

Public Private Partnerships, the Public Sector Comparator, and Discount Rates: Key Issues for Developing Countries

Chris Shugart
Independent Consultant
Email: chris@shgrt.com

Development Discussion Paper: 2008-02

Abstract

When a government considers using a public private partnership (PPP) – a long-term contractual arrangement with a private sector company to provide public infrastructure or services – an important question is whether the PPP will bring more value than using conventional public procurement methods. In some countries a “public sector comparator” (PSC) analysis, which compares the expected PPP with a similar hypothetical public sector project, is used to assess whether the PPP is likely to bring greater value for money (VFM).

The PSC exercise has been subjected to increasing criticism. This paper focuses on just one aspect: the *discount rate* to be used in the comparison. Since the comparison between the PPP project and the PSC is made in terms of present values, the discount rate used can have a significant impact on the result. Countries have taken widely different approaches to determining the correct or most appropriate discount rate (or rates) to be used. There is no consensus.

This paper does not attempt to provide a definitive solution to the problem. Instead, it aims to lay out and clarify some of the main issues and suggest possible approaches as a way to bring more light to the debate and give guidance to governments that use the PSC method in their assessment of PPPs.

Keywords: public private partnership, value for money, public sector comparator, discount rate, infrastructure, risk premium, idiosyncratic risk, systemic risk, CAPM

JEL Classification: D61, L33

Published as: *In Discount Rates for the Evaluation of Public Private Partnerships*, edited by David F. Burgess and Glenn P. Jenkins (Kingston, Canada: John Deutsch Institute, Queen’s University, 2010).

Part I

Discount Rates for PPPs: Overview of Theory and Practice

PPPs, the Public Sector Comparator, and Discount Rates: Key Issues for Developing Countries

Chris Shugart

Introduction

During the past 10-15 years, many countries around the world have turned to long-term contractual arrangements with private sector companies to provide public infrastructure and services. These arrangements are often referred to as “public-private partnerships” (PPPs).¹

This paper draws on a longer and broader-scope study prepared by the author for the NEPAD Secretariat and funded by PPIAF: *Quantitative Methods for the Preparation, Appraisal, and Management of PPI Projects in Sub-Saharan Africa* (August 2006). Some of the original ideas have been modified – and perhaps improved – in writing the present paper.

¹Although the term “public private partnership” may have objectionable connotations of *partnering, joint venture, and informal relations* rather than a rigorous and objective arm’s-length contractual relationship (which is the concept that should be at the core of the arrangement – even though a trusting relationship is required to make the arrangement work well), the term “PPP” has become a popular slogan and is difficult to avoid. Note that in the UK, “PPP” has a slightly different meaning; arrangements of the type discussed in this paper are usually referred to as “PFI” (Private Finance Initiative) projects.

PPP projects are complex. They require careful design, preparation, appraisal, procurement, contracting, and vigilant oversight if they are to succeed in yielding net benefits to society. Deficiencies in any of these aspects can lead to failure – sometimes disastrous failure.

The preparation of the *public sector comparator* for a PPP project has been a hallmark of most institutionalized PPP programs around the world. The basic idea is that it is important to demonstrate quantitatively that the PPP project is superior to an alternative public sector project that would deliver the same (or very similar) services. This hypothetical public sector project is often referred to as the “public sector comparator” (PSC).²

What might be the sources of the differences between the PPP project and the PSC? It is unlikely that one would estimate, *ex ante*, that the PPP project will have higher investment or operating costs than the PSC – for the same level of services. (If this is true in mature economies, it is even truer in most developing countries.) So the question is not usually whether the PPP project is likely to be more efficient in a technical sense. The main issue is whether there are other factors tending in the opposite direction – factors that might favour the PSC. The two main candidates are *financing costs* (possible additional costs due to private sector financing) and *transaction and contract oversight costs* (additional bidding, contracting, and monitoring costs in a PPP setting).

Either of these factors might bring additional costs that would outweigh the efficiency gains expected from private sector participation. One way to assess this would be to carefully examine and compare all the costs of both alternatives. If the costs of the PPP alternative were significantly higher than those of the PSC, then one could argue that it would be more beneficial to implement the project on a public sector basis.

In many countries, the PSC has played an important role in justifying PPP projects. If the PSC costs are higher, this can help counter the arguments of critics who may be resistant to the idea of private sector involvement, who are not convinced by theoretical arguments in favour of private sector participation, and who regard the PPP project as a way of benefiting private business interests at the expense of taxpayers, consumers, or workers.

²Morallos and Amekudzi (2008) give a useful summary of “value for money” analysis and the PSC exercise, as practised in a number of different PPP programs around the world.

The PSC may be used at different stages of the project preparation process. The main distinction is between using the PSC before the private sector bids are received and after the bids are received. An additional issue that arises when the PSC is used before the bids are received is that, in that case, a *hypothetical* PPP project (“reference PPP project”) has to be modelled in addition to a hypothetical public sector alternative. Ideally, this should be based on good data from a sufficient number of actual PPP projects undertaken in the specific country. More often in developing countries, the reference PPP project is based on a few public sector projects in the country, adjusted to take into account the efficiency gains one might expect based roughly on experience with PPPs in developed countries – with a great deal of subjective judgment used. When the PSC is used after bids are received, the PSC is compared against the bid price of the preferred bidder.

The PSC exercise has come under increasing criticism in recent years. Some of the identified weaknesses are the following:

- Great inaccuracy: an enormous amount of uncertainty in the results, made even greater when a hypothetical PPP project is used as opposed to an actual bid price.
- Omitted risks: some important risks are very difficult to estimate and are often ignored.
- Manipulation: strong bureaucratic incentives to adjust the inputs to achieve the desired results.
- High cost: a full PSC study can be time-consuming and costly. Critics argue that requiring a PSC exercise for every PPP project is a boondoggle for consulting firms.
- In many developing countries, it cannot be assumed that a feasible public sector project will deliver roughly identical services. In that case, the comparison becomes more complicated and speculative.
- In many cases, there is no realistic public sector alternative at all. If in fact no public sector funding will be made available, the PSC is not feasible and is therefore irrelevant.

Regardless of these criticisms, there remains the need to assess, in some way, whether the PPP project would be expected to bring net benefits compared with the realistically best public sector project (presuming that it is realistic even to consider a public sector project). If this appears unlikely, then the PPP project – at least, one with the envisaged design – should not be undertaken.

One possible approach would be not to require a PSC analysis for every PPP project but only for representative *types* of projects. Simpler rules of thumb – both qualitative and quantitative – could then be developed for routine use by those deciding whether to embark on a PPP project in a particular case.

This paper does not examine the PSC exercise in all its aspects; it looks only at one issue that must be addressed in carrying out a PSC exercise. The comparison between the public sector comparator and the PPP project must be made in terms of *present values*. The discount rate used can therefore have an important impact. Since the costs of the PPP, as seen by the public sector through the contractual payments it will make, are spread out over time to a greater extent than the PSC costs, using a lower discount rate will often increase their present value and hence disfavour the PPP project,³ and in that case, the comparative gains in PPP efficiency would have to be greater to make the PPP project worthwhile.

There is considerable controversy over how to determine the correct discount rate for this purpose. No consensus exists among respected economists, policy makers, and practitioners about the fundamentals of what the rate should be and whether it should be the same for the PSC and the PPP project.

This paper does not attempt to give a definitive solution. Instead, the more modest goal is to lay out some of the main issues as a way to help clarify the debate. The approach taken is to avoid taking sides where no strong consensus exists. In that sense, the paper takes the perspective of informed but non-specialist policy-makers in developing countries who are grappling with these questions. To keep it from becoming too long, however, the paper does assume basic familiarity with discounted cash flow techniques and with the Capital Asset Pricing Model (CAPM).

The *ultimate* goal, of course, is to give appropriate guidance to governments in developing countries. How *should* they deal with this complex issue, given that eminently qualified experts around the world differ about which methodology to use and what inputs to use in the calculations?

³For PPP projects that involve mainly recurrent operating and maintenance costs, the discount rate may not make much difference.

Overview of Practice in Several Countries

This section gives a summary of how several different countries approach the issue of the discount rate to be used in the PSC exercise. The assumptions and approaches differ widely. It is understandable that PPP units in developing countries that are looking to PPP programs in more advanced economies for guidance are likely to come away confused. The common solution will then be to hire a reputable consulting firm to recommend a methodology. This may protect the PPP unit against criticism, but it usually does not help get any closer to a sound understanding of the underlying issues.

United Kingdom (UK)

The 2003 UK “Green Book” (the Treasury’s guidance for appraisal and evaluation of government projects – applicable to PPP-PSC comparisons) (HM Treasury, 2003a) uses a “social time preference” (STP) rate, deriving from classic concepts in welfare economics fleshed out in the 1950s and 1960s. The Green Book STP rate is the sum of three components:⁴

- a “pure time preference” rate;
- a “catastrophe risk” rate;⁵ and
- a third component that takes into account the idea (roughly) that as per capita income increases, people will care less about additional income, and this increases their preference for money today relative to money in the future.

The Green Book estimates the pure time preference rate plus the catastrophe risk rate at 1.5% (with the pure time preference rate probably around 0.5%) and the third component at 2.0%. So the STP rate comes

⁴The first and third bullet points are the classic Ramsey formula.

⁵This is based on the idea that the typical risk adjustments to future cash flows do not take into account low-probability catastrophic events – climate-change catastrophe, nuclear devastation, massive asteroid impact, etc. – and so it is legitimate to include such risks in the discount rate.

out to 3.5%, which is the real discount rate that must be used in (among other things) comparing the PSC with the PPP project.

Ireland

Central guidance in Ireland states that the discount rate to be used for comparing a PPP project with an equivalent public sector project “should reflect the relative value of the cash flows from the State Authority’s perspective” (Central PPP Policy Unit, 2006). This is not “an economic discount rate ... which may be applied at an earlier stage of the evaluation of capital investment projects (including PPP projects) for conducting a cost-benefit analysis ...” Instead: “The discount rate is based on the risk free cost of debt to the public sector – the yield on the appropriate long term Government Bond” (the maturity of the bond presumably being the main characteristic of interest). This same rate should be used in discounting all cash flows.

If any adjustment for risk is called for, it should be made to the cash flows, not to the discount rate.

The PSC exercise is therefore clearly considered to be a type of *financial* appraisal – from the perspective of the government department.

Victoria, Australia

Partnerships Victoria takes a different approach from both the UK and Ireland. It builds up the discount rate by beginning with a risk-free rate and then adjusting for risk using classic methods based on the CAPM.⁶

Related to this, Partnerships Victoria says that only financial costs and benefits should be considered in the PPP-PSC comparison. Economic analysis is needed as part of the rationale for the project in general, but this appraisal should already have been carried out by the line department before the PSC exercise takes place.

The risk-free rate is taken to be the yield to maturity of a ten-year Commonwealth Bond. In 2003, this was 3% in real terms. In January 2005, the figure had risen to 3.5%.

⁶This section is based mainly on Partnerships Victoria (2003b). The values given may not reflect the values currently used.

The market risk premium is taken to be 6%. The risk adjustment is based on three “risk bands” according to type of project, with asset betas of 0.3, 0.5, and 0.9 yielding risk premiums of 1.8%, 3.0%, and 5.4%.⁷ Water, transport, and energy projects are considered to be in the middle band. For these, the real discount rate to be used should be 6.5% (= 3.5 + [0.5 × 6]), which is three percentage points above (almost double) the rate used in the UK.

But this is not the end of the story for Partnerships Victoria. The rate given above is the rate that would be used for net cash flows of the underlying project (before financing). Partnerships Victoria sees two further considerations in determining the rates to be used for the PPP-PSC comparison:

- It is *costs* that are being considered – negative cash flows. It makes no sense to say that a future cost is necessarily less onerous the riskier it is; this is the effect that normal discounting would have.
- Risks should be seen from the perspective of the public sector. For the PPP project, these are not the underlying risks of the project but the risks that are intentionally or unintentionally borne by the public sector – principally through the payments that the public sector makes to the private company.

It then proposes a pragmatic (rule of thumb type) way to deal with these two issues. According to Partnerships Victoria, the PSC cost flows should always be discounted using the risk-free rate; the PPP outflows (seen from the public sector perspective) should be discounted using the risk-free rate *plus* a risk premium that is proportional to the systematic risk that has been transferred to the private company (with 100% risk transfer meaning that the full, conventional risk-adjusted rate would be used). It should be stressed that these discount rates are meaningful *only* for purposes of comparing (ranking) the PSC present value against that of the PPP project. The guidance material makes it clear that using the risk-free rate for the PSC will not necessarily give the present value of the true costs to the government of that option. It is not the right rate to use in a stand-alone analysis of the PSC project.

⁷The term “asset beta” and several other terms and abbreviations are defined at the end of this paper.

