Technical Note

Theoretical Considerations on Quantitative PPP Viability Analysis

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Abstract: Public-private partnerships (PPPs) are an innovative procurement model that appeared as an alternative to traditional methods such as public work contracts. The public sector comparator (PSC) allows decision-makers to decide whether the project should be developed along one of two different paths: PPP or traditional procurement. This paper provides a theoretical base for PSC calculation and sheds some light on the main critical issues, particularly the choice of the discount rate through a real case—a hospital PPP. Alternative methodologies for calculating the discount rate and different assumptions can lead to completely different results, biasing the final decision. **DOI: 10.1061/(ASCE)ME.1943-5479.0000184.** *© 2014 American Society of Civil Engineers.*

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Introduction

Governments have been using public-private partnership (PPP) contracts worldwide as a tool to develop and manage public infrastructure and services. The underlying goal when developing a PPP project should be to ensure that the infrastructure and/or service are provided to maximize the social welfare. This means to provide the best service at the lowest cost. Therefore, PPP contracts fall into the category of procurement models, although the literature suggests several classifications for these projects (Bennett and Iossa 2006; Cheung et al. 2010; Marques and Berg 2011).

Over the last 15 years, the literature on PPP development and management has been growing (e.g., Truitt and Esler 1996; Guasch et al. 2008; Engel et al. 2009; Marques and Berg 2010; Cheung and Chan 2011; Cruz and Marques 2011; Papajohn et al. 2011; Rebeiz 2012).

Nevertheless, some key questions remain unanswered: Why do governments use PPP arrangements? What is the alternative? How is a choice made among the alternatives?

Notwithstanding the usefulness of the previous literature, a step back to analyze *what went wrong* previously may provide helpful tools to improve the future development of PPP projects. This means going back into the moment when the PPP option was first selected as the optimal procurement model. This particular area has been neglected by the literature.

In every project developed through a PPP scheme there is always an alternative—traditional procurement. The existence of this alternative requires a comparison, either qualitative or quantitative, so that the most appropriate model will be chosen. To avoid the subjectivity of qualitative assessment, practitioners have developed a quantitative tool called the *public sector comparator* (PSC).

The PSC can be described as the net present value (NPV) of all life-cycle costs and revenues, considering that the infrastructure, or service, is publicly developed and efficiently managed (Shugart 2010; Hui et al. 2010).

This paper will provide an overview on when and how the PSC is used and calculated, establishing the theoretical ground. After this brief introduction, we will discuss the definitions and concepts behind PSC and value for money (VfM), as well as the impact of the discount rate on the final outcome. Finally, concluding remarks and policy implications are presented.

Timing for PSC Calculation

When discussing what should be the criteria for selecting the *optimal* infrastructure delivery model, it is important to locate the decision in the global chain of infrastructure provision. The first level of decision-making addresses the question of whether or not the infrastructure should be built. Theoretically, this question is independent from the model chosen to provide the infrastructure or service. Initially, this question could be answered, for example, through a cost-benefit analysis whose purpose would be to determine the economic value of the project. If the NPV is positive, the infrastructure has economic value [sum of the projects cash flows over the lifetime (private economic value), as well as the externalities, such as time, greenhouse emissions, human life, and other considerations, (social value)], and it should be built. Otherwise, if the NPV < 0, it means that the economic resources consumed by the infrastructure or service are higher than the benefits generated (Dasgupta and Pearce 1972; Boardman et al. 2010). This is a *go/no-go* decision that is generally placed at a political level for large infrastructures.

Once the decision is made to go forward with the project, a second level of decision should be addressed: should the government develop the project on a *stand-alone* basis, or should it allow for private involvement? At this point, the PSC emerges as a technical tool to allow decision makers to choose the model with higher value for money (VfM), i.e., the model that optimizes the allocation of public resources. Fig. 1 illustrates this decision process regarding infrastructure provision.

