by a cost plus contract limits its rent but provides poor incentives for cost savings. The standard moral hazard model suggests an incentive contract to trade off these aspects, with reimbursement (t) being $t = \alpha - \beta C$, where a is a fixed remuneration and $0 \leq \beta \leq 1$ the cost sharing parameter. Except for the design of the remuneration, the granting of a contract after a bidding contest works to alleviate the adverse selection problems and to cap the possibility of excessive earnings in any class of contract.

In addition to the incentive-profits trade off, the power of contracts affects risk; the more risk over negative cost realisations that a contractor has to accept, the larger remuneration is required. A fixed price contract leaves all risk with the contractor while the procurer carries all risk with a cost plus contract. A bid for a specific project remunerated on a fixed price would – ceteris paribus – be higher than if cost plus remuneration would be used in order to compensate the bidder not only for the possibility of negative cost realisations but also for the very acceptance to carry this risk.

Chapter 7 in Milgrom and Roberts (1993) summarises the incentive intensity principle. Applied to the procurement context, the remuneration for an assignment should be closer to a fixed price contract the more discretion the agent can be given about how to do the job, including the pace of work, the methods to use, etc. In addition, the more the agent can do to reduce the expected costs of a project, the higher should the power in the contract be. If the agent can hedge ex ante, or can take precautionary action in order to reduce the consequences of negative realisations, it is therefore reason to provide incentives for doing so. Moreover, differences with respect to risk aversion between agents as well as the costs for quality monitoring should affect the power of the contract.

A PPP combines two stages of the process towards delivery of infrastructure services, i.e. investment and the subsequent maintenance of a finalised project. The common view, demonstrated in several different papers, on the pros and cons of bundling has been summarised in the following way:

(B)y "bundling" construction and operations, they induce the developer to internalize cost reductions at the operations stage that are brought about by investment at the development stage. But, by the same token, bundling … may encourage choices that reduce future costs at the expense of service quality. (Maskin & Tirole 2006, p. 2.)

Under the incomplete contracting perspective, inefficiencies arise not because one party to a contract ex ante knows more about matters of pertinence for the contract's execution than the other. Rather, the issue at hand relates to the difficulty for both parties to foresee and contract about the uncertain future. In these situations, ownership matters since the owner of an asset or firm can make all decisions concerning the asset or firm that are not included in the initial contract.

Applied to the PPP context, Hart (2003) concludes that bundling may be good if there are good performance measures which can be used to reward or penalise the bidder. If not, it may be beneficial to buy construction services from one provider and operations from another in order to block the risk for that cost savings during the investment phase come at the price of inferior quality for the final users. Conclusions are thus similar as in the complete but asymmetric information context.

Bajari & Tadelis (2001) analyse the choice between fixed price and cost plus contracts based on the empirical observation that the cost sharing parameter in reality is zero or one; incentive contracts are rare. This is attributed to that the ex ante information asymmetry may be small but that contracts have to be renegotiated, for instance due to unexpected preconditions for a project. An advantage of the cost plus contract is that it ex ante presupposes day-to-day communication between the contracting parties, making it easier to adjust the contract to the precise situation at hand when a project is to be implemented. It is demonstrated that the contracting issue is more concerned with how the parties may adapt once the contract once it has been signed rather than the possibility of ex ante information rents. Safeguarding the competitive pressure, the financial situation of the winning bidder as well as the winners track record from previous contracts may therefore be more important than the power of the contract for the outcome of a deal.

This perspective is further developed in Bajari et al (2007) where the incompleteness of the contracts is in focus. Final costs may be higher than the winning bid and the realisation of the contract may also result in substantial costs for adaptation and renegotiation. A database comprising road construction contracts in California is analysed and it is demonstrated that adaptation costs may account for about ten percent of the winning bid.

3. The Generic Welfare Maximisation Problem

The generic features of an infrastructure investment problem provide the framework for the understanding of issues also in the contracting of the tasks. The investment problem is concerned with the establishment the optimal capacity K and usage N of a certain road, given that optimal road pricing is implemented:[2] In equation (1), social welfare (S) is the difference between benefits (B) and costs (C) associated with the project. Benefits are represented by D(•), the inverse demand for trips which at the margin coincides with the willingness to pay for using a road. t is the toll – if any – to be paid for using the facilities and the restriction ascertains that supply is equal to demand in equilibrium.