The Partnerships Victoria approach may seem confusing and, at first glance, counterintuitive. The correct intuition is to think only about the ranking: the *less* systematic risk borne by the public sector with respect to a PPP project, the *higher* the discount rate that should be applied to the cost stream because the costs are less onerous to the public sector the less risky they are.

Partnerships Victoria guidance material states that this method will give the correct ranking of the PSC and the PPP project. It should be noted, also, that for routine projects, in practice the same discount rate – the full risk-adjusted rate – will often be used for both alternatives because of the complexity of trying to determine the risk allocation, and hence a more appropriate rate, with any accuracy.

It should be noted that Partnerships Victoria is the only PPP program of those discussed here to identify these issues as important.

Netherlands

The Netherlands Ministry of Finance has taken the position that the discount rate should be very close to the private sector weighted average cost of capital for both the PPP and the PSC.⁸

The risk premium should be based on non-diversifiable risk, as in the CAPM. This risk premium will be in the range of 1.5% to 4.5% for PPP projects, depending on what they call “market spread risks” – essentially the project beta (but in principle based on a wider portfolio of assets – not just financial assets). They consider the market risk premium to be 3%, so this implies an asset beta of 0.5 to 1.5.

The Ministry assumes a real risk-free rate of 4%; so the real discount rate to use will be in the range of 5.5% to 8.5%.

The Ministry of Finance changed its position to this market-based one following the recommendations of a special commission in 2003 (see Ewijk and Tang, 2003). The key change was that it decided to use the observed price of risk in the equity market (market risk premium), along with the underlying idea that risks are something that depend on the project; so there is no good reason why risks should change just because of the source of funding.

⁸The following is based on PPP Knowledge Centre (2002a and 2002b) and discussions with the Centre in The Hague in February 2006. It is not known whether the policy has changed since then.

An unusual feature of the Netherlands method is that, when doing the PPP-PSC comparison before receiving the bids, the Ministry of Finance looks at the underlying cash flows of the PPP project, not the envisaged *payments* that the public sector will make to the project company, as is more common. But the result is the same, since the discount rate the Ministry uses is the same as, or close to, its best estimate of the appropriate project weighted average cost of capital from the private company's perspective.

South Africa

The PPP Manual (National Treasury 2004, p. 22) states: "For practical purposes, the discount rate is assumed to be the same as the risk-adjusted cost of capital to government." Although acknowledging that the government bond yield is not really the correct value for the risk-free rate – because of, e.g., "tax implications of diverting funds from private to public consumption" – it ignores these factors as being too difficult to quantify.

The Treasury does not prescribe a rate to use for the discount rate. But it states that one should begin by using the yield of a government bond with a remaining maturity similar to the duration of the project. Then, in principle, risks should be accounted for as cash flow items and not in the discount rate. But for some projects, on a project-by-project basis, a risk premium could be added but only in cases "where it is not possible to accurately reflect the effect of all risks in the cash flow of the project". It says that transaction advisors should advise on this. No mention is made of any possible difference in the treatment of systematic and non-systematic risks.

The rate selected for the project must then be used for both the PSC and the PPP models.

The Discount Rate before Adjusting for Risk

Financial Flows or Economic Flows?

As we have seen in the second section, all the countries cited, except for the UK, build up the discount rate by beginning with the financial risk-free interest rate; the UK begins (and ends) with an independently

derived social time preference rate. A separate but related question is whether the PSC exercise should be considered a type of *financial* or *economic* appraisal. Partnerships Victoria guidance states explicitly (2003a, p. 7): “The PSC is intended as a quantitative financial benchmark against which to assess bids. Therefore only financial costs and benefits should be included in the PSC. Economic and cost-benefit analysis form part of the investment rationale for the project and will have already been considered at the investment decision stage.” Ireland is equally explicit. This approach implies the use of a financial, as opposed to economic, discount rate.

This paper takes the position that the discount rate used for the PPP-PSC comparison should be one appropriate for economic flows (costs and benefits), not financial cash flows only. It may be that the managers of a particular government department are concerned only with the government borrowing rate, as if the department were an individual person or company borrowing money. It is difficult to see the rationale for adopting that view as government policy, however. Surely the government should be concerned with costs and benefits in the economy as a whole and therefore should use an *economic* discount rate.

One justification for treating the PSC exercise as a form of financial appraisal might be to assume that the time-pattern of costs is likely to be roughly the same (e.g., as between capex and opex) in both the PPP project and the PSC and that the economic discount rate will not be much different from the government borrowing rate. These assumptions, however, may not hold up in many developing countries.

Economic Discount Rate

Let us assume, then, that the PSC exercise is a form of economic appraisal and that we must therefore begin with the economic discount rate: the cost (or opportunity cost) of public expenditures to society as a whole.⁹ This paper will not describe in any detail how to estimate the rate. This is a topic exhaustively treated elsewhere. A summary will suffice for present purposes.

⁹This rate is referred to variously as the economic discount rate, social discount rate, economic (or social) opportunity cost of public expenditures, etc. This paper uses the qualifier “economic” to avoid any confusion that “social” might entail (e.g., social policy, concerned especially with distributional issues, pro-poor focus, etc.). Cf. Harberger (1997, p. 79, endnote 1).

The classic approaches to the economic discount rate (before any specific risk adjustment) all involve looking at the sources of the funds that the government uses and what their cost or opportunity cost is. The assumption is often made that in the short run, the funds come from the capital market.

There are three possible sources for these funds at the margin: increased lending (or, more generally, financial investment) by members of society, displaced private investment, and foreign lending. In a textbook-case perfectly efficient economy, the three marginal rates would be equal. But since there are distortions in the economy, especially taxes, subsidies, and transaction costs, the rates will tend to be different – and, some would argue, different for different people and different situations.

According to the weighted average approach (the “sourcing” approach), widely used by practitioners, all three sources may be used to some extent when the public sector draws more funds from the capital market, which is assumed to be the immediate or marginal source of funds, and so a weighted average of the three rates should be used as the economic discount rate. It is also necessary to determine the weights, and this presents another source of divergence among final values. Some people argue that the weights may vary from time to time and according to how a project is funded.

Another method should be mentioned briefly: the shadow-price-of-capital approach, which looks differently at a project’s effect on consumption and investment and converts the effect on investment into an equivalent effect on consumption. This method increases the effective cost to society of capital expenditures by looking at consumption equivalents rather than discounting all net cash flows by a higher (weighted average) discount rate. Depending on assumptions, the result may not be exactly the same as when using the weighted average approach.

Proponents of the method say that it enables them to distinguish between public expenditures that displace private investment from those that do not; the latter would not have an associated shadow price if they displaced only consumption. The issues become complex, depending on, among other things, assumptions about hypothetical future patterns of consumption and reinvestment.¹⁰

¹⁰For an in-depth examination of the shadow-price-of-capital method, see the classic article by Sjaastad and Wisecarver (1977). See also Burgess (2009).

The shadow-price-of-capital method is not widely used by *practitioners* because of the somewhat arbitrary (or at least highly discretionary) assumptions that need to be made. There is no general agreement about these assumptions.

The main reason for mentioning this method in the present context is that there is an argument associated with it that in cost-effectiveness analysis – where only expenditures are considered and the benefit stream is assumed to be the same in both project alternatives, as in the typical (or at least ideal) PPP-PSC comparison – the shadow price of capital is irrelevant since it applies across the board, and so the cost flows, expressed in “consumption equivalents”, should simply be discounted at the social time preference rate.¹¹

Two critical assumptions in reaching this conclusion, however, are (i) that all types of expenditure considered in the analysis have the same shadow price of capital (note that one might be comparing trade-offs of capex and opex), and (ii) that the shadow price of capital is constant in all time periods. If these assumptions do not hold, the opportunity cost of displaced private investment may matter in a cost-effectiveness analysis, even within the shadow-price-of-capital framework.¹²

The last issue to be mentioned is the question of whether the marginal rate of return on private investment (e.g., in the weighted average approach) should include the average market risk premium, which it usually does, implicitly, if determined in a typical way. If instead one started with the financial *risk-free* rate – i.e., government borrowing rate – and grossed this up to a pre-tax level for the relevant component of the weighted average, then this might give a rough economic discount rate that does not include a premium for systematic risk.¹³

¹¹See Feldstein (1970) and Spackman (2004, 2006). To put the basic argument in the simplest of terms, suppose one multiplies every cost in both alternatives by the same factor. The ranking of present values would not change, regardless of the value of the factor.

¹²With respect to (i), if in one project alternative recurrent operating and maintenance expenditures are wholly or partially covered by user charges, then (within the framework of the shadow-price-of-capital method) there is no shadow price of capital associated with that part of the expenditures since the cost to the economy is determined simply by consumers’ willingness to pay. With respect to (ii), in Burgess’s (2008, 2009) analysis, the shadow price of capital decreases over time.

¹³The question of how to derive a risk-free economic discount rate is discussed in Brean *et al.* (2005, 75ff.). The method suggested in the text above is

In any event, the idea to retain for the purposes of this paper is that if one contemplates making a specific risk adjustment to the economic discount rate for systematic risk (as in CAPM), it is important to know the extent to which the rate one begins with already includes an *average* risk premium for the economy.

As noted at the start of this section, most PPP programs begin the calculation of the discount rate to use in the PSC exercise with the government borrowing rate. In a healthy open economy with low taxes, a risk-free rate based on the weighted average method will often not be far from the government borrowing rate. But we cannot depend on that result in many developing countries. There could be major distortions. If private investment with a high marginal return is displaced, or if the country's stock of foreign debt is becoming uncomfortably high, the correct rate might be significantly higher than the government borrowing rate – even before considering risk. This could easily add several percentage points to the resulting figure. PPP programs in developing countries that use the government borrowing rate as the risk-free discount rate may therefore be distorting the results, as will be discussed further in the next section.

Apart from the issue of how to deal with systematic risk, the various controversies over how to determine the correct economic discount rate will not be discussed any further in this paper.

Should the PPP-PSC Comparison Be Done through the Veil of Financing?

Cash flows viewed after financing

One important but neglected feature of the way the discount rate is used in the PPP-PSC comparison is that in the case of the PPP project, it is

roughly the approach they use. The method proposed by Glenday (2009), however, would seem to be more conceptually correct: the economic externalities should be calculated based on appropriate *market* rates, not the risk-free rate. For example, corporate income tax is based on actual profit, even if that profit contains a component remunerating companies' shareholders for bearing systematic risk. The externalities, related to average systematic risk in the market, would be considered to be a national parameter and would apply even if the specific project being appraised involved no systematic risk.

typically project cash flows *after financing* that are discounted since cash outflows from the public-sector perspective are mainly the payments made to the private company under the PPP contract – i.e., the revenue required by the private company after it has financed its capital expenditures. This is in contrast to general practice in economic appraisal, in which the economic discount rate is applied to a project's underlying cash flows *before* financing.¹⁴ Does this make a difference? The possible complications involved in using the economic discount rate for the *post-financing* cash flows of the PPP project have been ignored in most of the literature on the subject.¹⁵ Most PPP programs ignore the problem because they assume that they should be using a *financial* discount rate, but, as maintained in this paper, this cannot be right.

Throughout this section, we assume that there is no systematic risk (or no economic cost associated with systematic risk). The question of systematic risk will be introduced in the next section.

We also need to make an assumption about the impact of financing from foreign sources since the economic treatment of foreign and domestic financing can be different. The assumption made in this paper keeps to the assumption on which the method of the weighted average economic opportunity cost of capital is based: given the marginal rates of substitution among different sources of funds, it will be assumed that, regardless of the project-specific source, it is *as if* every marginal project is financed by all the sources according to their respective weights in the weighted average. Therefore, since the foreign financing component of the economic discount rate takes the government borrowing rate as the starting point, if the PPP project were financed by foreign sources at the government borrowing rate, the underlying project costs should simply be discounted using the economic discount rate, and we would not need to make any other adjustments for the cost of foreign financing.¹⁶

¹⁴One exception is Jenkins (2001), who looks at the economic costs and benefits arising from the foreign financing of PPP projects.

¹⁵Grout (2003) is an exception.

¹⁶Jenkins (2001) discusses how the economic appraisal would have to be modified in the two extreme cases (i) where new foreign financing is entirely additional to the pool of capital in the country, and (ii) where new foreign financing simply substitutes for other foreign capital inflows. Trying to add these considerations to the paper would introduce too many complications for present purposes.

One way to motivate the discussion is to consider two projects with identical capital and operating costs, as illustrated in Table 1 (lines 1 and 4). For present purposes, we assume that there are no transaction costs and that borrowing and lending rates are the same – i.e., a unique market interest rate.

In the PSC, it is the underlying costs (line 1) that are considered in the comparison. In the PPP project, capital costs are financed at the market interest rate, here assumed to be 5%; the resulting capital charge is given in line 5. After adding the recurrent costs of 50 in each year starting in year 1, the final costs, as paid by the public sector, are 205 in each year (line 6). The PSC exercise would typically compare line 1 and line 6.

