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THE PPP PREMIUM IN EUROPEAN ROAD CONSTRUCTION

Frédéric Blanc-Brude, Hugh Goldsmith and Timo Välilä

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Frédéric Blanc-Brude is with King's College, London.
Frederic.blanc-brude@kcl.ac.uk or +44 (0) 7726 796287

King's College London
Department of Management
Franklin-Wilkins Building
150 Stamford Street
London SE1 9NN
United Kingdom

Hugh Goldsmith is PPP Coordinator in the Projects Directorate of the European Investment Bank.
Goldsmit@eib.org or +352 4379 27 83
Timo Välilä is Senior Economist, in the Economic and Financial Studies Division of the European Investment Bank.
Valila@eib.org or +352 43 79 86 79

European Investment Bank
Economic and Financial Studies
100 Boulevard Konrad Adenauer
L-2950 Luxembourg

The PPP Premium in European Motorway Construction

Abstract:

This paper demonstrates the existence of a systematic premium on the ‘pure’ construction cost of public infrastructure projects that are procured as public-private partnerships (PPPs). It also attempts to quantify this premium in the case of the European road sector, with a focus on motorway projects.

Economic and financial literature suggests that a PPP should exhibit higher costs of construction than traditionally procured public infrastructure projects. We identify two key mechanisms which explain this: i) the presence of stronger incentives for developers to undertake investments at the construction stage which will lower life-cycle operation and maintenance costs, and ii) the transfer of construction risks to the private sector partner. We discuss the practical relevance of this literature, and test empirically for the existence of such a “PPP Premium” in European road construction costs. Using a new database of roads projects, we model the determinants of *ex ante* unit construction costs (i.e. estimated/contracted outturn costs to the public sector before construction begins). Our analysis confirms that a “PPP Premium” exists and yields a significant and robust estimate of the coefficient for a PPP “dummy”. After allowing for a systematic optimism bias in the cost estimates for non-PPP projects, the net PPP Premium for EU motorway construction is estimated at 23%.

The magnitude of the PPP Premium corresponds well with reported cost escalation for traditionally procured projects, suggesting rational pricing behaviour by contractors taking on project delivery risks.

1. Introduction

This paper compares the relative cost of procuring public infrastructure projects as public-private partnerships (PPPs) with traditional procurement routes (TP)[1]. Economic and financial literature suggests that a PPP should exhibit higher costs of construction than a comparable traditionally procured project. We identify two fundamental mechanisms that explain this: i) the presence of stronger incentives for developers to undertake investments at the construction stage to lower life-cycle operation and maintenance costs, and ii) the transfer of construction risks to the private sector partner. We discuss the practical relevance of this literature, and we test empirically for the existence of such a "PPP Premium" in European road construction. Using a database of roads projects financed by the European Investment Bank between 1990 and 2005, we model the determinants of *ex ante* unit construction costs (i.e. proposed costs before construction begins). We thus estimate the impact on *ex ante* construction costs of involving the private sector as an investor in public projects using linear regression analysis. Our analysis confirms that a "PPP Premium" exists and yields a significant and robust estimate of the coefficient for a PPP "dummy".

Ideally, the relative costs and benefits of PPPs should be evaluated over the entire project lifecycle, from start of construction through operations and maintenance to the end of the contract period. However, the widespread use of procurement PPP only started to take off in the mid-1990s. Therefore, most projects are either still under construction or in early stages of operation and most available information relates to the construction phase. Using a new unit cost database of publicly and privately financed road projects across Europe, we measure the effect of the "PPP premium" on ex-ante project costs in the EU15 area plus Norway. The PPP Premium refers to

[1] For the purpose of this study, we define public-private partnerships as those infrastructure projects procured under DBFO/M-type contracts that bundle Design, Build, Finance and Operation/Maintenance. When users pay directly for the service, such contracts are also referred to as "Concessions". Projects that do not exhibit all four characteristics are not characterised as PPPs. Traditional Procurement (TP) in this study means any procurement method that is not a DBFO/Concession. TP can encompass a wide range of contracting arrangements including separate design and construction contracts, design-build and prime contracting. However, all these forms involve public rather than private finance.

the difference in “pure” *ex ante* construction cost between PPP and TP projects. Thus our dependent variable is the proposed and agreed construction unit cost, just before the project is built and includes the price of construction works, design, engineering, and supervision. All other project costs are excluded from the “pure” construction cost; in particular, the price of land, technical and price contingencies, taxes, start-up costs and fees, as well as interest payments during the construction phase are not part of the definition of our dependent variable.