Costs comprise three components: The first refers to costs for N identical users each with cost function $C_u=c_u(N,K)$, which refers to time, vehicle operating costs etc of using a certain road. The second component represents costs for third parties, $C_3=C_3(N)$. This captures the possibility that traffic is noisy or generates other external hazards for residents along the road or for society at large. Thirdly, there is a cost for providing capacity, $C_{cap}=C_{cap}(N,K)$. K=1 if the road is built, and zero otherwise. All costs are related to the road's traffic (N). Benefits and costs are discounted present values.

$$\underset{N,K}{Max}\, S = B - C_u - C_3 - C_{cap} =$$
$$= \int_0^N D(n)dn - N * c_u(N,K) - c_3(N) - C_{cap}(N,K) \qquad (1)$$

$$s.t. \quad C_u + C_3 + C_{cap} + \tau - D(\cdot) = 0$$

Assume now that a decision to build the road has been taken. The tradeoffs in the construction and maintenance of this road, given a certain projection $\hat{N}$ for current and future demand, is captured by (2), where overall costs for society are minimised by choosing an appropriate quality (q). This refers to the standard of the infrastructure that is to be built, incorporating both its capacity (more capacity means lower user costs) as well as surface smoothness or safety performance. (3) is the optimality condition where superscripts denotes the partial derivative.

$$\underset{q}{Min}\, C = N * c_u(\hat{N},q) + c_3(\hat{N},q) + C_{cap}(\hat{N},q) \qquad (2)$$

$$\hat{N} * c_u^q + c_3^q + C^q = 0 \qquad (3)$$

Capacity costs is made up of both the resources allocated for building the facility (k) and for subsequent maintenance (c); $C_{cap}(\hat{N},q) = k(\hat{N},q) + c(\hat{N},q)$. Construction costs increase in quality since a better – i.e. a straighter and wider road – is more expensive to build than a more curvy and narrow road; $k^q>0$. But a thicker sub-structure may reduce future maintenance spending, meaning that there is an externality between construction and maintenance; $c^q<0$. The optimum quality from the perspective of direct, financial costs – q^p – is thus when $k^q=c^q$. Figure 1 illustrates this for reasonable assumptions about second derivatives.

[2] The notation in this section is based on Verhoef (2005).

But the better the quality of a road, i.e. the smoother and more convenient a trip is, the lower are (generalised) user costs; $c_u^q < 0$. Moreover, it is feasible to build and maintain the road in ways that reduce third party costs. Noise can be mitigated by using certain less noisy pavements. Emissions by way of particles from studded tires can be curbed by using pavements which are harder than others, emitting fewer particles. Costly extra spending on higher quality may therefore reduce third-party costs, i.e. $c_3^q < 0$.

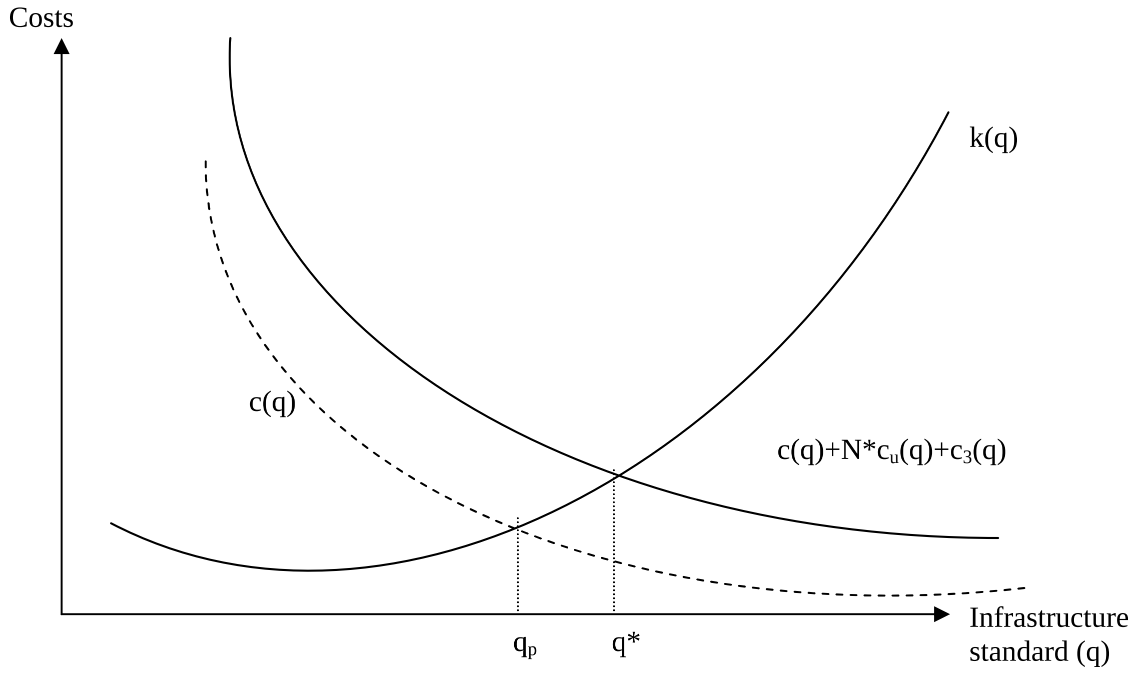

Figure 1: Balancing construction and maintenance costs against costs for users and third parties.

Social efficiency, illustrated as q* in Figure 1, calls for balancing construction costs against the implications of quality choice not only for subsequent maintenance but also with respect to its impact for users and third parties. The socially efficient quality is therefore higher than if the facility is built with the objective to minimise financial costs only, i.e. $q^* > q^f$. The challenge is to find a way to implement this policy.