Suppose we determine the present value of the costs using a weighted average economic discount rate that is higher than the market interest rate because of various price distortions in the economy – in the illustration, assumed to be 10%. Carrying out the analysis *after financing* appears to increase the economic value of the PPP project (i.e., the present value of costs is lower) – compare lines 2 and 7. If we assume that both the PSC and the PPP project are sourced in the same way from the capital market, something must be wrong.¹⁷ What is it? The answer surely is that it is not correct to apply the economic discount rate to the cash flows obtained after financing the project (more precisely, not correct unless various compensating adjustments are included). The underlying costs to the economy remain the same, regardless of how the financial impact is spread over time by the financing per se (ignoring for the moment any true economic costs *associated with* the financing).

Table 1: Comparing the PPP Project with an Identical PSC

	Rate	PV	0	1	2	3	4	5	6	7	8
PSC											
1	Underlying costs			-1000	-50	-50	-50	-50	-50	-50	-50
2	Present value	10%	-1267								
3	Present value	5%	-1323								
PPP project											
4	Underlying costs	10%	-1267	-1000	-50	-50	-50	-50	-50	-50	-50
5	Financing of capex	5%			-155	-155	-155	-155	-155	-155	-155
6	Costs as seen by public sector				-205	-205	-205	-205	-205	-205	-205
7	Present value	10%	-1092								
8	Present value	5%	-1323								

¹⁷The discussion in this section might not hold if we assumed different sources of funds in the economy for the PPP project and the PSC.

If instead we use the market interest rate, we get the same present value for both projects (see lines 3 and 8). The reason is simple: discounting at the market interest rate eliminates the effect of financing from the cash flows for the purposes of comparing the two projects. Note, however, that it does not yield the *correct* present value, given in line 2.

One upshot is that if the PPP project and the PSC have identical underlying cash flows and the only difference is financing, and we assume a unique market interest rate and no financial transaction costs, then, looking at cash flows after financing, we can simply use the market interest rate for the purposes of comparing the two projects (but not for more general purposes); this gives the same comparative result that would be obtained using the *economic* discount rate before financing. But this conclusion may not seem to be of much use if it applies only when the projects have the same underlying cash flows.

The conclusion is still helpful as an insight, however, for the following reason. Most PPP programs use the government borrowing rate as the discount rate (before adjusting for risk – which we are not considering in this section). *To the extent* that differences between the costs (as seen by the public sector) of the PPP project and the PSC are solely the result of a change in the timing of expenditures through financing in a way that does not give rise to any costs to the economy, then using the financing rate as the discount rate gives the correct comparative result. But this is not because the appropriate analysis is a financial, rather than economic, appraisal. It is because the analysis is carried out looking at cash flows after financing. In other words, PPP programs that consider after-financing cash flows and use the government borrowing rate as the risk-free component of the discount rate (for comparative purposes only) may, in some circumstances, be doing roughly the right thing after all – but for the wrong reason.¹⁸

But that is not the end of the story. Even if using the government borrowing rate were roughly the right way to address the issue of financing the PPP, it would not necessarily be correct, especially in many developing countries, as a way to deal with the net result of different underlying (economic) costs in different time periods – e.g., the *benefit*

¹⁸One correct reason for using just the government borrowing rate as the economic discount rate would be if all incremental financing (from the perspective of the economy) came from government borrowing and if the marginal cost of foreign financing were constant. These assumptions are questionable for many developing countries.

of greater capex efficiency in the initial years of a PPP project, but with additional oversight *costs* on a recurring basis throughout the life of the arrangement. The approach used for PPP programs in developing countries must address this issue, and for this, the economic discount rate is the appropriate rate to use.

This is illustrated in Table 2. The duration of the projects has been limited to eight years to fit conveniently on the page. The comparative effects would be greater if a more realistic duration for the projects was used – say, 25 years.

The PPP project now has different underlying costs in two respects (compare line 4 with line 1): initial costs are higher because (let’s suppose) despite greater capex efficiency, the PPP transaction costs are very high relative to the size of the project; but recurrent costs are one-half the PSC costs because of more efficient O&M (e.g., reduced costs for personnel). Applying the economic discount rate of 10% to the underlying costs shows that the PPP project is more costly (lines 4 and 2). But what happens if we use the *financial* discount rate applied to the after-financing cash flows, as would be done in most PPP programs? The PPP project now erroneously appears *less* costly (lines 3 and 8). The problem is that we are trying to do two things with one rate: correct for the effect of financing the PPP *and* compare the differing underlying costs. This cannot necessarily be done; it will not give the right result in all cases. In this respect, the approach used for the public sector comparator analysis in most PPP programs rests on shaky grounds.

The tendency to use the government borrowing rate instead of the economic discount rate is an example of how PPP programs in developing countries have often blindly copied PPP programs in advanced economies without going back to fundamentals. In developing

Table 2: Comparing the PPP and PSC When Costs Differ

	Rate	PV	0	1	2	3	4	5	6	7	8
PSC											
1			-1000	-50	-50	-50	-50	-50	-50	-50	-50
2	10%	-1267									
3	5%	-1323									
PPP project											
4	10%	-1283	-1150	-25	-25	-25	-25	-25	-25	-25	-25
5	5%			-178	-178	-178	-178	-178	-178	-178	-178
6				-203	-203	-203	-203	-203	-203	-203	-203
7	10%	-1083									
8	5%	-1312									

countries, there can be a large difference between the economic discount rate and the government borrowing rate. The PPP-PSC comparison of underlying project costs must be made using the economic discount rate.

Why might this make a difference, in practical terms? One can think of a number of examples. Here are three.

- PPP projects involve high up-front transaction costs, and because of their partially fixed nature, these costs make up a greater proportion of initial costs the smaller the size of the project. Suppose that for a certain kind of project, these higher initial costs for a PPP project may be offset by lower recurring costs because of the expected greater O&M efficiency of a private operator.¹⁹ The higher the discount rate, the greater will be the impact of the higher costs in initial years relative to the lower recurrent costs. So one might expect that for a certain type of project, the threshold in size below which a PPP simply does not make sense – because transaction costs are too high – will be *higher* in countries that have a higher economic discount rate. This sort of effect may not be discovered by using the government borrowing rate as the discount rate for the PPP-PSC comparison.
- In countries with a high economic discount rate, achieving operating efficiencies through a PPP will not be as important as reducing design and construction costs occurring during the first few years. So the focus should be more on these aspects. Once again, we may not see how this plays out in a particular project unless we carry out the comparison using the right discount rate and the right set of cash flows.
- If demand is growing, it might be optimal to increase capacity in stages rather than build the full capacity needed at the start of the PPP. But it is easier and less risky from a transaction point of view not to include major construction stages later in the contract. The economic cost of *not* choosing a staged approach, where this is optimal, will be greater the higher the economic discount rate.²⁰

¹⁹They may also be offset by lower capex, but we are ignoring that here. Since both the main capex and the transaction costs occur in the initial period, the discount rate used will be of less importance in this comparison.

²⁰As an approximation, the optimal design period is inversely proportional to the discount rate (for a given economies-of-scale exponent and assuming that demand is a linear function of time). So, for example, if in using a discount rate of 5% the optimal design period is 25 years (i.e., the full term of the PPP), it

Financial intermediation costs

So far, we have been considering only the effect of financing that involves no economic costs. But financial intermediation involves true costs to the economy, and the PPP-PSC comparison should take these costs into account. One way to do this would be to carry out the comparative analysis using the economic discount rate applied to: (i) the underlying costs (i.e., before any financing), *plus* (ii) the economic costs associated with financial intermediation. Financial intermediation costs will almost certainly be greater for the PPP project than for a public sector project financed by government loans.

In general, the costs that might be considered for domestic sources of credit – costs that make up the spread between a bank’s borrowing rate and lending rate – are the following:²¹

- *Bank operating and administrative costs.* These are true costs to the economy and should be included.
- *Markup for required cash reserves.* If the reserve requirement is R (expressed as a proportion of funds borrowed), then the bank has to borrow $1+R$ pesos for every peso it lends.²² The economic discount rate takes into account the cost to the economy of one peso for every peso of funds provided to the project. So the markup for R should be accounted for as a separate cost item in the calculation.
- *Provision for loan losses.* The cash flows used in the economic analysis should be *expected values*.²³ (See the next section.) So on

would be optimal to build a stage with half the capacity at the start and then another similar stage after about 12.5 years if the correct discount rate were instead 10%.

²¹Note that the purpose here is not to carry out a full economic appraisal with respect to these costs. It should be considered sufficient for purposes of the PPP-PSC comparison (given the considerable uncertainties involved) just to make sure that one takes into account the major cost *items* that would otherwise have been neglected.

²²This component of the spread is determined by multiplying the bank’s borrowing rate (e.g., the interest rate on deposits) by $R/(1-R)$. For example, if the reserve requirement is 20% and the interest rate on deposits is 3%, this component of the spread will be 0.75 percentage points.

²³In this paper, the term “expected value” is used in its technical sense. See the definition on page 76.

average, this item does not represent a cost to the economy: some borrowers will pay the full interest rate; some will pay less because they default. (The costs incurred by the bank in dealing with a defaulting borrower – workout costs – should be considered true economic costs, however.)

- *Bank profit.* Normal profit should be included as an economic cost since it is a return to capital invested in the financial institution. Strictly speaking, supra-normal profits of domestic banks should not be included. But it is probably a good rule of thumb simply to include the entire amount of this item as a cost unless there are convincing reasons not to do so.²⁴

As an example, Table 3 shows the interest rate spread for banks in three East African countries.

So as a rough rule of thumb, the entire spread should be considered to be an economic cost except for the loan-loss component, which would typically be in the range of 10–30% of the total spread in most developing countries. In addition, one should add the various fees that banks would charge – e.g., up-front fee, commitment fee.

Table 3: Interest Rate Spreads for Banks in Three East African Countries

	<i>Kenya</i>	<i>Tanzania</i>	<i>Uganda</i>
Interest rate spread (% points)	14.9	11.4	14.4
Operating (and misc.) costs	5.9	7.5	8.7
Cash reserves	0.3	0.1	0.2
Loan losses	2.5	2.1	3.5
Residual (pre-tax profit)	6.2	1.7	2.1

Source: Čihák and Podpiera (2005). For Kenya and Tanzania, based on 2002 data; for Tanzania, data for June 2001–June 2002.

²⁴For example, Čihák and Podpiera (2005) attribute the high profit component in the interest rate spread in Kenya shown in Table 3 to a lack of effective competition in the sector. It might then be a policy question for a PPP program (or the Ministry of Finance) whether one should deem these supra-normal profits to be a cost or not for purposes of the PPP-PSC comparison.

A further question is what time-profile to give to the economic costs associated with the interest rate, for the purpose of adding them to the costs of the project before discounting. The simplest way would be to treat them as a fixed proportion of the interest payments (which are not included in full since the simple financing effect is not considered in the analysis).²⁵ They would then be discounted, along with all other costs, at the economic discount rate.

Table 4 illustrates one way that the PPP-PSC comparison could take into account the financial intermediation costs associated with the financing, using this approach.

In this case, looking only at the underlying costs, the PPP project is less costly in present value terms (compare lines 1 and 2): up-front costs are greater (1100 compared with 1000), but more than offset by lower recurrent costs. We do not consider the after-financing costs as seen by the public sector contracting party (line 3), but as an intermediate step, we do need to calculate the interest costs paid by the PPP company (line 4). Suppose that this is a loan of 1100 from a local bank, to be repaid in constant, annuity-style debt service payments over eight years, and of the 7% interest charged, the spread between this rate and the bank's borrow-

Table 4: Taking Financial Intermediation Costs into Account

	Rate	PV	0	1	2	3	4	5	6	7	8
PSC											
1 Underlying costs	10%	-1267	-1000	-50	-50	-50	-50	-50	-50	-50	-50
PPP project											
2 Underlying costs	10%	-1233	-1100	-25	-25	-25	-25	-25	-25	-25	-25
3 Debt service	7%			-184	-184	-184	-184	-184	-184	-184	-184
4 Interest paid	7%			-77	-69	-61	-53	-44	-34	-23	-12
5 Economic costs re financing				-22	-20	-18	-15	-12	-10	-7	-3
6 Total costs for comparison			-1100	-47	-45	-43	-40	-37	-35	-32	-28
7 Present value	10%	-1312									

²⁵This may not always be the best way to handle these costs. For example, some of the preparation costs for a project finance loan may be included in the interest rate margin instead of charging all of them in a specific up-front fee. If there is reason to believe that the time-profile of actual costs diverges substantially from the time-profile of interest payments, the actual profile should be used.

ing rate – but excluding the project-specific *default* component²⁶ – is two percentage points. That means that the intermediation costs we need to consider equal two-sevenths of the interest payments (line 5). Given the *total* costs of the PPP project, including the economic costs associated with the financing (line 6), the PPP project is now seen to be more costly than the PSC in present value terms (line 7). In this illustrative case (designed to give this result), financing has made a material difference.