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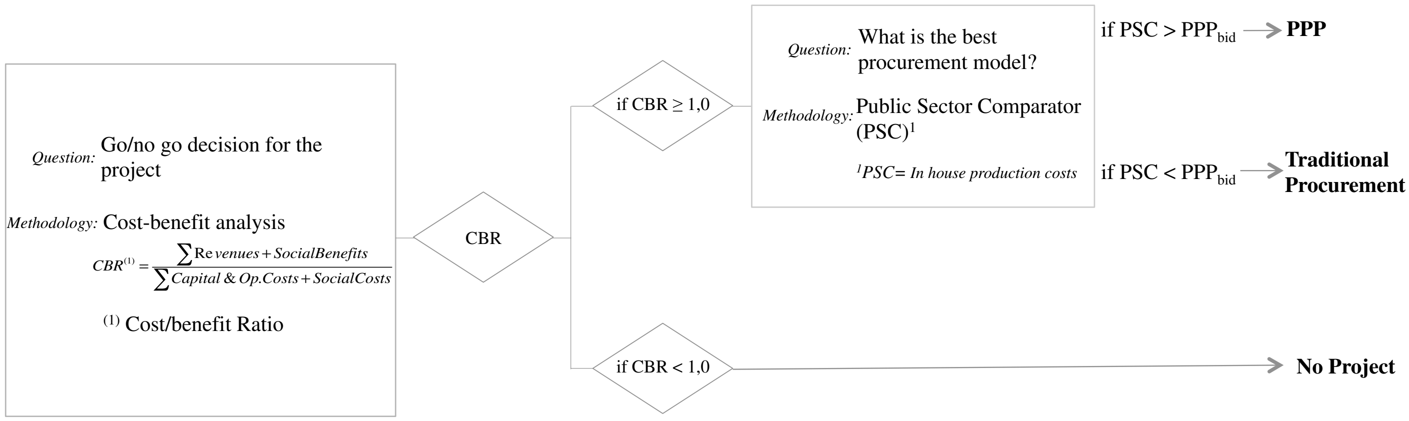

Fig. 1. Decision chain of an infrastructure investment project

PSC Calculation Model

The PSC can be defined as the NPV of the sum of cash flows (including capital costs) for the whole infrastructure lifecycle, incorporating efficiency gains and risk costs and assuming a public management. Nevertheless, the literature presents some definitions with different scopes: some authors refer to the PSC as just a number that corresponds to the above mentioned calculation (Quiggin 2004); others, like Grimsey and Lewis (2005), define the PSC as the entire process of comparing the two costs, traditional procurement versus PPP, thus a much wider definition.

The literature on PSC has been more based on technical reports than on academic papers. In fact, little academic research has been published on this subject, except for Heald (2003), Bain (2010), and Hui et al. (2010).

Algebraically, the PSC can the defined according to Eq. (1):

$$\mathrm{PSC} = \sum_{t=1}^{n} \left[\frac{\mathrm{Cashflow}_t + \mathrm{Transferablerisk}_t + \mathrm{Non\text{-}transferableRisk}_t}{(1+d)^t} \right] \qquad (1)$$

where t = year; and d = discount rate.

Value for Money

Although the terms PSC and VfM are often used interchangeably, they refer to different concepts. The concept of VfM is a measure of the utility for money spent. This definition is different from the *cheapest solution*. Maximizing VfM is to search for the maximum efficiency. As the U.K. Audit Commission claims, "Put it simply, VfM is about obtaining the maximum benefit with the resources available." This is a decision taken by economic agents, and largely studied by decision theory (e.g., Schoemaker 1982; Anand 1993). Maximizing VfM needs to take into account the concepts of efficiency (to ensure low costs) and effectiveness (to achieve the goal—utility). So, one can determine the VfM function as

$$\mathrm{VfM} = f\left(\frac{\Delta\mu}{\Delta c}\right) \quad \text{or} \quad \mathrm{VfM} \sim f(\mu, c^{-1}) \qquad (2)$$

where c = cost; and μ = utility.

The value of VfM is directly proportional to utility, and inversely proportional to cost. Conceptually, when analyzing the configuration of a given investment, one should search for the point that maximizes the VfM ($c_{\max \mathrm{VfM}}, \mu_{\max \mathrm{VfM}}$), as illustrated by Figs. 2 and 3.

When comparing the procurement option for a given project, the utility is defined, since most PPP projects have the service perfectly specified in the terms of the public tender.