Our data is drawn from the project appraisal files of the European Investment Bank (EIB), which has been involved in the financing of hundreds of roads projects throughout Europe over many decades. Thanks to this large and coherent dataset, we are able to observe *ex ante* cost variables for a large sample of roads projects within a comparable set of European countries.

Involving the private sector in the delivery of public infrastructure services is not a new phenomenon but has recently known significant developments in Europe. Following early UK experiments with real-toll fixed links (bridges and tunnels), the modern form of PPP was pioneered with the introduction of PFI shadow toll roads projects, which made the public granting authority rather than users responsible for payments, whilst demand risk (traffic) was transferred to the private operator. The expansion of the PFI program to social sectors, such as schools and hospitals, with no user charges, introduced the idea of unitary payments, by which government agreed to pay for future services according to pre-defined service standards, in return for the private sector designing, building, operating, maintaining and financing the facilities for a defined period of time.

PPPs are sometimes criticised for their supposed high cost to the public sector. This is the issue of so-called “value for money”, which we do not address here (see Grout 1997 and 2003 for a discussion). Suffice it to say that the argument against the high development cost of PPPs is a difficult one to make on the basis of costs alone. Indeed, the mechanisms at play in a PPP *imply* higher transaction costs to prepare and bid for output specification, complex contracts, and higher pricing of explicitly specified risks. They also imply greater benefits from innovation, life-cycle cost savings and contractually committed performance and maintenance standards.

Three economic concepts discussed in the literature suggest that PPPs should exhibit higher costs: a) control rights, b) contract bundling and c) risk transfer. In this paper, we test empirically for the existence of higher construction costs in PPPs. Our analysis confirms the existence of a statistically significant difference in *ex-ante* unit costs between the two procurement routes. After allowing for data quality differences between the TP and PPP observations, we conclude that the net PPP Premium for EU Motorway construction is 23% (with a range of 13 to 33%).

It must be stressed that this finding does not allow us to conclude anything regarding the desirability or otherwise of PPP as a procurement policy. Rather, it is a first step towards our empirical understanding of the contractual and financial mechanisms at play in such schemes and our broader understanding of “value-for-money” in public procurement.

The rest of this paper is organised as follows: section 2 summarises the theoretical literature on mechanisms that should explain the difference in unit costs between TP and PPP projects. After the theory, Section 3 presents our data and empirical test using OLS. Section 4 interprets the results and Section 5 offers some preliminary conclusions.

2. Construction costs in traditional public procurement and in PPPs: Some theoretical considerations

2.1 Introduction

The purpose of this section is to consider, based on economic theory, how the costs of constructing an infrastructure asset differ between traditional public procurement and a PPP. The prior thus obtained will then serve as our null hypothesis, to be tested in the subsequent empirical analysis. One of the defining features of a PPP is that the public authority ceases to be the designer, financier, purchaser and operator of assets[2] and instead becomes either a definer and purchaser of services or a grantor of a concession of which either it or the economy as a whole becomes the client. In the former, the public authority pays for the availability of the service. In the latter case, the concessionaire has the right to charge users for the service.

Instead of contracting with a private company to build a road, the public authority either contracts to pay for available road capacity or agrees that the contractor can build the road for the right to charge user tolls for a given period of time. In both cases, the private company is strongly incentivised to deliver the project on time and budget as it bears the risks of cost overrun and any delay in the start of revenues has a direct impact on debt service and the financial sustainability of the project[3].

The PPP contracting formula is intended to address the problems of cost overruns and delays commonly encountered in traditional public procurement (House of Commons, 2003). In practice, this is achieved by a combination of contractual clauses and incentives: the risk of cost overruns or delays are passed on to the construction consortium via a fixed-price, date-certain construction contract. Intuitively, if contractors are prepared to accept this risk of delivering the project on time and on budget, they will charge a price that is higher than under TP.