The Treatment of Risk

Non-Systematic Risk

This section and the next section deal with the question of risk adjustments to the discount rate. Most of the controversy over the right rate to use involves systematic risk, but it is good to start by briefly reviewing other kinds of risk, too.

Asymmetric risk

“Asymmetric risk” is risk whose expected value is not equal to zero – i.e., upside or downside risk. The upside or downside impact cannot, of course, be eliminated by simple diversification or spreading.

There is a general consensus that asymmetric risks should ideally be handled by adjustments to cash flows rather than to the discount rate. “Optimism bias” is one kind. If project cash flows are built up as expected values, as they should be, then an adjustment for optimism bias should not be included in the discount rate.²⁷ The net present value (NPV) of the project will be lower because of the downward adjustment to net cash flows, not because a “risk premium” has been added to the

²⁶We assume here that the default component is correctly priced and does not include transaction costs (e.g., legal fees, which can be considerable) related to a default or potential default. In other words, the *expected value* of what the bank will receive (according to best judgment) is equal to the interest rate excluding this default premium.

²⁷Following the British example, in the method used by most PPP programs, it is assumed that the base cost estimates for the PSC are optimistically low and so a separate “optimism bias” adjustment must be made.

discount rate. A typical mistake is to ignore optimism bias in estimating the costs of the public sector project, whereas the costs of the PPP project, as estimated by the project developers, are closer to expected values. This makes the PPP project look worse.

Another example is the default premium in the cost of debt. Corporate and project finance lending rates include a default premium because there is some probability that borrowers will default on their debt service payments. The interest rate including the default premium is the *stated* cost of borrowing, i.e., the rate the borrower promises to pay. What the lender *expects* to receive is lower. The economic discount rate should not include a borrower- or project-specific default premium so long as the cash flows have been estimated on an expected-value basis. (Nevertheless, there are likely to be transaction costs associated with a default or impending default, and these should be included, ideally in the cash flows.)

This issue comes up frequently in comparing the cost of government debt with the cost of PPP company debt. Critics of PPPs have often pointed to the higher cost of debt to the PPP company as an argument in favour of public sector financing. But if the default premium is based on a good estimate of the probability of default, the premium does not result in an added cost, on average.²⁸ (The expected value of the transaction costs associated with a debt workout, however, would be an added cost of a PPP project and should not be ignored.)

Another way of conceptualizing this issue is to assume that project costs have been *underestimated* in the cash flows, and it is appropriate to consider the default premium in the loan to the PPP company loan as a true cost. But in that case, to be able to compare like with like, something equivalent is needed for the PSC: if there is no possibility of a default on the government loan, then contingent costs have to be funded somehow – e.g., an implicit guarantee from taxpayers to be called on if project cash flows are not sufficient to repay the debt.²⁹

²⁸But if you have good reason to believe that because of, e.g., lack of good information, wary *foreign* lenders are charging a default premium that is higher than a premium based on the best estimate of the probability of default, then the high cost of PPP financing would constitute an economic cost to the host country.

²⁹Klein (1996) takes this approach in demystifying problems encountered in comparing the costs of PPP financing and government debt.

An analogous issue may arise with respect to the equity returns that investors say they expect. When investors say they need to be assured of very high rates of return in certain emerging markets (sometimes 20% or higher, in real terms), in some cases they are implicitly assuming that the purported “expected” cash flows are overly optimistic, sometimes because they ignore low-probability financial-disaster scenarios.³⁰ The rates may build in a cushion against downside risk – analogous to a lender’s default premium. Once again, the question to ask is whether this premium appears to be based on a correct assessment of future risks.³¹

Non-systematic variability risk

It is generally accepted that both the public sector, through taxes, and the private sector, through dispersed shareholding, can in most cases diversify away or sufficiently spread symmetric non-systematic variability risk – i.e., the volatility around the expected value that is not correlated with the economy (national income).

According to some, this may not be quite true for the private sector because of agency considerations: managers might not have the same viewpoint as shareholders with regard to non-systematic risk. There are two ways to respond. First, from a financial point of view, in a competitive market, one would have to explain how this could be sustained for very long; strategic investors should try to increase the competitive advantage of their companies by finding clever ways around this agency problem so as to reduce the cost of capital. Second, from the economic point of view, any added premium would not be an economic cost (provided we are considering only domestic shareholders) – just

³⁰One would have to look at all the components – especially the sovereign risk premium for the country and the leverage of the capital structure of the company – to have a good idea of whether a rate like this seems excessive if interpreted as an expected value.

³¹This can be problematic, however. Suppose that one of the largest risks for equity investors is that the public entity will renege on the PPP contract or resort to creeping expropriation of some kind – and that investors must therefore add a substantial risk premium in expectation of that contingency. It is hard to imagine the PPP unit admitting this officially and therefore being willing to exclude this premium in estimating true cost of equity. The irony is that the PPP project may then appear prohibitively expensive, even though it is the propensity of the *public entity* to act in an opportunistic way (as perceived by investors) that makes it seem so.

supra-normal returns to shareholders. Irrespective of whether these responses are adequate, it is generally accepted that symmetric non-systematic variability risk should not be considered to affect the cost of capital for either the private or the public sector.

Most discussion of the impact of non-systematic risk in the public sector context relates to taxpayers. The issue might be different with regard to customers of the PPP service who pay user charges. There could be a big difference between risks borne by all taxpayers in a country and risks borne by a much smaller group of service users. What is most important to understand is that if people face *significant* non-systematic risk (i.e., it is not spread very thinly) and they cannot remove it by diversification or insurance, then *even non-systematic risk can have an economic cost*.³²

The following thought experiment highlights the issue.³³ Let's assume that some groups in society cannot completely diversify away or hedge non-systematic risk. Now consider the case of non-systematic risky costs and benefits that are fully, and negatively, correlated with each other so that *net* cash flow does not vary at all. If one group in society receives both streams, there is no risk-related economic cost. But if the costs and benefits are split and different groups (who cannot contract with each other) receive the two different streams, there will be a risk-related economic cost *for each group*.

Some monetary impacts of PPP projects that involve customers who pay for services might well remain concentrated among these service users and not fall on the entire population of taxpayers; so even non-systematic risk might require a premium if the effects are large enough.

In conclusion, non-systematic risk could increase the cost of either the PPP project or the PSC because of the impact of idiosyncratic risk on a relatively small group of customers; the group may be small enough so that people cannot achieve the full benefits of risk spreading and may not be able to diversify or hedge the risks sufficiently. It is probably more likely that risky customer payments figure more prominently in the PPP project than in the PSC; there is likely to be more emphasis on cost recovery from customers in the PPP project instead of filling deficits by government subsidies or by decreases or deferrals of maintenance expenditure. On the other hand, it is more likely that there will be greater

³²The possible importance of this in public sector projects is discussed in Arrow and Lind (1970, p. 377).

³³This illustration is based on Arrow and Lind (1970, p. 377).

risks in service quality – and hence risky coping costs – in the PSC. All in all, owing to the lack of good information, non-systematic variability risk should therefore probably be ignored in the analysis.

Systematic Risk

“Systematic risk” is risk that co-varies with the entire market or, depending on the type of analysis one is doing, with national income (loosely speaking, with the “economy” – the way it will often be expressed in this report). This means that it will not disappear through diversification or spreading.

Might a premium for systematic risk matter in the PPP-PSC comparison? Suppose for the moment (just to start the discussion) that the appropriate premium to use is the same as that used for a single-purpose PPP company.³⁴ The cost of capital for private sector companies engaged in PPP-type activities does include a risk premium. Empirical results show a range of values for the asset beta (i.e., what the beta would be for an *unlevered* company – a company with only equity and no debt in the capital structure).³⁵ As one would expect, given these companies’ reduced exposure to market forces (being regulated by contract or by agency), the asset beta values tend to be below the average asset beta for the market as a whole (which is around 0.65–0.75 in Western economies). Let’s say the asset beta for a typical PPP project company (assuming a PPP contract with a good-practice allocation of risk) is between 0.3 and 0.5.³⁶ Given a market risk premium of 6% (an oft-cited figure – perhaps somewhat on the high side), this translates into a project risk premium of between 1.8 and 3.0 percentage points to be added to (or subtracted from – see the next section) the discount rate.³⁷ That is not

³⁴In fact, this may not be the right benchmark to use, as will be discussed in the fifth and seventh sections. But this sets the scene.

³⁵See definitions of beta and leverage on pages 75–76.

³⁶See, e.g., the figures given in PricewaterhouseCoopers (2002).

³⁷The discussion in this paper assumes that the project-specific risk premium, using CAPM, is calculated using a market risk premium and a beta similar to those found in advanced economies. Some would argue that in many emerging markets, adjustments must be made that might greatly increase the risk premium. See, e.g., Estrada (2007) for a concise review of different models.

insignificant. But how often would it switch the ranking of the PPP project and the PSC – especially in developing countries where the economic discount rate is relatively high? (If very infrequently, perhaps the whole issue should be ignored.)

Systematic risk might not disappear just because the government borrowing rate does not include a premium for systematic risk and the government does not raise its funds in the equity market. Variability risk is not reflected in the stated cost of government financing; to the extent that it exists, it falls on taxpayers instead.³⁸

The standard argument to support the idea that systematic risk adds a cost to government financing goes something like this. Suppose, for example, that consumers pay a fixed price per unit consumed of some service, that demand for the service decreases when the economy is in a slump, and that the production process involves a certain proportion of fixed costs. Then in the case of a private sector company providing the service, shareholders' returns will decrease during an economic downturn. If we keep the same pricing policy, but this is a *public sector* project instead and the net cash flows go to and from the government's coffers, then in an economic slump, taxpayers will have to pay more taxes than they otherwise would and so will have less money to use for consumption purposes.³⁹ So the impact of a project on taxpayers' consumption would be positively correlated with the state of the economy.

In this story, it does not matter if the government practises tax smoothing by increasing its borrowing when there is a deficit so long as we subscribe to some form of *permanent income hypothesis* according to which present consumption is determined by long-term income expectations – in which case there is a close analogy between an investor's *asset* in the capital market and a taxpayer's perceived long-term *wealth*. This analogy may seem strained to some people – especially since investors in the capital market, as opposed to taxpayers, engage in a continual process of explicitly quantifying asset values and of trading –

³⁸Klein (1996) makes a related point: if the cost of risk associated with public finance is truly low, we need to ask “what it is about the tax system that allows it to tap lots of ‘investors’ with low costs of risk-bearing”. Are “all the financial advantages of sovereign finance ... due to [the] coercive powers” of the government?

³⁹It may well be that pricing policy would tend to be different in a public sector project, but for the purposes of comparing private sector and public sector projects, it is simpler to hold this aspect constant.

but many economists will view the two cases as virtually the same, despite empirical studies that show departures of consumers' behaviour from the permanent income hypothesis.

Nevertheless, the question of whether a premium for systematic risk should be included in the *economic* discount rate is generally ignored in the economic appraisal of public expenditures – even by those economists who basically accept the story outlined above,⁴⁰ leading to the view that the risk premium should not be the same for the PPP project and the PSC. This view is based on the belief that there is something different about public sector and private sector financing in terms of risk and hence cost to the economy. In particular, there might be something peculiar to the equity markets that makes the financing of the PPP project especially risky and costly.

In the following discussion, we are concerned only with the financing of the projects and monetary costs – and not with benefits and non-monetary costs – on the assumption that these will be the same for both the PSC and the PPP projects. In fact, this assumption is unrealistic in some developing countries since we would expect service quality to be lower and riskier with the PSC, and perhaps riskier in a way correlated with the economy. But trying to take this into account would only add to the complications of the analysis.⁴¹

What is the basis for the view that risk (or the cost of risk) is different for private and public sector financing? The landmark Arrow-Lind article (1970) is often brought out to dismiss the idea that there is a risk premium related to public sector projects. It is sometimes stated categorically that according to Arrow and Lind, one should use a risk-

⁴⁰In the weighted average sourcing approach, one component of the economic discount rate does include a premium for *average* market systematic risk. The question here is whether the overall premium should be adjusted to reflect the systematic risk of the particular project being appraised.