4. Service delivery

The provision of infrastructure services is a basic responsibility of the public sector. For many years and in most countries, in-house resources were used to maintain existing infrastructure and partially or fully also to undertake investment projects. This is a command-and-control strategy where the policy, in section 3 defined in terms of the infrastructure's quality, is implemented by devising detailed instructions to the agency's own staff. The concrete cornerstone of this strategy has been a set of manuals with detailed technical instructions about how to build and maintain a road, a bridge, a tunnel etc. Manuals and construction norms represent the accumulated experiences of design and maintenance strategies and provide state-of-the-art instructions for how roads are to be built under various external conditions.

In order to enhance productive efficiency, the common practice for implementation has shifted from using in-house resources towards competitive procurement. This section will specify four different approaches for designing the procurement process and the subsequent contract(s) between a representative for the public sector and one or more commercial provider(s) of construction and maintenance services. The purpose is to pinpoint how these models differ from each other and to establish their overall efficiency qualities in a descriptive way. Engineers refer to traditional contracting as Design-Bid-Build (4.1) where after three alternative models are described to be Design-Build (4.2), performance contracting (4.3) and Public-Private Partnerships (4.4).

4.1 Design-Bid-Build

It is not straightforward to get an overview over how different countries organise their procurement contests and which contract format that is subsequently used. In this section, the DBB procedure applied in Sweden will therefore be used to characterise what seems to represent procedures used also elsewhere.

A first feature of the traditional framework is the unbundled procurement of separate tasks. At date $t = 1$, based on a crude description of the project conceived at time $t = 0$, the principal tenders the services of a consultant to undertake the detailed project design using the codified construction norms developed by the procurer (cf. figure 2). At date t=2, the investment project is advertised in a quote for bids based on the resulting detail plan. At date t=3, when the project is opened for traffic, a maintenance contract is let, typically for a period of 4-8 years.[3] In addition to contracts for on-going maintenance, the road surface has to be renewed every 10 to 20 years, projects which also are tendered separately from the rest of the activities. Maintenance and reinvestment activities are re-let until the end of the project life, T.

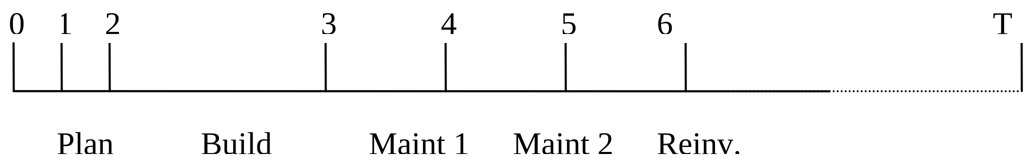

Figure 2: Time line

The t=1 contract for detailed planning has a fixed price structure, while unit price contracts (UPC) is the received way to remunerate the agent for construction works. Maintenance and reinvestment contracts combine fixed price and performance contracting (to be described further in section 4.3 below).

To be more specific about the construction contract, the consultant's work plan is made the core of the quote for bids for the t=2 assignment.The quote comprises a detailed description of all activities that have to be carried out in order to have the road built. This includes estimated hours of work to undertake meticulously defined tasks, volumes of clay, gravel, rock and asphalt to be moved from here to there and a host of other activities. The UPC therefore codifies an assignment in terms of project inputs, quantities $\bar{x}_i$ for all activities i=1,…,n required to have the road built. Some activities which are necessary for implementation can not be quantified a priori. The quote therefore only describes

[3] To be precise, the finalised project is made part of a maintenance district which is re-let with approximately this interval.

these activities. Each interested entrepreneur submits a bid comprising the unit price, p_i, for each $\bar{x}_i$ as well as a (typically small) fixed sum for the non-quantified activities (P). The aggregate bid from the winning bidder is $B = P + \sum p_i \bar{x}_i$. Actual disbursements are made according to actual volumes up to $\bar{x}_i$.

UPC puts all risk with respect to the cost assessment – the p_i's – with the agent while the principal is responsible for any deviations from volume assessments. If the estimation of work load is risky, for instance due to problems with the geotechnical preconditions for a project, it may be efficient to relieve the more risk-averse agent from carrying this risk. But even in the presence of completely external risk it is reason to have the agent accept at least some risk. If not, the builder has no incentives to hedge against the possibility of negative cost realisations or to reduce the consequences of a negative realisation, should it occur.

The UPC moreover provides poor incentives to make productivity enhancing changes of the way in which a project is implemented, once the contract has been awarded. This is potentially important since a consultant is used to calculate $\bar{x}_i$ based on ex ante estimates without regard to the precise skills and equipment of each contractor. In addition, the situation at the work site may differ from the ex ante estimate. But a contract which specifies a maximum volume of $\bar{x}_i$ generating revenue $p_i \bar{x}_i$ discourages the agent to use some alternative approach which would only require $\tilde{x}_i < \bar{x}_i$ even if the implementation process makes it obvious that it would save on costs. On the contrary, the contractor has reason to claim that $\bar{x}_i$ underestimates the actual quantity.

While the UPC format preserves the motives for saving on p_i relative to the bid which is submitted, for instance by purchasing more cost efficient equipment, it provides no incentives for productivity enhancement once the builder has been identified. Since volume estimates often have to be adjusted during the implementation process[4], $\bar{q}_i$ may become a volume floor rather than a ceiling.