Thus, there are three key features of a PPP that can make its productive efficiency – and construction costs – differ from traditional public procurement:

- Property/control rights: the infrastructure asset to be constructed and operated is owned or at least controlled by the private sector partner, not by the public sector[4].

[2] Whether or not the public sector then subcontracts construction and/or operations

[3] Incentives can also be built into the PPP payment mechanism to encourage contractors to spend more during construction. A good example is the Nordic model for roads PPP, under which the contractor is rewarded if the PPP road has a better safety record than comparable roads in the network (Bjoerlo, 2003).

[4] Ownership structures of PPP project can vary widely, from fully privately owned to full public ownership of underlying project assets with all managerial control contractually transferred to the private partner. In effect, PPPs constitute a problem of de-integration (moving from full public procurement to contracting for service) and as such, the issue of control rights is reversed: the question is not to know whether contracts are incomplete but if they are *complete enough* for an output-based PPP framework to be more efficient that the integrated solution. See Hart, Schleifer and Vishny (1997) for a discussion and an application to the prison sector.

- Contract bundling: the construction and operational phases of the project are bundled into a single contractual framework[5], instead of separate contracts for asset construction and operation (service provision).
- Risk transfer: risks (and rewards) inherent to the project are shared between the public and private sector partners, with some risks traditionally carried by the public sector now transferred to the private sector partner. Since PPPs are privately financed, the responsibility for running a project on a financially sustainable basis lies with the private sector, which underwrites overall project risk with private equity and debt.

How exactly these three features affect productive efficiency and construction costs according to economic theory is discussed below. Before embarking on that discussion, however, it is important to point to a gap in the nascent "theory of PPPs". As will become clear below, the impact of both asset ownership and bundling on efficiency has been well articulated in the theoretical PPP literature. In contrast, risk transfer has received much less attention. With this caveat duly noted, let us start the overview of construction costs by considering what difference asset ownership or control makes.

2.2 Control rights to asset

The most commonly used theoretical framework to analyse PPPs is that of incomplete contracting, formulated by Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995), based on earlier work by Williamson (1979). Williamson's key insight was that contractual relationships involving relation-specific investment—that is, investment in an asset that cannot be readily used for purposes other than that stipulated in the contract—are problematic in an environment that is so complex that it renders the contract incomplete. In other words, relation-specific investment tends to be sub-optimally low in a complex world where contracts can never

[5] PPP "contracts" can comprise tens of different legally binding documents. There is never one PPP contract. However, PPPs embody a single, project-focused contractual relationship between the public and private parties and as such can be treated as a single contractual framework.

fully account for all future eventualities. The reason for this, according to Williamson, is that contractual incompleteness creates incentives for *ex post* bargaining about the profits generated by the investment in the specific asset, as contractual incompleteness implies that it is difficult to distinguish between good-faith renegotiation of the contract (prompted by an unforeseen change in the contractual environment) and bad-faith renegotiation (prompted by the wish to extract unforeseen rents). Given the risk of bad-faith renegotiation, the investment in a specific asset will be smaller than optimal.

As an example of this 'hold-up' problem, consider a fixed-price contract between the public sector and a firm for the maintenance of an existing public road. Assume that a new, cheaper technology for road maintenance becomes available after the fixed price for the maintenance contract has been agreed. Will the firm invest in acquiring this new technology? Possibly not, as it cannot be sure that the investment would pay off. On the one hand, the investment would seem to increase the firm's profits, as it would continue to receive the agreed fixed payment from the public sector, while its costs for complying with the maintenance contract decline. On the other hand, the public sector would be aware of this increase in the firm's profits so there is a risk that it would try to renegotiate so as to lower the fixed price it pays the firm by as much as the firm's costs decline. In this case, the firm's incentives for adopting the new technology would be eroded, it would not undertake the investment, and the economy would forego an increase in productive efficiency.

Based on this analysis of Williamson's, Grossman, Hart, and Moore suggested that the assignment of ownership rights of the relation-specific asset can be designed so as to alleviate the under investment problem. Ownership rights are in this context taken to mean residual control rights that confer bargaining power, giving the owner of the asset full control over the asset and the final say in case of any disagreement.