⁴¹It is not clear how to deal with the riskiness of non-monetary impacts (e.g., risky non-monetary benefits to users of the service). One view is that risk aversion is not relevant here (see, e.g., Spackman, 2001). But risky benefits from an infrastructure project could affect disposable income by way of coping behaviour: e.g., if a water system breaks down, people might have to spend more money or time getting water from standpipes, carriers, or tankers – and these extra expenditures (or reduced income) might be correlated with the economy if the service breakdowns are.

free discount rate for public sector investment projects.⁴² In fact, Arrow and Lind focus their attention on cases involving non-systematic risk; they state explicitly that their main contention does not apply to *systematic* risk. It is true that they do not believe that systematic risk is relevant or significant for public sector projects, but this is not a conclusion they reach through a detailed examination; they express it almost as a passing thought.

One preliminary point is that according to the general view, if systematic risk has a cost to the economy, it must be because of how it impinges on *individuals* somewhere along the line. Statements, therefore, that government departments should perhaps add risk premiums for systematic risk (using the CAPM methodology) “in the case of large investment projects where the risk is borne by an individual [government] agency” are puzzling or at least incomplete.⁴³ An organization, per se, does not experience the kind of risk aversion referred to in conventional theory.⁴⁴

A major stumbling block is that economists do not yet fully understand the causes of the observed high equity risk premium in the capital market – referred to as the “equity premium puzzle”. The puzzle, first noted in the mid-1980s, results from the conclusion from theory that the equity premium should be no more than about one-half a percent, rather than the 4-7% based on empirical data on actual market returns. Many explanations have been proposed, but there is not yet a consensus among economists.

This leads to a serious problem for deciding whether something similar to the equity premium should apply to public sector projects. In discussing the question of a risk premium for the economic discount rate, it is common for economists to refer to theory, and to empirical studies of the variability of national income and its correlation with project costs and benefits, and to conclude that even if a premium for systematic risk should be included for public sector projects, it is surely very small.

⁴²For example, Klein (1996, p. 6): “Arrow and Lind argued that government finance was indeed cheaper than private finance. They claimed that the government discount rate should be a risk-free rate reflecting risk-neutrality on the government’s part.”

⁴³Taken from Department of Treasury and Finance, Western Australia (2002, p. 142).

⁴⁴If an organization per se is posited as experiencing risk aversion, we have left behind the usual assumptions of methodological individualism.

But since we do not really know why the observed premium in the equity markets is so high relative to theory – and it is the same basic theory that applies – it is difficult to say with confidence whether the same discrepancy should or should not also apply to public sector financing. Authors steeped in the welfare economics tradition tend to believe that this cost is negligible; those schooled in financial economics generally see no reason to apply different assumptions from those applicable to private sector financing.⁴⁵

This is not the place to review all of the possible explanations advanced for the equity premium puzzle, of which there are many.⁴⁶ There is an important distinction, however, for the purposes of this paper: some explanations would apply only to financing from the equity markets, and some might apply across the board.

- *Peculiarities of equity markets.* Explanations of this type would probably not apply to public sector financing. This is the kind of explanation usually cited by those who believe that there is no reason to think that systematic risk involves a significant cost in the public sector. If reasoning along these lines is correct, this would tend to support the idea that there is indeed a significant extra cost associated with PPP projects. (But note that the efficiency gains and quality improvements brought about by the PPP project could still outweigh these extra costs; so this would not be the end of the story.) Some examples of this category of explanation (or description) are the following:
 - The pattern of returns in the equity market exhibits extreme values (“fat tails”) – for example, because of traders’ irrational behaviour (e.g., noise trading, speculation, contagion, bubbles, information cascades). This might cause concern to investors but might not be captured adequately by the statistical variance of the returns.
 - Emergent characteristics of market behaviour – e.g., fractals – with unspecified causes but having broadly the same effect as in the first point.⁴⁷

⁴⁵Spackman (2006), among others, makes this comparison among different academic traditions.

⁴⁶See, e.g., Grant and Quiggin (2004) and Spackman (2006) for summaries.

⁴⁷For “fractal finance”, see Mandelbrot and Hudson (2004).

- Systematic risk in the capital markets might be concentrated on a relatively small group of people because the markets are not complete and frictionless – for a number of possible reasons.
- *More general features of beliefs, preferences and psychology.* Explanations in this category might possibly affect the cost of risk in the public sector as well as in the equity market, but much would depend on the details. Examples:
 - People’s risk aversion may be greater than is generally believed.⁴⁸
 - Anticipated impact of low-probability economic disasters.⁴⁹
 - “Myopic loss aversion”: people may be more concerned about losses than about gains, and they may focus too much on short-term volatility.
 - Other unconventional specifications of people’s utility functions (e.g., habit persistence).
 - People may believe there is more uncertainty about future economic growth than one might predict based on past data (e.g., there may be uncertainty about model type and parameters) – a problem of “unknown unknowns”.⁵⁰

Another possibly important distinction affecting some of the explanations in both categories – but probably more so in the capital-market explanations – is whether a *mistake* may be involved.⁵¹ Explanations along these lines would not involve any economic cost since the error would simply result in someone in the economy getting a windfall –

⁴⁸But see Layard, Mayraz, and Nickell (2008). Using data from six surveys of reported well-being and happiness, they estimate the coefficient of risk aversion (assuming a CRRA utility function) to be around 1.2-1.3, well within the usual range as estimated by other methods (e.g., choice under uncertainty and intertemporal choice).

⁴⁹See, e.g., Barro (2006).

⁵⁰Economists tend to use point estimates based on past sample averages for their model parameters; this may be an inadequate way to model future uncertainty. For example, see Weitzman (2007). Weitzman is concerned with capital market phenomena, but the idea of subjective structural (parameter) uncertainty could be applied more broadly.

⁵¹For example, a mistake about what will happen in the future or perhaps about one’s own true preferences.

someone ends up earning more or less than they bargained for.⁵² We might not object to this in developing countries if it benefited *domestic* shareholders: strengthening local business groups is likely to help develop the economy. This would, however, involve an economic cost if the error resulted in a *foreign* investor receiving the windfall – e.g., a foreign investor believing that the project is more risky than it really is.

In short, most specialists addressing the issue come down strongly on one side or the other: either the systematic risk premium appropriate for public sector financing is negligible, or it should be the same as for private sector financing. Since competent, highly regarded economists are ranged on both sides of the issue, the best policy advice to governments is perhaps to say simply that the question is undecided at present. The implications of this noncommittal position will be developed more in the seventh section.

Taking Systematic Risk into Account in the PPP-PSC Comparison

In this section, we assume, *solely for purposes of argument*, that it is appropriate to make a CAPM-type adjustment for systematic risk in the discount rates used for the PPP-PSC comparison. In that case, how should one go about it?

As noted in the second section, Partnerships Victoria has identified two problems with the way discounting is often done in the PPP-PSC comparison.

- In the case of costs, we are looking at negative cash flows. It makes no sense to say that a future cost is less onerous the riskier it is⁵³ – which is the effect that normal discounting would have. (The greater the riskiness, the higher the discount rate and so the lower the present value of the cost.) So we have to approach the discounting issue in a different way.

⁵²This is like the notion of the *happy pessimist*: the person who habitually prepares for the worst and is continually pleased by outcomes more favourable than he or she expected.

⁵³Assuming here that the risky cost (expressed as a negative value) co-varies positively with the state of the economy.

- Riskiness should be seen from the perspective of the public sector. So, in discounting the payments to be made to the private company under a PPP contract, it is not the underlying risks of the project that matter but the risks that are intentionally or unintentionally borne by the public sector – principally through the payments that the public sector pays to the private company. Supposing (hypothetically) that *all* systematic risks were borne by the private company, then the rate to use in discounting the PPP project cash flows, from the public sector’s perspective, should be the risk-free rate.

Most PPP programs discuss the question of risk adjustment as if they were using the discount rate in the canonical way – i.e., to discount the *net* cash flows of a project. But we are not looking at net cash flows; we are looking just at costs.

Within the CAPM framework, there is nothing wrong with disaggregating various inflows and outflows so long as one applies the appropriate risk premium to each flow. The sum of the present values of each line must equal the NPV of bottom-line net cash flow, discounted at the appropriate project rate. The risk premium that should be used for each flow is based on the covariance of that particular cash flow with the market or economy. The rules to be used for the sign of the risk premium (i.e., the sign of conventional CAPM beta) are shown in Figure 1.

The reason that the sign of the risk premium (i.e., of beta) is different for outflows and inflows is that the conventional CAPM beta (project beta) is based on correlations of *returns*, not cash flows, and with respect to outflows, this introduces a negative value in the denominator.⁵⁴ The relevant algebra is summarized in Annex 1.

⁵⁴The sign of the *cash-flow* beta is the same as the sign of the correlation (see Annex 1), but it is the conventional CAPM beta (the project beta, based on returns, not cash flows) that must be used to determine the sign of the risk premium; for outflows, the signs of the two different types of beta are different. There has been an ongoing debate about how to apply the CAPM-type risk premium to negative cash flows. See the discussion in Ehrhardt and Daves (2000), which includes an appendix setting out the basic algebra. One concern in the literature has been whether flipping between positive and negative risk premiums could present arbitrage opportunities, which would not make sense (see Brealey, Cooper, and Habib, 1997). The rules given in Figure 1 would not lead to this problem.

Figure 1: Determining the Sign of the Risk Premium to Be Added to the Discount Rate

		Correlation of cash flow with the market or economy	
		Positive (“bad risk”)	Negative (“good risk”)
Inflow	Positive risk premium	Negative risk premium	
Outflow	Negative risk premium	Positive risk premium	

For convenience, let’s refer to cash flows that are positively correlated with the economy as “bad-risky” cash flows (risk reduces value) and cash flows that are negatively correlated with the economy as “good-risky” cash flows (risk increases value).

In the projects we often consider where the *net cash flow* is bad-risky, we have to include a positive risk premium above the risk-free rate. That can come about either because both inflows and outflows are bad-risky, which amplifies the effect in the net cash flow, or because inflows and outflows are different in this respect but the effect of the bad-risky cash flows outweighs that of the good-risky cash flows. For example, take the case of a project in which demand, and hence revenue, is positively correlated with the economy. One would expect variable costs to be good-risky since they will also be lower when demand is less (they are negatively correlated with the economy). But the bad-risky revenue outweighs this, and so the net result is bad-risky.

What happens when we do a PPP-PSC comparison? The ideal case is one in which benefits are the same for both alternatives; so we will ignore the benefit side and look only at the comparison of costs. When we look at the costs, what kind of cash flows are we looking at? They are outflows. If they are bad-risky, by the rules above we would use a *negative* risk premium in the discount rate.

But it is not at all clear why all the costs should be bad-risky. As noted in the example above, *variable costs* might well be good-risky in an overall bad-risky project, and this is a type of cost that will extend throughout the life of the PPP project. We should use a *positive* risk premium for good-risky costs. Moreover, one can imagine bad-risky

projects in which almost all the systematic risk comes from the revenue (or benefit) stream. In that case, one should use the risk-free rate to discount the costs.

In fact, even though the PPP-PSC comparison typically involves analyzing only costs, any adjustment made for systematic risk has to be the adjustment appropriate for *net* cash flow since part of the risk – and often the major part – arises on the revenue side. This does little to make the adjustment easily comprehensible.

Partnerships Victoria is certainly on to something important in recognizing that within the CAPM framework, the discount rate to be used for components of disaggregated cash flows is not necessarily the discount rate that would be used for the overall net cash flow – i.e., the normal project discount rate. But it is not immediately obvious that there is an easy solution: it would seem that a careful case-by-case, line-by-line examination is needed. (It may be that with further study, some useful rules of thumb would emerge.)

The second novel aspect of the Partnerships Victoria approach is that it looks at the riskiness of the PPP cash flows *as faced by the public sector*. The overall systematic risk of the PPP project is not what matters to the public sector in discounting the payments it will make to the company if the company's shareholders bear most of that risk. In the extreme case, where shareholders bear all systematic risk, the payment stream made to the private company would have zero systematic risk from the public-sector perspective. (The internalized risk may affect the cost of financing for the private company, but that would affect the size of the contractual payments to be made, not their riskiness.)

In contrast, the public sector would face the full risk in the PSC because no one else is taking any of it. Since we are looking at outflows in each case from the public sector's perspective, if we assume that we are dealing with outflows with zero or positive correlation with the economy (i.e., neutral or bad-risky outflows), if there is any risk premium to use in the discount rate, it will be negative. So in the extreme case, where all systematic risk has been transferred to the private company, the discount rate to use for the PPP outflows will be the risk-free rate, and the rate to use for the risky PSC outflows will be lower than the risk-free rate.

The Partnerships Victoria method may seem confusing at first because it uses the risk-free rate for the PSC costs and possibly a higher rate for the PPP outflows. It may have the right ranking of rates and the

right difference in percentage points between them, but the rates are at the wrong levels.⁵⁵

Does this matter? In fact, it may indeed matter because of the non-linear relation between discount rates and present values. Suppose the real risk-free rate is 3% and the appropriate risk premium is 4% (the figure is exaggerated to show that the discount rate could actually be negative). For the typical cash flow profiles, and assuming that all types of costs require the same risk premium, there would be a significant difference between (i) comparing the PSC using a discount rate of 3% with the PPP at a discount rate of 7%, and (ii) comparing the PSC at a discount rate of -1% with the PPP at a discount rate of 3%. It can easily be shown that method (i), the method used by Partnerships Victoria, distorts the results in favour of the PPP project. How often that might matter with actual cases is another question.