Unbalanced bidding is another potential problem of a UPC contract. A bidder who believes that the assessment of the work load, i.e. $\bar{q}_i$, is incorrect can increase p_i on quantities that are believed to be underestimated, simultaneously reducing bids on items that have been overestimated. B is then left unaffected but the expected earnings increase. Unbalanced bidding reduces the potential of a bidding contest to identify the most cost efficient agent since there is no automatic link between making better estimates of work volumes and being most efficient. Ewerhart & Fieseler (2003) argue that UPC still may have a potential for efficiency in that it sharpens competition by giving also less efficient bidders scope for remaining in the market. Bajari et al (2007) report that unbalanced bidding is not a major issue in the contracts they have analysed.

Except for volume adjustments, the nature of many projects often have to be adjusted once the winning bidder has been named and the construction process initiated.[5] The costs for the necessary change orders have to be negotiated on a bilateral basis between the principal and the agent, which may drive up costs considerably. In particular, these cost increases may be higher under fixed price and UPC cost reimbursement than if costs are reimbursed on going concern; cf. Bajari & Tadelis (2001)

DBB can be seen as an instrument to ascertain that the procurer is really buying the “correct” product. The implementation programme detailed in the quote for bids is meant to guarantee the delivery of a high quality road so that excessive maintenance due to poor design or implementation is avoided. Nothing is left to chance or to the discretion of the entrepreneur, who first and foremost is made as an engine for construction, i.e. for completing a detailed programme to the last nuts and bolts. It differs

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[4] The Swedish Road Administration makes a standard 10 percent reservation in the budget to account for cost increases of this nature.

from using in-house resources primarily in that there is competition for each contract. Competitive procurement using DBB with Unit Price Contracts may therefore deliver substantial cost savings compared to in-house production[6] but it does not make use of the innovative potential of commercial firms. Taken together, these downsides with DBB may provide at least one reason for the lagging performance of the industry.[7]

4.2 Design-Build

In the same way as DBB, a Design-Build (DB) contract separates the procurement of an investment project from subsequent maintenance and renewal activities. It differs from DBB in that the quote for bids describes a road with certain overall qualities that should be made available. Both detailed design and construction methods are therefore to be established by the same contractor who is subsequently to implement the project; the builder is engaged in project planning at time t=1 rather than at t=2.

A downside of DB contracts is that all bidders must prepare their own detailed project planning before submitting a bid, inevitably generating a degree of cost duplication.[8] These costs can at least to some extent be reduced if the principal undertakes some of the costly background work for volume estimates, for instance by making geotechnical surveys available to all bidders. Based on site examinations made by both own staff and external experts, it is still necessary for each bidder to identify the idiosyncrasies of a project in order to make cost estimates and to pinpoint the types of risk that have to be dealt with.

DB replaces a UPC with a fixed price contract, providing stronger incentives for cost savings. The increased risk that the contractor has to accept can be balanced by relaxing the restrictions on the way in which a contract has to be implemented, providing scope to counter unanticipated conditions in the

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[5] One Swedish example is a large project where it became obvious that a non-anticipated interchange had to be built. After negotiations between the parties this added almost 10 percent to construction costs.

[6] Arnek (2001) estimates the costs savings when Sweden's road maintenance was being outsourced from 1993 and onwards to be in the 15-30 percent range.

[7] Cost overruns and late delivery seem to be endemic; is there a reference? In Sweden, national accounting data indicate that labour productivity doubled in overall commercial activities between 1980 and 2005; in industrial activities it more than tripled while the construction industry saw a more modest 30 percent increase.

best way possible. To cap the increase in profits of a high-powered reward structure, it is important to safeguard competition during the bidding contest.

Furthermore, exceptionally risky parts of an assignment can be singled out and handled separately from the fixed price contract. In 2005, the Swedish Road Administration signed a SEK 555 million contract with a builder for a new 7 km highway. One part of the project was a 1,1 km tunnel. With the quality of the rock being uncertain, the quote had specifically asked for separate bids for the tunnel and the rest of the project respectively. The quote also indicated that the builder could retain 40 percent of any cost savings made, and had to accept 30 percent of cost overruns, relative to the bid. Out of the winning bid, SEK 51 million was for the tunnelling.

4.3 Performance contract and bundling

The DB sharpens incentives for cost savings by affording more flexibility during the project's implementation phase. A further step to enhance the entrepreneur's control over, and responsibility for the way in which a project is built is to extend the construction contract to include also maintenance and renewals. Initially assuming that the contract extends into eternity, a performance contract[9] bundles a DB-type investment project with subsequent maintenance and renewal activities, replacing the sequence of procurement contracts in figure 3 with one single.

In the same way as for DB, performance contracts are signed with a fixed price reimbursement of construction costs or possibly with incentivising clauses. Payments for maintenance costs are routinely indexed in order to make the principal carry the risk for unexpected changes of absolute and/or relative price levels.