To illustrate, consider the earlier road maintenance example. If now the firm was the owner of the road to be maintained, and the public sector paid the firm for the availability of the road, the public sector could not impose a renegotiation of the contract following the introduction of the cost-saving maintenance technology. After all, the firm as the road's owner controls alone the use of the asset. As bad-faith renegotiation is unlikely in this case, the firm will invest in the new maintenance technology, thus improving productive efficiency (and pocketing higher profits).

In essence, then, an appropriate assignment of ownership (or control) rights of an (infrastructure) asset can increase productive efficiency by encouraging relation-specific investment even when contracts are incomplete. This is an important starting point for considering the economic pros and cons of PPPs: the surrender of control rights for an infrastructure asset to the private sector partner can boost productive efficiency beyond what can be achieved under traditional public procurement, with public sector ownership and an absence of private profit motive. For our purposes, a notable corollary of this insight is that asset construction costs should be higher under a PPP than under traditional public procurement whenever relation-specific cost-saving investments can be made.

2.3 Bundling of asset construction and operation

As alluded to earlier, another reason for possibly higher productive efficiency of PPPs is the bundling of the asset's construction and operation into a single contractual framework, which allows the internalisation of any positive externalities that may exist between the construction and operational phases. In the case of a road project, bundling would allow the private contractor to make choices at the construction stage that could lower the life cycle maintenance cost of the road. Without bundling, such externalities would not be taken into account in the construction phase and productive efficiency would be lower.

This insight has been formalised by Hart (2003). We will present a slightly modified version of his model below, as it allows us to zoom in on the specific issue of construction costs in traditional public procurement and in PPPs. In Hart's model, the public sector is assumed benevolent, thus seeking to maximise net social benefit, while private sector firms maximise their profits. The public sector procures a project involving the construction of a specific asset and its operation, and it can choose the procurement method: either the project is procured as a traditional public sector investment project, with the construction and operation procured separately with two different private sector firms, or they are procured as a bundle with just one firm. Obviously, the former corresponds to traditional public procurement, while the latter corresponds to a PPP[6].

Either way, Hart assumes that the private firm has sufficient control over the asset to be built and operated so as not to expect bad-faith renegotiation, which implies that asset ownership is not considered as a channel to boost productive efficiency in this particular model. This assumption allows a sharper focus on bundling as one of the theoretical *raison d'être* of a PPP.

The private sector firm that is awarded the construction contract—be it bundled with operation or not—can in turn choose to make two types of investments at the construction stage. While both investments will affect the outcome in terms of the firm's profits and net social benefit as discussed below, either can be undertaken by the firm without violating the contract between itself and the public sector i.e. contracts are incomplete.

The first investment, call it *i*, would reduce maintenance costs in the operational phase and it would also improve the quality of the end-product offered to consumers. An example could be investment in new road surface material that has superior endurance and better safety characteristics compared to older alternatives; thus, it would both reduce maintenance costs and

[6] In practice, bundling is not unique to PPP. In the "pure" TP model, the public authority would contract separately with a designer, a construction company and, possibly, an operator or do this "in-house". This approach is inherently confrontational and is identified as a major reason for claims in construction contracts. Palmer (2000) explains that many of the theoretical and practical benefits of bundling can be achieved through contractual forms such as design-build (DB), design-build-operate (DBO) and lump-sum contracts. There is a trend towards early contractor involvement and "partnering" across a wide range of sectors. Traditional procurement is not a static model of cost-plus contracts, but rather an evolving set of options for providing incentives and allocating risks. Each country in the EU has its own procurement systems for delivering public projects, although these must comply with the legal framework established by EU public procurement Directives. Bult-Spiering & Dewulf (2006) describe the various approaches to PPP and TP across the EU and set out a model of the key differences between PPP and a range of TP options in terms of roles and responsibilities of public and private actors. PPP is just one option for improving public procurement. Changes in TP can lead to substantial improvements in performance. Following implementation of recommendations of the *Modernizing Construction* review by NAO (2001), the subsequent audit report (NAO, 2005) found that 55% of non-PP projects were delivered to budget compared to 25% in 1999 and cost overruns had reduced to 4.1%. So reforming TP can pay dividends with or without PPP.

improve the quality of the road. This investment *i*, if undertaken in the construction phase, yields therefore higher productive efficiency and higher allocative efficiency.