Apart from this question, there are difficult issues in knowing what the risk premiums should be for the PSC and for the PPP project from the public sector perspective. (Here we ignore the added problems of understanding just what the cost of systematic risk is outside the context of the capital market. We assume here that the public sector costs the risk in the same way that the equity market does.)

For the PSC, it is typical to suggest looking at publicly traded private sector companies that are engaged in similar types of activities (i.e., PPP projects in the same sector) and determining their betas based on equity prices over a past period. But this would reflect the systematic risk faced by the company's *shareholders*.⁵⁶ Some of the systematic risk may well have been passed on to customers or a public entity. What we are really interested in knowing is what the beta of a PPP company would be, hypothetically, if *no* systematic risk were passed on to customers or the public sector through the PPP contract – i.e., if all of it were borne by shareholders. But there may be no market benchmark for that.

For the PPP project, from the perspective of the public sector, we would need to understand the systematic risk inherent in the payment

⁵⁵According to Gómez-Ibáñez (2005, p. 7): “Victoria’s Treasury did not recognize that the betas for the Partnerships projects were likely to be negative, ...” (It is true that Partnerships Victoria [2003b] does not mention the idea of negative betas.) If this is correct, this would explain why Partnerships Victoria used the risk-free rate and a *higher* rate.

⁵⁶A similar point is made in Gómez-Ibáñez (2005).

formula,⁵⁷ including all adjustment provisions (indexation, specified events, price resets, etc.), as well as in any guarantees that might be given by the government outside the PPP contract. This is no easy matter. Suppose the contract passes demand risk through to government or customers but only under certain conditions. First, one has to understand the extent to which demand risk in this sector and for this project is systematic. Second, one has to figure out how the specific contractual allocation mechanism allocates that systematic risk. This is likely to be highly speculative.

In conclusion, even if we assume that the cost of systematic risk is the same in the public sector as in private sector financing (and it is not clear that this is so), deciding how to take this into account in comparing the PPP project with the PSC is hardly straightforward.

Questions and Puzzles

One way to sum up the discussion in this paper – before turning to a possible practical way forward – is to highlight a number of key questions and puzzles that arise when looking at how PPP programs in different countries conceptualize the discount rate issue and also in other writings on the subject oriented for the practitioner or the public. The following gives some of the key questions that often arise. Short and informal responses follow each question. Not all specialists will agree with all the responses given below. What is most important to note for the purposes of this paper is that these are the kinds of issues that PPP programs must wrestle with to determine the appropriate discount rate to use. PPP units should attempt to understand what these issues involve and not unthinkingly take on board the conclusions in a consultants' report.

- (1) **Q.** Should the PSC exercise and the discount rate be based only on financial costs to the government (or to the particular government department), or should they be based on costs to society as a whole? That is, is the PSC exercise

⁵⁷See Grout (2003) for a careful examination of what the result might be if the private company is paid a fixed unit cost while the sales quantity varies with demand.

fundamentally a form of *financial* appraisal or *economic* appraisal?

A. PPP programs have not taken a consistent position on this. But it is difficult to see why the government should not look at costs and benefits in the economy as a whole.

- (2) **Q.** Is the correct discount rate, before possibly accounting for systematic risk, the government borrowing rate?

A. This would make sense from the purely financial perspective. If the economic perspective is taken, however, in principle, externalities (if any) should be taken into account. See (1). In some countries, the economic discount rate will be (or will be close to) the government borrowing rate.

- (3) **Q.** Why is the UK, which has led the way in the PPP movement in so many respects, the only country (of those noted in the second section) that seems largely to ignore market rates and the opportunity cost of displaced private investment in its determination of the appropriate discount rate (or at least, not use them in a straightforward way)?

A. UK Treasury guidance does not give a direct answer to this question. In most of the usual approaches to the economic discount rate, the opportunity cost of capital plays some role, and it had a prominent place in the thinking of the UK Treasury before 2003. Some cynics suspect there was pressure to lower the rate to make it more favourable to the public sector solution for infrastructure projects (as well as responding to pressure from interest groups in other sectors), and using just the social time preference rate was a convenient way to accomplish this. Others note that the rate arrived at (3.5% real) is fairly close to the government borrowing rate plus a corporate profit-tax gross-up; so the result may not be far from what the risk-free economic discount rate would be, derived that way, even if there appears to be a gap in the conceptual story. It is important to note, however, that the economic opportunity cost of displaced private investment could have a much greater effect on the rate in developing countries.

- (4) **Q.** Should the cost of risk be accounted for as a cash flow adjustment or as an adjustment to the discount rate?
- A.** This depends on the type of risk. Symmetric variability risk can be accounted for in the discount rate in certain circumstances. Asymmetric risk – e.g., the expectation of a future downside shock of some kind – should ideally be accounted for in cash flows. Default risk would fall into the latter category. Optimism bias is another example.
- (5) **Q.** Do risks and the cost of risk depend only on the underlying project and not at all on the way the project is financed?
- A.** This statement is often made, taking cue from modern finance theory. But this theory looks at risk in capital markets, so it begs the question. There is no reason, a priori, to think that the cost of risk must be the same in funding projects from the capital market, from user charges, and from taxes.
- (6) **Q.** Does risk disappear in the public sector financing of infrastructure projects because it is diversified or spread over all taxpayers?
- A.** There is a consensus that the cost of non-systematic variability risk will tend to go to zero when spread over a large number of people – the oft-cited Arrow-Lind (1970) result. But this can occur by way of taxation *or* through the capital market. Moreover, it does not happen with systematic risk.
- (7) **Q.** Suppose we grant that the discount rate should take into account “systematic risk”. How do we know what the economic cost of systematic risk is in a public sector project?
- A.** This is not a simple matter; there is no consensus among experts or practitioners.
- (8) **Q.** Supposing that it is correct to adjust the discount rate for systematic risk, should one use as the discount rate the market-derived weighted average cost of capital (WACC) that would be appropriate for the same kind of project implemented by a company in the private sector?

A. Even if we ended up with a rate close to that, it would be after we carefully thought through all the issues and made calculations, not because it simply seemed natural to use this rate.

- (9) **Q.** Isn't it true that public sector funding cannot be less costly because if it were, it would mean that the government should finance all investment projects, and that would be absurd. As Partnerships Victoria (2003b, p. 27) puts it: If the government's borrowing rate were used as the discount rate, "the logical consequence would be that government would finance everything, and replace commercial sources of finance".

A. This is not a good argument because there are other reasons why we would want certain organizations rather than others to bear the risk of financing projects. Often the way to ensure that an organization puts adequate effort into reducing costs or improving service is to make it bear the associated risks. It is often too complicated to unbundle financing from the rest of the business without disturbing the incentive structure – too complicated to find ways to transfer risks to the private sector in a different way.

- (10) **Q.** Shouldn't the same discount rate (including risk premium, if any) apply to both the PSC and the PPP project since the underlying project is the same?

A. The answer depends on the approach used. Most PPP programs use the same discount rate even when they discount project cash flows on an after-financing basis, as they generally do. But if the discount rate is applied to the stream of payments that the public sector will make under the PPP contract (along with some other adjustments), then the risk characteristics of the cash flows may have changed since risks have been allocated between the private company and the public sector. In one extreme case, where all variability risk is borne by the company, clearly a *risk-free* discount rate should be used to discount the PPP contract payments if the discount rate is applied after financing. (The contract payments might be expected to be greater, however, because investors would

require a higher return to compensate them for bearing all the systematic risk.)

If the view is taken that systematic risk does not have a significant cost to the public sector, then it is correct to use the same (risk-free) discount rate for both the PPP project and the PSC when the discounting is done after financing: in both cases, one is looking at cash flows from the perspective of the public sector.

It is argued in the present paper, however, that discounting the PPP project and the PSC on an after-financing basis is unsound: it is the true resource cost of the projects that is relevant, and so one should ignore the financing per se. But one still has to account for the costs to the economy of systematic risk (certainly for the PPP project, perhaps for the PSC too). The most conceptually appealing way to deal with this would be to use certainty equivalents. A rougher screening test is proposed in this paper that adjusts the discount rate for systematic risk. Using that test, if it assumed (as one possibility) that systematic risk has a significant cost for the PPP project but not for the PSC, then one should indeed use different discount rates.

- (11) **Q.** Is the risk premium (more fundamentally, the appropriate CAPM beta) *negative* for negative cash flows?

A. This depends on whether the negative cash flows are positively or negatively correlated with the market or economy (as the case may be). In the case of negative cash flows that are positively correlated with the economy (i.e., where systematic risk reduces value), one should indeed use a negative beta and a negative risk premium so that the appropriate discount rate will be *below* the risk-free rate – thus making the present value of outflows *greater*.⁵⁸ This is something that appears to have been ignored by all PPP programs, although Victoria has got it partly right.

⁵⁸The beta referred to here is the project beta (i.e., based on returns). Since we are looking at cash flows, we may think more naturally in terms of cash flow betas. But for outflows, the corresponding project (or “return”) beta is opposite in sign to the cash flow beta. See footnote 54, Annex 1, and Ehrhardt and Daves (2000).

A Practical Approach to Carrying Out the PSC Exercise

Regardless of the complexities, in some circumstances PPP units may want to use a method of some kind to compare a PPP project with the public sector comparator. What follows is a sketch of a possible approach. The purpose is to provoke thought and encourage people to test and then develop these ideas further in a more operational way. The approach is developed in more detail in Annex 2.

► ***Carry out a PSC comparison for different types of projects, not for each specific project.***

There is no need to carry out the PSC exercise for each project. It is sufficient to determine that a type of project with certain key features is likely to yield greater benefits if implemented as a PPP. So long as a specific project conforms well enough to the general type, there is no need to repeat the exercise. The country's PPP unit can develop routine-level instructions and guidance (as appropriate) for the appraisal of individual projects of a specified type.

The fact that the initial assessment would be made for *types* of projects offers some new ways to decide whether to embark on a PPP project instead of a public sector one. For example, suppose that the PPP unit's assessment does not yield a clear conclusion that the PPP project will offer greater benefits than a well-designed public sector alternative. Instead of treating the issue as having been decided by the evidence one way or the other, one solution would be to embrace the ex ante uncertainty and recommend that the line department undertake, on a random basis, some of the projects on a PPP basis and some on a public sector basis, while setting up a system to carefully monitor the comparative results. A solution like this would not emerge naturally from a project-by-project PSC analysis.

Most important, the PPP unit's attention would shift to modelling the envisaged PPP project not for purposes of comparison with a PSC but to better understand and hence improve the PPP arrangement and transaction itself.

► ***Consider the cash flow streams before the financing of the project (for both the PPP and the PSC), but include costs associated with the financing.***

This eliminates the problem discussed in the third section (cash flows viewed after financing). The costs to be included – those associated with the financing – are (i) financial intermediation costs and, if applicable, (ii) the cost of systematic risk (see below).

► ***Carry out the analysis looking at both costs and benefits – i.e., net cash flow – especially whenever a premium for systematic risk is included in the discount rate.***

The PSC exercise is normally carried out as a comparison of costs only. If the exercise is restricted to apply to project *types* rather than individual projects, fewer PSC exercises will be conducted, and there is no reason not to spend more time and conduct a full cost-benefit analysis. There are several advantages. First, it is likely that a sound economic cost-benefit analysis has not yet been carried out (contrary to the common assumption in more advanced economies); so the exercise will bring out problems on the benefit side. Second, a complete analysis will permit a comparative distributional analysis (who gains and who loses and by how much), which is a very useful tool in PPP appraisal and comparison with the PSC. Third, discounting net benefits instead of cost streams, makes it possible to retain the conventional, and more intuitively appealing, practice of *adding* the risk premium to the discount rate.

► ***See if the issue of systematic risk can be sidestepped by examining critical test cases for the PPP project and the PSC.***

Given that there is no consensus among experts about whether and how systematic risk might constitute a significant cost in the context of a publicly financed project, it would be best to try to avoid the issue completely. If the analysis is carried out by adding a risk premium to the discount rate for both the PPP project and the PSC, and the PSC wins (i.e., has the highest NPV), then one can accept this result as decisive since this is the toughest test for the PSC to meet. If, on the other hand, the analysis is carried out by including the cost of systematic risk only for the PPP project and the PPP wins, then one can accept this result as decisive since this is the toughest test for the PPP. It is expected that most projects would meet one or the other of these conditions, and hence the issue of systematic risk could be avoided.