However, in practice, when using PSC as a VfM test, the search is for the cheapest solution, if one assumes that the infrastructure or service put to tender is perfectly specified. This is not a merely academic formulation, since in most systems the service is easy to define, like a light rail metro system, for example, where the service

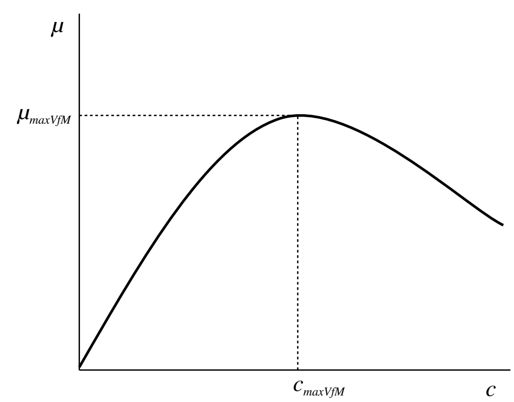

Fig. 2. Utility versus cost: optimal VfM

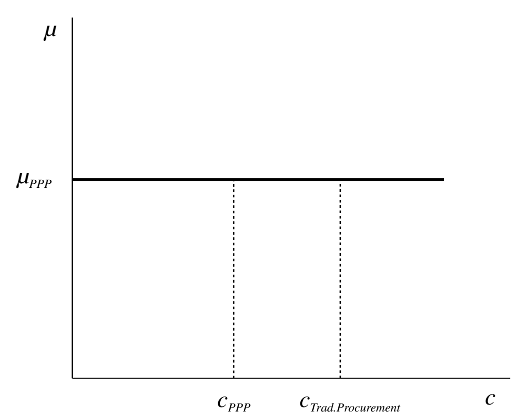

Fig. 3. Utility versus cost: flat μ

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can be defined by its schedule, number and location of stations, and quality of vehicles. Other systems, such as healthcare, are more difficult to specify. Although it is possible to detail the portfolio of services offered in a given hospital (e.g., oncology, surgery, cardiology, neurology), measuring quality is a much more complex task (Pitman and Holve 2009), and there is no perfectly accurate and objective methodology to do it.

Therefore, assuming that the service is perfectly predefined [the numerator in Eq. (1) is a constant], when performing VfM tests for most PPP contracts we are simply evaluating the costs, c. Which solution, traditional procurement or PPP, provides the same service, at a lower cost, while increasing the VfM? The utility for the society is a constant, μ', regardless of who builds and operates the system, either the public or the private sector (the horizontal straight line in Fig. 3). It is the cost that can differ. Thus, the cost of one option should be put against the other, and the lowest is the one providing higher VfM (in the hypothetical case presented in Fig. 3, $C_{\text{PPP}} < C_{\text{Trad. Procurement}}$, so the PPP option should be chosen).

Discount Rates and the PSC

Despite all the variants for PSC calculation, one of the factors with great impact on the PSC is the discount rate. In order to understand the impact of alternative discount rates used, we have simulated different discount rates for two projects and measured the impact on the final PSC. The idea is to understand the extent to which the discount rate can affect the final outcome of the process. Both of the projects concern healthcare PPPs, specifically two hospitals in Portugal, although the object of the partnerships is different. The first is a PPP just for the infrastructure, including construction and maintenance (Fig. 4), while the second incorporates the infrastructure and also the clinical services (Fig. 5). The idea of using both these case studies is to capture the effect of a PPP with most of the costs in the first years of contract (infrastructure) with a more flat financial profile (infrastructure and clinical services).

Table 1 presents the impact of selecting alternative discount rates. An increase of 1% will decrease the PSC by 7.2% and 8.2% for PSC 1 and 2, respectively, while a decrease will increase the value by 8.5% and 9.5%. The higher the discount rate, the less valuable the future cash flows. If the government builds the infrastructure under typical public work contracts, the first years of construction will represent a large burden, unlike the PPP option that typically starts requiring payments in the first year of operation.

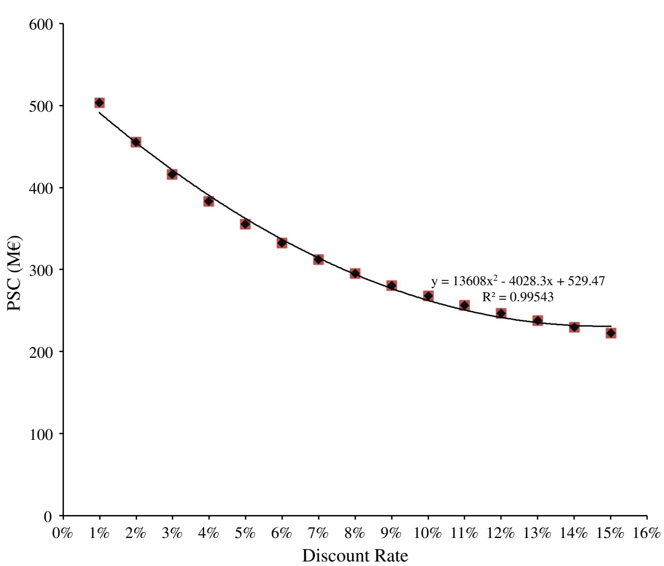

Fig. 4. Impact of the discount rate in the PSC for Case Study 1: infrastructure PPP