A performance contract is a Public-Private Partnership minus one aspect to be addressed in the next section. The conventional wisdom in the literature on the welfare properties of PPP's, is that the

[8] To the extent that a firm considers submitting an unbalanced bid, at least some exercise of this nature is required also under a DBB scheme.

bundling of construction and operations induces the contractor to internalize cost reductions at the operations stage that are brought about by the original investment. More (or less) may be spent on the investment in order to save on (accept higher) future maintenance costs, provided that life cycle costs come down. Even if the industry's standard manuals and methods can still be used, this is at the discretion of the entrepreneur.

Equation (3) and figure 1 however show that bundling may encourage choices that optimise construction and maintenance costs at the expense of service quality. Rather than detailing the methods to be used (the inputs in DBB procurement) or the qualities of the road at opening (the output specified by a DB procurement), the quote for bids must therefore establish the functional targets – the performance standards – that should be delivered during the service life of the contract. The agent will subsequently be reimbursed for the annual maintenance costs according to whether these targets have been met or not.

A core claim of the present paper is that the ex ante design of appropriate parameter values is straightforward. This is so since value of time savings, of reduced accident risks etc. is available to undertake the Cost Benefit Analysis (CBA) preceding the decision to build the road. CBA for infrastructure investment has a long history (references to World Bank, Europe and Sweden), and research on the appropriate parameter values is extensive. As always, uncertainties remain but most probably not more so than in any material required for decision making.

The quote for bids must therefore condition payments on the principal's knowledge about c_u^q and c_3^q. Since C^q is the contractor's private information, incentives are given to implement q* rather than q. A performance contract will therefore have to quantify at least the following parameters:

[9] In a World Bank paper, Stankevich et al (2005) refer to performance contracts as first and foremost renewal contracts that also include several years of maintenance. In Sweden, performance contracts are labelled "functional contracts".

- Availability: Payments from principal to agent for a new piece of infrastructure must be conditioned on lanes or sections becoming available for use and on being available during the duration of the contract. Technically, this can be done by a conditioning the first payment on a certain date for traffic opening with a penalty/bonus to punish/remunerate late/early opening. The strength of the incentives can be calculated based on users' travel time savings. In the same way, availability clauses can provide incentives for undertaking (planned) maintenance activities during off-peak periods of the day or of the year.
- Road surface quality: The quality of travelling deteriorates when a road gets increasingly uneven. Bumpy rides have consequences for the time of a journey, for vehicle operating costs, for riding comfort and possibly also for safety. CBA parameter values are available to estimate these consequences for users, while the contractor's maintenance costs c(q) is private information. Based on ex ante estimates, it is still feasible to estimate c(q) and consequently pinpoint a proxy for q*, say $\tilde{q}$. Deviations from $\tilde{q}$ can be penalised/rewarded according to an incentivising scheme.
- Safety: Except for road surface quality, also other contractor activities may affect road safety; examples include snow clearance, maintenance of street lights, road markings and side-rails as well as clearing of side areas in order to reduce the risk for wildlife accidents. These aspects may be tricky to steer by using economic incentives but can be dealt with by minimum standard clauses in the contract. In addition, the actual number of accidents can be benchmarked against risks on other, similar roads in order to punish poor and remunerate good performance.
- Environmental concerns: The choice of material of a road's top layer may have consequences both for noise from traffic and the extent of particles worn off by studded tires. To the extent that the principal has information about these and other environmental externalities, these concerns should be included in the contract. Again, it could either be done by way of direct instructions or with bonus/penalty constructions linked to the annual remuneration.

Not only ex ante information about user benefits, but also the information required to monitor performance is readily available already under today's institutions. It is obvious when a project is opened for traffic and information about lane closures due to maintenance or accidents is straightforward to collect. Road surface smoothness (rut depth and longitudinal waves) are routinely measured on a continuous basis. Essential aspects of quality can therefore be controlled in a performance contract to reduce the risk of substandard quality in long contracts to build and maintain roads.

Proposition: Since quality can be ex ante specified and ex post measured and monitored, the risk for that savings of investment and maintenance costs are made at the expense of users is small. Bundling therefore dominates the separate procurement of investment and maintenance in infrastructure projects.

The discussion so far is based on the assumption of an eternal maintenance contract, which induces the contractor to internalise any and all implications of the choice of construction quality for future maintenance and user costs. There are obvious problems with never-ending contracts. One is that the initial tendering contest may generate high bids to insulate the winning contractor against an uncertain future. Moreover, any and all future improvements in cost efficiency in maintenance will benefit the contractor. It is therefore reason to consider contracts with shorter duration.

The prime trade-off in the choice of contract duration lies in the necessity to induce the contractor to internalise the consequences of the choice of the construction standard. In particular, it is vital to avoid that the contractor optimises construction so as to satisfy performance criteria during the contract period but that the facility falls apart shortly after that it is handled over to the principal.