If neither of these conditions holds – i.e., if the PPP project wins when a risk premium is applied to both projects but ranks below the PSC when a risk premium is applied only to the PPP – then one should conclude that systematic risk might make a difference. It would then be best to look more closely at the details of the projects and consider a wider range of factors. One should pay particular attention to the underlying characteristics of the PPP project that, based on theory and experience, argue in favour of or against using the PPP approach (e.g., is a fairly *complete* long-term contract feasible, or is it likely that the public sector will want considerable flexibility as the project advances?).

Conclusions

The issue of what discount rate to use in comparing a PPP project and an equivalent public sector project is complex and in some ways confusing. This paper has tried to show that the way the issue is being addressed at present in many countries is too simplistic and for some aspects clearly incorrect. The main conclusions of the paper can be summarized as follows:

- The appropriate rate to use is some variant of, or is based on, an *economic* discount rate.
- There are differences of professional opinion about how to determine the discount rate – even before any adjustment for systematic risk. An important consideration is whether the rate should include a component reflecting the marginal economic rate of return on private investment. Doing that could make a significant difference, especially in developing economies.
- There are peculiarities that arise from applying the economic discount rate to PPP project cash flows viewed *after* financing (the typical practice in the PSC exercise) – especially in countries in which the government borrowing rate is not a good approximation of the economic discount rate. Not enough attention has been given to this issue in the developing country context.
- Whether or not, and the extent to which, systematic risk adds significant cost to public sector projects is a matter of debate and speculation.

- Even if one accepts in principle that the cost of systematic risk is significant for public sector financing, the analytical issues remain complicated: we cannot easily rely on market benchmarks to determine the beta of the PSC since we want to know the impact of the *entire* underlying systematic risk, not just the part typically borne by PPP company shareholders (the part that would show up in market benchmarks).
- Adding to the complications, risk to the public sector from the PPP project should be viewed after being filtered through the PPP contract. So in addition, we have to understand how the PPP contract allocates systematic risk – not always an easy matter.
- In any event, for many developing countries, it would probably be better to focus on analyzing financial intermediation costs in comparing public sector and private sector financing rather than possible differences in a premium for systematic risk.
- One solution to the question of systematic risk would be simply to ignore it in the PPP-PSC comparison. The previous section and Annex 2 suggest an alternative, pragmatic approach (which needs to be tested, refined, and developed further in a more operational way) that might be used by PPP units. It might be used as a preliminary exercise that would lead to a more general conclusion by the PPP unit that systematic risk should henceforth be ignored in the PPP-PSC comparison. The analysis would separate the question of underlying project costs from the effect, if any, of private sector financing. The analysis also would be carried out in a number of different ways, with a view to determining whether the PPP project should definitely be eliminated or definitely be selected. For a range in the middle, given the uncertainties of the discount rate issue, the PPP-PSC comparison would not yield definitive results. One would then have to give more attention to other factors tending to favour or disfavour the PPP project.

Annex 1

Determining the Sign of the CAPM Beta

This annex summarizes the algebra underlying Figure 1 (see page 52).

The conventional CAPM *project* beta can be expressed as follows:

$$\beta = \frac{\text{cov}(r, r_m)}{\sigma_m^2},$$

where r is the rate of return for the asset in question, r_m is the market rate of return, and σ_m^2 is the variance of the market returns.

This is equivalent to:

$$\beta = \frac{\text{cov}\left(\left(\frac{CF_1}{V_0} - 1\right), r_m\right)}{\sigma_m^2} = \frac{\text{cov}(CF_1, r_m)}{V_0 \times \sigma_m^2},$$

where V_0 is the value of the asset, or stream of future cash flows, at the end of period 0 (i.e., the starting value or present value) and CF_1 is the risky cash flow occurring at the end of period 1 (assuming a one-period model, with CF_1 being the total return received).

So long as CF_1 and r_m tend to move together in the same direction along the real number line, the covariance will be positive, regardless of whether CF_1 is positive or negative. This is systematic risk that *reduces* value (“bad risk” in the shorthand used in the fifth section). Likewise, the value often referred to as the “cash flow beta” will be positive:

$$\text{Cash flow beta} = \frac{\text{cov}(CF_1, r_m)}{\sigma_m^2}$$

But the conventional CAPM beta (“ β ” above), the project beta (sometimes referred to as the “return” beta), will depend also on the sign of the cash flows: in the case of negative cash flows (e.g., costs), V_0 in the denominator will be negative, and therefore so will β . So in the case of a stream of *costs*, value-reducing systematic risk will lead to a *negative* risk premium to be applied to the discount rate.

Annex 2

One Possible Practical Approach

This annex develops in more detail the approach sketched out in the seventh section.

PPP programs need a pragmatic way to deal with the discount rate issue – a way that makes sense given all the uncertainties involved. This annex sketches a possible way forward. First, a few caveats and other considerations.

- Although this scheme involves a method for carrying out the PPP-PSC comparison, the more limited focus here is on the discount rate and how it should be used and on how the additional costs of private sector *financing* are to be taken into account.
- What follows should not be taken to be a recommendation. It is simply one possible solution, put forward to stimulate thought and discussion. What is most important is the approach being suggested, not the details; some details may be misguided or impractical. More work needs to be done using real PPP projects to test approaches like the one sketched out below (and others also) and then to modify and refine them before including them in any guidance material for PPP units.
- Given all the uncertainties, the quantitative findings of the PPP-PSC comparison should not necessarily be decisive in themselves. They will be one factor to examine, along with others. This consideration is even more pertinent if the PPP-PSC comparison is carried out not for each individual project but instead for representative *types* of projects.
- To simplify matters, and in keeping with common PSC practice, it is assumed in steps 1 and 2, below, that the gross benefits of the alternative projects will be the same, and so we will look only at costs. As noted above in the first section, this may well be an unrealistic assumption, especially in developing countries. In that case, adjustments would have to be made to the details outlined below.
- The PPP-PSC comparison referred to in this section is assumed to be carried out *before* the bids are received and is therefore based on a hypothetical PPP project. There is a danger that a PPP-PSC comparison done after the bids are received turns into more of a

bureaucratic exercise in ex post justification than a serious decision tool. In any case, the approach given below is not suitable, without further modification, for that purpose. Note, however, that the PSC model is to be distinguished from a sensible financial model of the expected PPP project (reference PPP project), which is indeed an essential tool to be used throughout the process of project preparation.

The tentatively suggested approach would consist of three steps. Step 1 begins by making some comparisons of costs without doing any discounting. It may be possible to reject the PPP project without going any further. Step 2 involves discounting and includes financial intermediation costs but not the costs of any systematic risk. Step 3, in which the possible cost of systematic risk is introduced, is separated from Step 2 because the issue of systematic risk is problematic, and there is no consensus about its relevance for the public sector comparator. So Step 3 gives a rough cut and simply looks at the two extremes with respect to the issue of systematic risk.

The three steps are as follows.

Step 1

The first step would involve examining the cash flows of the PPP project and the PSC *before any discounting*. An important purpose is to try to understand what is likely to be driving any cost advantages and disadvantages of the PPP project relative to the PSC.

Two broad kinds of comparison are the most important. For each of the two categories, (1) and (2) below, (a) is compared with (b), and if (a) > (b), then the PPP project is considered more advantageous with respect to that aspect.

- (1) Costs during the early years of the project – the development and construction phases:
 - (a) Capex for the PSC *minus* capex for the PPP project.
 - (b) Transaction (and early contract oversight) costs due for the PPP project *minus* costs of a similar type for the PSC.
- (2) Recurrent costs during the operating phase (for a typical year or years after completion of construction):
 - (a) Opex for the PSC *minus* opex for the PPP project.

- (b) Costs of ongoing contract monitoring and management for the PPP project *minus* costs of a similar type for the PSC. (This is worded as if we expect these costs to be higher for the PPP project. We might expect them to be lower in a specific case, in which case the value of (b) would be negative.)

The following decision rules would be used:

- If *clearly* $(1)(a) < (1)(b)$ and $(2)(a) < (2)(b)$, then we can see that the PPP project is a bad choice without needing to go any further. We can assume that the added effect of private sector financing would be negative, or at best neutral, for the PPP project.
- If *clearly* $(1)(a) > (1)(b)$ and $(2)(a) > (2)(b)$, we can see that the PPP project is the better solution before taking private sector financing into consideration, but that step might switch the ranking. So we need to go to Step 2.
- In the two other cases, namely:
 $(1)(a) < (1)(b)$ & $(2)(a) > (2)(b)$, and
 $(1)(a) > (1)(b)$ & $(2)(a) < (2)(b)$,
we need to proceed to Step 2 because the comparison must be done across time using present values.

Step 1 is important for several reasons. First, it is done on the basis of underlying costs without need to estimate any economic costs associated with private sector financing. Second, no discount rate is needed. Third and perhaps most important, it brings out the main underlying reasons why the PPP project might be more or less costly than the PSC. It is better to try to understand these reasons rather than to crank out a PPP-PSC comparison as a black-box exercise, ending up simply with a present value – which can easily lead to a specious sense of precision.

Step 2

In Step 2, a discounted PPP-PSC comparison is made using the underlying project costs of the PPP project (not the net cash flows, just the costs), considered before financing, *plus* the economic costs associated with the financing (e.g., certain financial intermediation costs – see the third section), except for costs that might arise from systematic

risk. The discount rate used for both alternatives would be the usual economic discount rate.

This analysis gets at the comparison between cost advantages and disadvantages occurring in different time periods. For example, suppose that the project is relatively small and so the PPP transaction costs are proportionally large and outweigh any expected capex efficiency of the PPP project, but it is expected that there will be considerable opex efficiency gains with the PPP project, offset to some extent by financial intermediation costs. Do these gains tip the balance in favour of the PPP project? Discounting is needed to make the comparison. The higher the discount rate (and the economic discount rate could be fairly high in a developing country), the greater are the opex efficiency gains that will be needed to outweigh a cost disadvantage in the early years.

If the PPP project comes out ahead in this step (i.e., present value of costs lower than for the PSC), we must proceed to Step 3. If the PPP project does worse than the PSC in this step – i.e., if the PPP looks worse even before we take into consideration the question of systematic risk – then it is likely that the PPP route is not the way to go. This does not mean that the PPP project should automatically be rejected; a deeper analysis should be carried out to see what is giving rise to this result and whether it makes sense.

Step 3

In the final step, we would do a discounted comparison of economic *net cash flows* (economic benefits minus economic costs), taking into account a premium for possible systematic risk.

We would do the analysis in two ways:

- (A) *Best case for PPP and private sector financing.* Here we assume that systematic risk requires a premium for both projects. This is the most favourable assumption for the PPP project. The appropriate risk premium (see below) is added to the risk-free economic discount rate for both the PPP project and the PSC. Doing this in a *carte blanche* manner, applying the risk-adjusted discount rate to all economic flows, is surely too coarse – e.g., should a risk premium really apply to *non-monetized* consumer benefits? But trying to disaggregate the flows and applying the risk-adjusted rate (or determining certainty equivalents) for some but not all flows would be

complicated and would once again run into the controversies set out in section five. A crude adjustment is perhaps the best we can do here.

Given that we are making the same adjustment to the discount rate for both the PPP project and the PSC, it is unlikely that this will change the ranking determined in Step 2 (where the same rate, but with no risk premium, was used), but it might do so in some circumstances. If the ranking changes relative to Step 2, the cash flows should be examined in detail to understand what the factors are that switch the ranking and whether there is a reasonable explanation.

- (B) *Best case for PSC.* For this case, we make an adjustment for systematic risk only for the PPP project. This is the most favourable assumption for the PSC. This reflects the view of some authors that the premium for systematic risk associated with the PSC is insignificant (see the fourth section).

Rather than add a risk premium to the discount rate used for the PPP project, it might be better to look at just the PPP financing flows (debt and equity), estimate the cost of systematic risk, add that cost to the overall project costs, and then use the usual economic discount rate in the cost-benefit analysis.

Ideally, the cost of systematic risk should be estimated using certainty equivalents.⁵⁹ This would be consistent with separating the issue of the cost of systematic risk from the discount rate. But the assumptions needed for the required calculations – e.g., the covariance between each risky cash flow in each year and the market return – are likely to be unknown.⁶⁰ An easier, if rougher, alternative method would be to estimate the present value (PV) of systematic-risk costs by taking the difference between the NPV of the financing flows, discounted at the risk-free financial rate, and the NPV of the same financing flows, discounted at the risk-adjusted financial rate.

⁵⁹See page 75 for the definition of “certainty equivalent”.

⁶⁰For a detailed discussion of how to use certainty equivalents instead of a risk-adjusted discount rate in a CAPM framework, see Sick (1986).

If the PPP project has the higher NPV even in case (B), where the PPP project has a handicap, then this is a favourable result for the PPP project. In this case, we can feel fairly confident about going ahead with the PPP project.