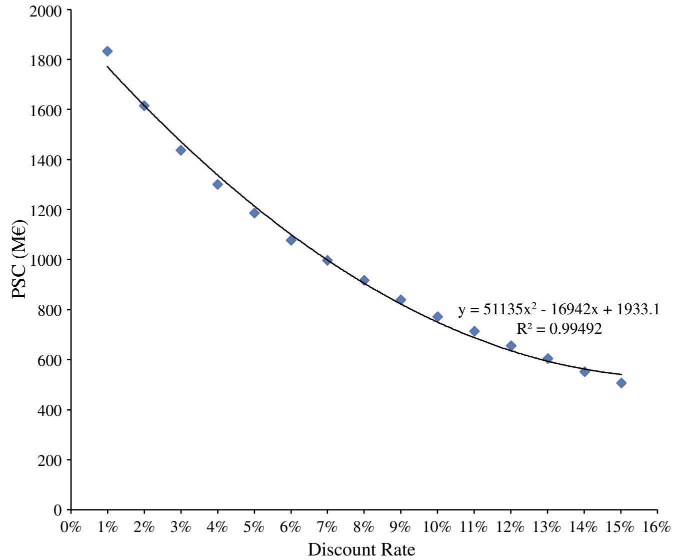

Fig. 5. Impact of the discount rate in the PSC for Case Study 2: infrastructure plus clinical services PPP

Table 1. Impact of the Discount Rate in PSC

	Variation in the discount rate (considering reference value of 4%)	
PSC	−1%	+1%
PSC 1 (%)	+8.5	−7.2
PSC 2 (%)	+9.5	−8.2

Assuming a higher discount rate will devalue future payments and, therefore, will make the PPP option look cheaper.

This impact can affect the final outcome. The six bids presented for Case Study 2 had values between 851 and 1,136 million Euro. Considering that the PSC was 1,186 million Euro, all the bids presented VfM. If, however, the discount rate increased by 1%, the value would drop to 1,089, and only three bids had lower values. As long as there is a single bid below the PSC, there is VfM in the PPP option, but this illustrates how subjective the test can be.

Another effect visible in the figures is that the slope of the curve for PSC 2 is much higher than for PSC 1. This is due to the higher relative weight of operation costs in PSC 2 than in PSC 1.

The choice of the discount rate is also related to risk management in the model. When preparing the bids, risk can be accounted for in two separates ways: (1) as a risk premium, added to the risk-free discount rate (in this case risk is accounted for as a percentage); or (2) as a annual cash flow added to the costs, and later discount at a risk-free discount rate (account for as monetary unit). In the Portuguese hospital PPPs, risk was not considered independently, but incorporated directly into the estimation of costs, as mentioned earlier.

Main Findings

The methodologies for calculating the PSC are diverse and can lead to different results. The baseline estimation of costs, the global methodology for assembling the PSC, and the discount rates used are different not only across countries, but even within the same national border.

Regarding cost estimations, it is possible to find completely different approaches: (1) using past data from the project (LRSP), (2) updating data from different projects and using international benchmark, and even (3) selecting historical data from similar projects (hospital PPP). The approach to follow is related to the type of project. For each of these approaches, more sophisticated statistical methodologies are required to analyze the data (Sonmez and Ontepeli 2009).

When there is a high degree of standardization, and a relevant and reliable database of costs, using past data to forecast future costs can be the best alternative. Nevertheless, this methodology raises some issues related to the quality of the data. It is important to ensure that the data are consistent and comparable. In many cases, the rules and guidelines to account for costs changes over time and might include, or not, the additional works and cost overruns. The team responsible for the calculation has to be sure of the quality of the data. In new projects, where there is no previous experience, the alternatives are less accurate and may include adaptation of data from other projects as well as international benchmarks. This is particularly relevant for estimating risk costs, since for the *raw PSC* the estimated costs of preliminary design can be enough.