On the other hand, tradeoffs in engineering design with respect to life length are highly imprecise, i.e. it is difficult to construct a facility to pinpoint precisely when the infrastructure starts falling apart. This may mean that the contract could cover a period of one or two expected renewals in order to avoid any excessive strategic policy to shirk on long-term quality to save on investment costs.[10] It is also straight-forward to reintroduce some specific technical restrictions on construction in the contract and to require inspection before and at hand-over with quality requirements that have to be met. Both techniques will constrain the contractor's control over design and the possibility to implement innovative construction solutions but will reduce the threat against future requirements for extensive rehabilitation of malfunctioning assets.

4.4 Public Private Partnership

Public Private Partnerships (PPP) are often thought of as a mechanism for bundling investment and maintenance into one single contract. Here, PPP is rather defined as a combination of bundling and external funding: a PPP is a performance contract where the contractor uses a combination of equity and external loans to have the project built and where construction costs are repaid during the lifetime of the contract.

There are different ways for the contractor to recoup the initial costs. Tolls and shadow tolls (where the government, not the vehicle users pay the toll) expose the contractor to traffic risk. Without any loss of generalisation, it is assumed here that costs are recovered by the government making availability payments to the contractor. Based on the original bid, the contractor is compensated for annual maintenance costs plus a down payment, for instance an annuity, of the initial investment cost. Compensation is affected by performance by way of carrot-and-stick clauses according to the design outlined in the previous section.

Figure 3 is used to be more precise about the difference between PPP and a performance contract. The performance contract remunerates the entrepreneur for investment costs during the construction period and for maintenance costs during the rest of the contract period (the graph with diamonds).[11] The

[10] A Swedish performance contract was signed for 15 years maintenance after traffic opening. The argument seems to have been that any construction failures would have materialised within that time span.

[11] The figure is constructed assuming that the project lasts for a period of 40 years where after it has no scrap value. It costs 330 to build the project, 110 for each of three years of construction. The annual maintenance cost is 1 percent of the total investment, increasing with 1,5 percent per year. Every 12th year a reinvestment, which

upper graph with squares, starting year 4, illustrates disbursements under the PPP alternative, assuming an annuity with 6 percent interest to pay back the investment costs plus the annual maintenance cost and the spending on recurrent reinvestment.

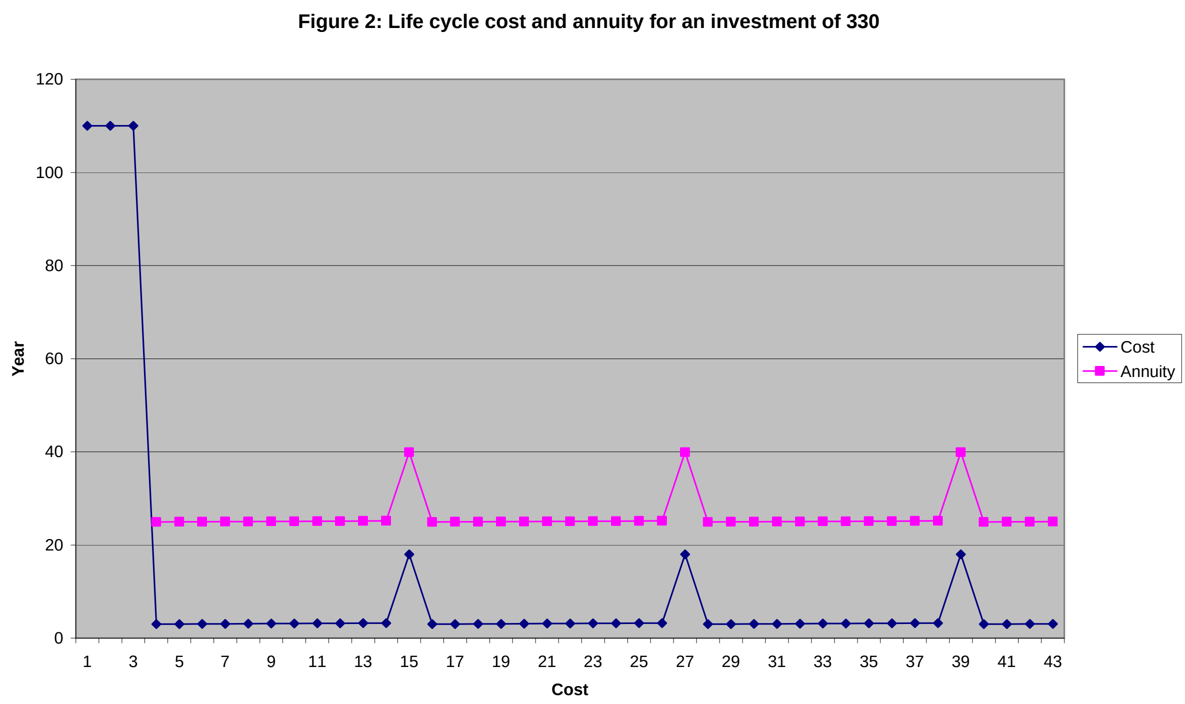

Figure 3: Life cycle costs and annuity for an infrastructure investment.

An obvious down side of having the contractor raise project financing is that commercial firms typically are charged a higher interest than if a public sector representative would borrow the same amount of money. In view of that the private borrower has a contract with the public sector which guarantees an income stream to service debt the interest rate differential is, however, not necessarily large.