If the PSC has the higher NPV in case (A), then things do not look good for the PPP project. This does not mean that the PPP solution should be rejected out of hand. A deeper look should first be taken to understand what produced this result and whether it seems plausible.

If the PPP project wins (i.e., has the higher NPV) in the case of (A) but not (B), then we can see that the thorny issue of systematic risk is critical – systematic risk might make a difference. After looking more deeply to see what led to the overall results (apart from the possible systematic risk premium), we should probably give somewhat more weight to other positive or negative factors (e.g., a qualitative assessment of why this *type* of project might or might not be conducive to being implemented as a PPP project) in reaching our decision about whether to go ahead with the project on a PPP basis.

The risk premium to be used in the analysis would be determined in the following way: For simplicity, the risk premium could be based on the standard CAPM paradigm. In case (A), we would want to include the *total* systematic risk of the project, not just the systematic risk faced by a typical PPP company. The total systematic risk would be captured in the increased cost of financing for the PPP company, in markups charged by subcontractors to the extent that they bear part of the systematic risk, and possibly in the contractual payments made to the company by the public sector (i.e., unless the public sector takes no systematic risk). For present purposes, we do not need to distinguish between these components since we are interested only in the total effect – an advantage of the method outlined here, which begins with the underlying costs before financing.

What value should we use for the asset beta in case (A)? As noted in the fourth section, the market average (*unlevered* beta) in developed economies is around 0.65-0.75.⁶¹ Demand risk is an important driver of

⁶¹In this discussion, since the purpose is just to outline an approach and methodology, we will look at values for beta and the market risk premium applicable to mature equity markets – e.g., the US and the UK. Estimating these values for an emerging market is much more problematic, especially if we assume that the market is not fully integrated with the global equity market. Another problem is that even though we want to exclude downside country risk from this particular calculation (since it is picked up elsewhere), in some models the beta coefficient itself is assumed to be related to the country risk premium. See Sabal (2004) for a good summary of the different views.

asset betas. Many infrastructure and utility-type projects produce necessities (as opposed to luxuries) – they are not cyclical businesses – and so they face a lower income elasticity of demand than the average market-based project. We might therefore think that the appropriate asset beta would be lower than the market average. On the other hand, the scope of activities of PPP companies is tightly regulated: they are often locked in to their technologies and market, and so they have much less flexibility to adjust to changing market conditions. That characteristic might tend to increase the asset beta.

Given that we are not aiming for precision in Step 3 but intend simply to compare the two extreme possibilities, for want of better information, perhaps using a rough market average would be best in case (A) – say, 0.7. Alternatively, one could take the approach of Partnerships Victoria and use three different values depending on the type of project. Partnerships Victoria uses 0.3, 0.5, and 0.9 (see section two).

The calculation used in case (B), however, must be different. Since the assumption in case (B) is that systematic risk has a negligible cost to the public sector, any systematic risk transmitted to the public sector through risky contractual payments to the PPP company should be ignored. But we would still want to include the systematic risk passed on to subcontractors of the PPP company, unless the cost estimates used for this purpose implicitly incorporate this already. As noted in the fourth section, one might expect the asset beta of a PPP company (with a good contract) to be in the range of 0.3-0.5. So perhaps we should take 0.5 as the figure to use for the rate applicable to the PPP project in case (B). The difference between the asset beta for the PPP project in cases (A) and (B) – namely, 0.2 in the assumptions we are using here – reflects the assumption in case (B) that systematic risk passed on to the public sector by way of risky contractual payments has no societal cost.

If we assume an asset beta 0.5 in case (B) and a market risk premium of 6% (a figure sometimes used these days for many advanced economies, although some would say it is on the high side), we should add three percentage points to the risk-free economic discount rate to account for systematic risk when applied to the financing flows for the PPP project. We can see that the maximum impact of systematic risk in the PPP-PSC comparison is likely to be less than the impact of the financial intermediation costs that are typically found in many developing countries (see the examples from East Africa, Table 3, section three). It might be advisable, then, to focus more in the PPP-PSC comparison on assessing economic financial intermediation costs than to spend time trying to refine the CAPM calculations.

In fact, it may well be that after testing this approach with a range of typical PPP projects in developing countries, one will be able to conclude that it is a waste of effort to try to take the possible cost of systematic risk into account in the PPP-PSC comparison: perhaps the three percentage points would hardly ever switch the ranking of the PPP project and the PSC, and even if they did, this itself might not be considered decisive in deciding to reject the PPP project. Other aspects of the analysis might be much more important.

In any case, by separating the effects of financial intermediation costs (Step 2) from the possible effects of systematic risk (Step 3), the disaggregated three-step approach outlined in this section can help reveal the underlying drivers better than does the typical PPP-PSC exercise.

References

- Arrow, K.J. and R.C. Lind. 1970. "Uncertainty and the Evaluation of Public Investment Decisions", *American Economic Review* 60(3), 364-378.
- Barro, R.J. 2006. "Rare Disasters and Asset Markets in the Twentieth Century", *Quarterly Journal of Economics* 121(3), 823-866.
- Brealey, R.A., I.A. Cooper, and M.A. Habib. 1997. "Investment Appraisal in the Public Sector", *Oxford Review of Economic Policy* 13(4), 12-28.
- Brean, D., et al. 2005. *Treatment of Private and Public Charges for Capital in a "Full-Cost Accounting" of Transportation*. Prepared for Transport Canada. Final Report, 31 March.
- Burgess, D.F. 2008. "A Critique of Feldstein's Shadow Price Algorithm". Unpublished paper. Department of Economics, University of Western Ontario, London, Canada, 25 November.
- _____. 2009. "Toward a Reconciliation of Alternative Views on the Social Discount Rate", in this volume.
- Central PPP Policy Unit (Ireland). 2006. "Discount Rate Principles for Public Private Partnership Capital Investment Projects", Central Guidance Note No. 7. February.
- Čihák, M. and R. Podpiera. 2005. "Bank Behavior in Developing Countries: Evidence from East Africa". IMF Working Paper WP/05/129. June.
- Department of Treasury and Finance (Government of Western Australia). 2002. *Project Evaluation Guidelines*. January.
- Ehrhardt, M.C. and P.R. Daves. 2000. "Capital Budgeting: The Valuation of Unusual, Irregular, or Extraordinary Cash Flows", *Financial Practice and Education* 10(2), 106-114.
- Estrada, J. 2007. "Discount Rates in Emerging Markets: Four Models and an Application", *Journal of Applied Corporate Finance* 19(2).

- Ewijk, C. and P.J.G. Tang. 2003. "How to Price the Risk of Public Investment?", *DE Economist* 151(3).
- Feldstein, M.S. 1970. "Choice of Technique in the Public Sector: A Simplification", *The Economic Journal* 80(320), 985-990.
- Glenday, G. 2009. "The New (but Old) Approach to the Economic Opportunity Cost of Capital", in this volume.
- Gómez-Ibáñez, J.A. 2005. "Partnerships Victoria: The Public Sector Comparator". Case. Kennedy School of Government, Infrastructure in a Market Economy Executive Program. Revised 11 August.
- Grant, S. and J. Quiggin. 2004. *The Risk Premium for Equity: Implications for Resource Allocation, Welfare and Policy*. Risk & Uncertainty Program Working Paper 8/R04. Risk & Sustainable Management Group, Schools of Economics and Political Science, University of Queensland. August.
- Grout, P.A. 2003. "Public and Private Sector Discount Rates in Public-Private Partnerships", *The Economic Journal* 113(March), C62-C68.
- Harberger, A.C. 1997. "New Frontiers in Project Evaluation? A Comment on Devarajan, Squire, and Suthiwart-Narueput", *World Bank Research Observer* 12(1), 73-79.
- HM Treasury (UK). 2003. *The Green Book: Appraisal and Evaluation in Central Government*. London.
- Jenkins, G.P. 2001. "Economic Aspects of Foreign Financing". Unpublished paper, 23 February.
- Klein, M. 1996. "Risk, Taxpayers, and the Role of Government in Project Finance". Policy Research Working Paper No. 1688. Private Participation in Infrastructure Group. Washington, DC: World Bank. December.
- Layard, R., G. Mayraz, and S.J. Nickell. 2008. "The Marginal Utility of Income". SOEP Papers on Multidisciplinary Panel Data Research. Berlin, April.
- Mandelbrot, B. and R.L Hudson. 2004. *The Misbehavior of Markets*. Basic Books.
- Morallos, D. and A. Amekudzi. 2008. "The State of the Practice of Value for Money Analysis in Comparing Public Private Partnerships to Traditional Procurements", *Public Works Management & Policy* 13(2), 114-125.
- National Treasury (South Africa). 2004. "Module 3: PPP Feasibility Study", *Public Private Partnership Manual*. Issued as National Treasury PPP Practice Note No. 4 of 2004.
- Partnerships Victoria. 2003a. *Public Sector Comparator*. Supplementary Technical Note. Department of Treasury and Finance. July.
- _____. 2003b. *Use of Discount Rates in the Partnerships Victoria Process*. Technical Note. Department of Treasury and Finance. July.
- PPP Knowledge Centre (Netherlands). 2002a. *Public Private Comparator*. Ministry of Finance. August. The Hague.
- _____. 2002b. *Public Sector Comparator*. Ministry of Finance. August. The Hague.

- PricewaterhouseCoopers. 2002. *Study into the Rates of Return Bid on PFI Projects*. Academic advisor: Prof. Julian Franks. Commissioned by the UK Office of Government Commerce (OGC). London. October.
- Sabal, J. 2004. "The Discount Rate in Emerging Markets: A Guide", *Journal of Applied Corporate Finance* 16 (Spring/Summer), 155-166.
- Sick, G.A. 1986. "A Certainty-Equivalent Approach to Capital Budgeting", *Financial Management* 15(4), 23-32.
- Sjaastad, L.A. and D.L. Wisecarver. 1977. "The Social Cost of Public Finance", *Journal of Political Economy* 85(3), 513-548.
- Spackman, M. 2001. "Risk and the Cost of Risk in the Comparison of Public and Private Financing of Public Services". NERA, London. March.
- _____. 2004. "Time Discounting and of the Cost of Capital in Government", *Fiscal Studies* 24(4), 467-518.
- _____. 2006. "Social Discount Rates for the European Union: An Overview". Working Paper 2006-33, October. Fifth Milan European Economy Workshop.
- Weitzman, M.L. 2007. "Subjective Expectations and Asset-Return Puzzles", *American Economic Review* 97(4), 1102-1130.

Abbreviations, Acronyms, and Definitions

asset beta	<p>Refers to the beta (see below) of an asset (e.g., company or project) after removing the effect of financial leverage – i.e., what the beta would be if the financing consisted entirely of equity capital. Sometimes called “unlevered beta”. The asset beta indicates the systematic risk intrinsic to the project or company and permits comparison among projects or companies, regardless of their leverage.</p> <p>Roughly: $\beta_{asset} = \beta_{equity} \times \frac{E}{D + E}$,</p> <p>where β_{equity} is the beta of the equity shares of the company, E is the value of equity in the capital structure, and D is the value of debt. (This simplified formulation assumes that there is no debt beta.)</p>
beta	<p>A coefficient used in the CAPM that measures the degree to which the return on a specific asset co-varies with the return on the entire portfolio of assets (in financial analysis, usually defined to be the stock market). So beta indicates the proportion of the asset’s riskiness – i.e., referred to as <i>systematic</i> risk – that cannot be removed by a diversified portfolio.</p>
capex	capital expenditures
CAPM	Capital Asset Pricing Model
certainty equivalent	<p>The certainty equivalent of a risky cash flow is the amount that the recipient (respectively, payer) would need to receive (pay) <i>with certainty</i> to leave the recipient (payer) indifferent between receiving (paying) the risky cash flow and the certainty equivalent. If the recipient (payer) is risk averse, the certainty equivalent will be less (more) than the expected value of the risky cash flow.</p>

expected value	The sum of the values obtained by multiplying the probability of each possible outcome by the value of that outcome. Strictly speaking, this definition applies only to <i>discrete</i> random variables.
leverage	Used in this paper to mean, roughly, the ratio, in the capital structure of a company, of (i) debt to (ii) the sum of debt and equity. The common British term for this concept is “gearing”.
NPV	net present value
opex	operating expenditures (including maintenance)
PFI	Private Finance Initiative (a British program)
PPP	public-private partnership
PPI unit	Used in this report to mean either: (i) a central unit in the country that has the main responsibility for structuring and appraising PPP projects or for issuing guidance for these activities, or (ii) a unit in a line department with similar functions, relating to sectoral projects.
PSC	public sector comparator
PSP	private sector participation
PV	present value (i.e., the NPV when all the cash flows are either positive or negative, so no netting is required)
systematic risk	See the fourth section.
WACC	weighted average cost of capital