One can argue that there is no such thing as a best model to estimate costs. In each case, considering the alternatives and the data available, the PSC team has to select the most accurate alternative. Naturally, the availability of data from within the same project, only a couple of years old, like in the LRSP, can be the most accurate alternative for estimating future costs, nevertheless it is not possible for most projects. In fact, even this method can be challenged. The first lines had a significantly higher risk, since this was a greenfield project with no past experience. In the meantime, more knowledge was developed and one could expect a lower risk for future developments.

The assembling of the final PSC can also be performed under different methodologies, especially regarding the way risk is included. In some countries, the PSC is divided into several components, and each one of them is calculated separately. The typical components are related to the baseline costs, or *raw PSC*, and the risks involved in the projects are either transferred to the private partner or retained by the grantor agency. This is the most transparent methodology. Nevertheless, since it requires a higher degree of complexity in costs and risk estimation, some projects incorporate the level of risk (or transferred risk) into the discount rate, in what is sometimes referred to as the *adjusted discount rate*. This leads to the last and probably most critical choice teams have to make: what discount rate should be used? The choice of discount rates accommodates an extremely diverse set of options, and their impact on the final decision can bias the conclusions. Regarding the discount rates, the question is not only related to the value itself, but also to whether or not to use the same discount for both PPP and PSC, or to incorporate or not the projects global risk in the discount rate, etc. These questions are discussed next.

Discussion and Concluding Remarks

The methodologies for calculating the PSC vary significantly across countries, displaying different levels of sophistication. Some methodologies only calculate the costs based on past experience, and do not account for the risk effect, while others incorporate the effect of transferred risk in the discount rate. The most sophisticated methodologies make a distinction between the raw PSC and risks (transferred and retained), and also account for the competitive neutrality effect. Disaggregating the PSC into raw PSC, transferred risk, retained risk, and competitive neutrality (following the approach developed by Partnerships Victoria) allows for a better understanding on what is being considered.

Using different discount rates can have an enormous impact on the calculation of the PSC. The simulation performed has shown significant changes in the PSC value if the discount rate increased or decreased by 1%. Using the infrastructural hospital PPP study, and based on a hypothetical 5% discount rate, any decrease of 1% would mean decreases on the PSC around 6 to 8%. This can bias the comparison with the PPP option.

It is important to notice that a 5% discount rate is a relatively low rate, and usually corresponds to low-risk projects. In projects with a high technological component, like telecommunications, the discount rate can increase up to 8%.

The choice of the discount rate may not be independent from the question of risk, which makes the problem even more complex.

One of the main problems with PSC is that, in many cases, there is political pressure to develop PPP projects. This pressure arises mostly from a difficulty for public budgets to cope with the tremendous financial pressure in the first years of a large infrastructure provision (the construction phase). In this case, the alternative for not developing a PPP arrangement is not doing the project at all. So, to some extent the alternative is not really an alternative. This does not mean that the PSC should not be calculated. Instead of being used to choose the model, since there is no real choice, the PSC can be used to cap the expenditure with the project.

Using the same discount rate for both PSC and PPP implies to adjust the cash flows for risk transfer. If the discount rate is the risk-free rate, then the NPV of the PPP alternative has to be adjusted, and if the discount rate is the private cost of capital, then the adjustment has to be made in the PSC.

There are still some important questions to be addressed, for example, whether or not the PSC should be disclosed to bidders. There are arguments supporting both views. On the one hand, disclosing the PSC may limit the cost effectiveness of bidders, since they will look at the PSC as the price cap. On the other hand, this downside can be minimized, or eliminated, if there is real competition. It can even help the bidders to improve their proposals, and, eventually, improve the risk allocation proposed in the PSC (if the terms of the tender allow for it).

Besides all the questions related to how the PSC should be calculated, there is also another set of critical questions regarding the use of this tool: when should it be used, and how should the result be used?

Concerning the question of when the PSC is used, several approaches are followed, varying from a dynamic perspective, where the PSC is created at the very beginning of the project to help decision makers to evaluate the economic merit of the project (e.g., in the United Kingdom), to a procurement tool with the single purpose of testing the VfM of the PPP alternative. Even regarding this last approach, the test can have a mandatory status, meaning that if the PPP model fails the VfM test, the tender procedure is automatically canceled (e.g., in Portugal), or it can be more informative and less determinant (e.g., in Canada).

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