There are two arguments to balance this cost increase. First, any potential lender will make a detailed review of the project in order to assess the downside risk of the loan. This includes due diligence analyses of any technical aspects of the project proposal which may affect its financial viability. The

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costs 6 percent of the investment cost, is undertaken. After that this new pavement has been laid, maintenance review could for instance scrutinize the intertemporal trade-offs made in the investment proposal between investment and maintenance costs. This scrutiny benefits not only the lender but will also increase the chances for a project as a whole to be beneficial. External reviewing on a commercial basis is typically much more scrupulous than if project finance is raised over the state budget. The interest rate differential is therefore at least partially a payment for risk reduction.

A second argument for private financing is that it can operate as a lever to enhance the agent's commitment to the contract in a world of opportunism and incomplete contracts. To see this, the financial streams under a performance and a PPP contract, respectively, will have to be compared. In both situations, it is assumed that the agent is corporatised in the shape of a special purpose vehicle (SPV) to insulate the ultimate owners against extreme risk exposure.

Assume now that an unanticipated quality problem appears in year $t<T$, making it necessary to increase maintenance costs from c to $\hat{c}$. Under both contracts it is assumed that the SPV has built the project according to its own specification in order to optimise costs over the life of the contract. With a fixed price reimbursement of maintenance costs the contractor is liable for cost increases of this nature.

Under a performance contract, the SPV has been reimbursed for initial investment costs but will only receive c to pay for maintenance costs $\hat{c}>c$. If the difference between $\hat{c}$ and c is large, or with little or no own capital left, the SPV risks going bankrupt. The principal's choice is between increasing payments to $\hat{c}$ or to take over the facility, possibly re-let it but still having to pay a higher maintenance cost than contracted for.

Also under a PPP contract, the SPV faces costs $\hat{c}>c$ at date t. At the same time, it has an asset (A) in the shape of a claim on the public sector being A_t. Its debt is D_t and H_t, representing what is left of the

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costs drop to the original level of 1 percent of the investment cost again. The discount rate is 4 percent.

investor's debt to banks and risk capital, respectively, at this point of time. One part of this asset is the SPV's profits from having won the contract. Rising maintenance costs means that the SPV will seek to renegotiate the contract. One extreme outcome would be to receive c and make a loss of $\hat{c} - c$; the other extreme outcome would be to go bankrupt. The banks would then still sit with their claim D_t on the SPV and the owners would loose H_t. If $H_t > (\hat{c} - c)$ there is scope for bargaining and the principal will not necessarily have to pay the full cost increase.

The significance of this shift of bargaining power can be further emphasised by backtracking to the situation when the project was first tendered. Each bidder will then make its own estimate of project costs and the lowest aggregate bid B will win the contest. Assume for simplicity that each bidder has a choice between two strategies. Strategy I combines a high (h) investment cost with low (l) future maintenance costs while strategy II has the opposite combination; ε is a random term specific for each bidder.

$$B^{I} = k^{h} + c^{l} + \varepsilon$$

$$B^{II} = k^{l} + c^{h} + \varepsilon$$

Assume furthermore that the winning bidder – in spite of that actual costs follow paths I or II – submits a bid $\tilde{B} = k^{l} + c^{l} + \varepsilon$. $\tilde{B}$ will on average be lower that any bid submitted by competitors following strategy I or II. Some years into the contract maintenance costs will start to grow, and the bidder will seek to renegotiate the contract. The chances of successful renegotiation are then higher under a performance contract than under a PPP contract.

A PPP contract obviously contributes to disciplining the agent into submitting bids that can be expected to be viable for the whole life cycle of the contract. This is particularly important in view of the long contract periods and the impossibility to account for, or indeed to envisage, all feasible contingencies at the date of contracting. A contractor can claim that cost increases are due to external events not accounted for in the original contract, while they in reality may be due to poor effort or incorrect investment decisions.[12]

But the long contracting periods also means that much may happen that can not be anticipated at contract closure, and renegotiations should be seen as something natural.[13] Many of the frequent adjustments and complementary investments that have to be made on fairly new roads or railways could indeed be conceived of in this way. The benefit of using private investment resources to pay for PPP investments lies in that it increases the chance that the parties handle any future renegotiation in a balanced way. The risk that the tax payer will have to foot the bill not only due to random events that are bound to appear irrespective of if a project is implemented within the public sector or by way of some procurement strategy, but also for poor project construction due to fallacies in contract design is therefore reduced.

5. Conclusions

Governments around the world seem to be pushing for PPP contracts, but partly for the wrong reasons. One motive is the wish to circumvent fiscal restrictions on deficit spending and the size of public sector debt. In some countries restrictions have the shape of budget balance or surplus rules; in (much of) the EU it is Maastricht criteria for fiscal stability that are bypassed. Mince and Smart (2006) demonstrate that this is but a motive for fooling oneself.