Another possible investment, call it *e*, is also associated with higher productive efficiency in that it would lower maintenance costs, but as opposed to *i*, it is associated with lower allocative efficiency. As an example, consider the use of durable but less reflective paint for the purpose of road surface markings. The durability of the paint would again lower maintenance costs, but the fact that it does not reflect as well in the dark would lower the quality of the road by making driving at night riskier.

With this characterisation of the project, we can now proceed to analysing the agents' choices. Let us consider first the case of traditional, unbundled public procurement. Firms bidding for the construction contract face the following profit maximisation problem:

(1) $$Max \pi = P_C - C_C$$

Where P_C denotes the revenue from the contract and C_C is the construction cost. Assuming a competitive market for the construction contract, $P_C = C_C$, so the firm winning the contract seeks to minimise C_C and will therefore not incur the cost of undertaking the investments *i* and *e*, as they would just increase construction costs.

In this case, the net social benefit equals:

(2) $$B_O - C_C - C_O$$

where B_O denotes the gross social benefit from the operation of the road and C_O denotes the cost of operating (maintaining) it. Note that as none of the potentially cost-reducing investments *i* or e was undertaken, the maintenance cost does not depend on how the asset was constructed.

Clearly, unbundling is not socially first best, since the choice $i = e = 0$ involves too little of the unambiguously socially beneficial investment *i*, which would improve both productive and allocative efficiency. Whether the amount of the investment *e* is in this case socially optimal or not depends on how much it reduces allocative efficiency. If the decline in allocative efficiency from *e* equals exactly the improvement in productive efficiency then the socially optimal amount of investment in *e* is indeed zero and can thus be obtained under unbundling.

Let us now consider the same project, but procured with the construction and operation bundled. Now the firm winning the contract would face the following profit maximisation problem:

(3) $$Max\pi = P_B - (C_C + i + e) - (C_O - b(i) - \beta(e))$$

where P_B is the value of the contract. Note that the investments *i* and *e* increase construction costs but reduce maintenance costs by *b(i)* and *β(e)*, respectively, where $b, \beta > 0$. The optimal amount of *i* and *e* can now be determined by considering the first-order conditions

(4a) $$\frac{\partial \pi}{\partial i} = -1 + b'(i) = 0$$

(4b) $$\frac{\partial \pi}{\partial e} = -1 + \beta'(e) = 0$$

Denoting the optimal values of *i* and *e*, obtained from (4a) and (4b), by *i** and *e**, respectively, the net social benefit from the bundled project becomes:

(5) $$B_O + a(i^*) - \alpha(e^*) - P_B = B_O + a(i^*) - \alpha(e^*) - [C_C + i + e + C_O - b(i^*) - \beta(e^*)]$$

where the value of the bundled contract, P_B, equals the cost of constructing and operating the assets, assuming again that the market for obtaining the contract is competitive.

As opposed to unbundling, bundling delivers the socially optimal amount of investment in i, but it delivers too much investment in e whenever $\alpha > \beta$. Thus, bundling is also not socially first best. Based on (2) and (5), we can derive the condition for the public sector to prefer bundling to unbundling. Bundling is preferable when (5) > (2), i.e.

(6) $$[a(i^*) - \alpha(e^*)] + [b(i^*) + \beta(e^*)] > i + e$$

This inequality has a simple, intuitive interpretation: whenever the cost of making the two cost-saving investments (right-hand side of the inequality) falls short of their net benefits (left-hand side), bundling is preferable because it internalises the positive externality between the construction and operational phases of the project. Otherwise unbundling is socially preferable.

Note that the net benefits from bundling consist of two components. First, the second square brackets in (6) denote the benefit from improved productive efficiency achieved through the investments i and e. Second, the first square brackets denote the net impact of these investments on allocative efficiency (quality), with i increasing it and e reducing it. Obviously, whether the net impact on allocative efficiency is positive or negative depends on the parameters a and α.