Another reason behind the growth of PPP contracts is the belief that it is a tool for attracting new funds. To the extent that PPP's are introduced as a mechanism for introducing a capital spending budget, there may indeed during a short period be some extra scope provided for additional

[12] The Arlanda railway link is a Swedish PPP contract signed in 1993 with services opening in late 1999. Shortly after, the September 11 attack had severe consequences for international air traffic, for patronage at the airport and on the train, and put the operator of the airport commuter service under severe financial strain. The financing solution established in the 1993 contract, however, meant that the SPV could not expect the government to make up for the losses. In case of bankruptcy, the owners would have lost their risk capital while the banks would have retained their claims on the company. Losses were therefore covered by owners and after a couple of years, results were again in the black. Se further Nilsson et al. (2008).

[13] "Commitment does not mean that the parties will abide by their contract in the future but only that the contract will be implemented if at least one of the wishes so. The parties are always free to agree to modify the contract to their mutual advantage. Full commitment is an idealized case." Laffont & Tirole 1993, p 437)

(investment) spending. Within short, down payments on the accumulating debt will however start to grow and in a steady state the only difference between financing over the current or a capital budget will be the extra costs interest costs incurred under the latter strategy (cf. OECD 2008, in particular ch. 8 for a simple numerical example plus a description of countries where this has happened).

A third motive for the introduction of PPP's which also is based on the idea of attracting extra financing, is that projects can be paid for by way of user charges. Although there certainly are situations where for instance a road toll may be first or second best efficient, there is nothing which makes this an intrinsic feature of PPP contracting; tolls can be implemented without PPP contract backing it.

The focus of the present paper is on the potential efficiency qualities of PPP projects. Although data is hard to get by, the construction industry's productivity performance seems to be well below the average for industry at large in several countries (source?). There are probably a number of reasons for this feeble performance, but it is reasonable to include the micro-foundations of standard contracting procedures in the industry, in particular the rigidities superimposed by Unit Price Contracts, on this list. This paper has argued that PPP projects offer a way to loosen the tight ties of the received way to contract in the sector. Even if PPP's may not be appropriate to use for all types of projects, they facilitate the testing of novel construction approaches which subsequently may spread to other parts of the industry.

A second conclusion of the analysis is that it is feasible to control for user benefits and costs in the performance clauses signed between public sector principal and private sector agent. There is therefore no quality tradeoffs in the bundling dimension of PPP's, discussed in both the asymmetric and incomplete information literature.

This does not mean that PPP's are a panacea in infrastructure contracting. There are, indeed, substantial challenges left. One of them, the risk for poor commitment, is however at least partly handled by way of the contractor's obligation to finance the project with loans and risk capital. It has been demonstrated that this can be seen as a mechanism for reducing the risk that the winning bidder has based the victory on a presumption of that future negotiations can make up for cost increases in maintenance due to a sloppy construction design.

In view of the extensive interest in PPP's, it is surprising that relatively few ex post assessments have been made. One obvious reason is, of course, that most long-lived PPP's are still under operation, making it impossible to summarise their life-cycle performance. Three micro-based reviews of European experiences have, however, been made of the situation after that the construction part of the contract has been completed; (CEPA 2005, NERA 2003 and Sandberg et al 2007).[14] An overall observation is that PPP projects seem to have at least three features in common; they are opened before or on time while standard contracts often run late; they face fewer cost overruns than their peers; but there are no indications of cost savings for the principal.

All three features could be rationalised within the framework of the present paper. No payment for services rendered by a contractor will be made before it is opened to traffic, providing strong motives to be on time. PPP contracts make extensive use of fixed price reward schemes which reduce the possibility to require compensation for cost overruns. And there may be several reasons for that no cost savings have been reported. One of them is that bidders could have padded their bids in order to bolster the risk for future cost increases; another that construction is made more expensive in order to save on future maintenance, providing for reduced life cycle costs. In addition, there are indications that representatives of the principal have problems with letting the conventional wisdom of manuals go. Also contracts which are said to be signed on performance criteria may therefore include restrictions on the way in which the projects are to be built. This eliminates one possible source of cost savings.

[14] In addition, experiences from South America are discussed by for instance Guash 2004 and Guash et al (2008).

The absence of ex post reviews of Public Private Partnerships may provide an indication of an overall attitude towards monitoring and learning in the public sector. Considering the huge shares of public sector services being provided by way of procurement rather than using in-house resources, it would be expected that there is an intense interest in the performance of the different mechanisms which are being used. There are indeed a number of good examples of performance analyses undertaken in different countries, some of them cited here. More often than not, this however seems to be the result of researchers having stumbled over a dataset which has been assembled for some random reason, or by someone – often a pd d student – spending a lot of time on assembling data. At the end of the day, this means that we lack a good overall understanding of how alternative designs of procurement and remuneration mechanisms actually function and indeed of whether procurement at large delivers the benefits that theory predicts.

For the present paper, this means that several claims, in particular about what is referred to as traditional procurement, is based on a semi-structured discussion rather than on rigorous empirical scrutiny of data. Much remains to be done to improve the performance of the public sector's purchase of goods and services. This paper has argued that Public Private Partnerships may fit into the toolbox to enhance efficiency.

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