This straight-forward comparison of bundling and unbundling assumes implicitly that both investments i and e are contractible, that is, the public sector can monitor, verify, and sanction the firm's investment in them. In case where one of the investments is not contractible, the comparison has to be qualified. Recall that, in this model, the private firm possesses residual control rights of the asset, so it can decide whether or not to undertake the investment *i* or *e*, unless otherwise specified in the contract. Now if the investment *i* is contractible but *e* is not, unbundling is socially preferable because it yields the socially optimal amount of the quality-shading investment *e* (zero if $\alpha > \beta$), while the amount of *i* can be contractually set at the social optimum with the builder. In contrast, if *e* is contractible but *i* is not, bundling is socially preferable because it will yield the optimal amount of *i*, and *e* can be set at its social optimum in the contract.

Hart’s model yields thus clear-cut insights into the choice between bundling and unbundling, including when contracts are incomplete. What is more, it yields an unambiguous hypothesis concerning construction costs in each case: under unbundled procurement, the construction costs equal simply C_C, as no cost-saving investment is undertaken in the construction phase. On the other hand, under bundling the construction costs equal $C_C + i + e$, as the positive externality between the construction and operational phases is internalised. Consequently, the construction costs under bundling are unambiguously higher than under unbundling, the difference being equal to the cost of the cost-saving investments.

2.4 Risk Sharing between the public and private sectors

Practitioners regard the sharing of project risks (and rewards) between the public and private sector partners in a PPP as the key feature separating PPP from traditional public procurement[7]. Despite the fact that risk pricing is well addressed in the corporate finance literature on the risk premium and certainty equivalent approaches, the theoretical PPP literature on incomplete contracts has paid much less attention to risk sharing than to asset ownership and bundling. Therefore, we only discuss here briefly the intuition behind the link between risk sharing and construction costs, leaving a more formal analysis for future research to tackle.

At a general level, as elaborated by Grout (1997), risk transfer from the public to the private sector can lead to a more explicit recognition, quantification, and pricing of the risk transferred. One of the axioms of PPP procurement is that risks should be transferred to the party best able to manage them. It follows that this party will price the cost of reducing to a minimum the risk that a particular outcome with adverse financial consequences occurs. Consequently, risk transfer *per se* does not affect productive efficiency; rather, it is the likelihood that risk transfer improves risk management that can make a PPP more cost efficient than traditional public procurement[8].

The risks customarily transferred to the private sector partner in a PPP include those related to construction costs and schedule. At the risk of oversimplification, one may characterise traditional public procurement of an infrastructure asset as cost-plus contracting, with the public sector carrying the majority of construction cost and delay risks. As a result, cost and time

[7] PPPs represent a important shift in contractual forms from traditional procurement. Analysis of the reasons for cost overruns and delays in TP usually identify a variety of factors at play, most notably changes to client requirements and unexpected site conditions. Anything that is not well specified in the contract potentially comes back as a claim for additional payment. In fact, there is anecdotal evidence that some contractors' strategy is to bid low to win the work and later increase profit margins from claims.
In a PPP, the public granting authority has no direct contract with the construction company. The public authority contracts with a special purpose vehicle (SPV), which is a joint venture company formed by the construction and operations contractors plus, increasingly, financial investors. All debt is contracted at the level of the SPV, so the banks also have a significant influence in ensuring that costs are controlled and risks are appropriately managed. The public authority specifies the service required (for which either it or users will pay) and various penalties if the project is not ready on time or if the service is not up to standard. In extremis, the SPV's contract could be terminated for failure to deliver the service. The SPV in turn contracts with the construction contractor to design and build the asset and with the operations contractor to operate and maintain the asset. The prices of these contracts must be fixed in advance and must pass through risks such that the SPV is essentially a hollow shell to manage cash flows and balance interests between shareholders.
[8] Given the probabilistic nature of this argument, it follows that the ex-post benefits of PPP should only be judged at the procurement programme level rather than on individual projects for which risks may or may not become manifest.

overruns are commonplace in traditional public procurement, as vividly illustrated by Flyvbjerg et al. (2003). In contrast, a PPP can be characterised as date-certain fixed-priced contracting, with the private partner instead of the public sector carrying the construction cost and schedule risks.

The fact that the private partner fully carries the construction risks in PPP contracting but not in traditional public contracting must be reflected in the *ex-ante* price that the public sector has to pay for the asset. The transfer of construction risk implies that the private sector partner evaluates and prices them, which increases the value of his bid for the contract. In other words, construction costs are expected to be higher in PPPs than in traditional public procurement because of the explicit recognition and pricing of construction risks transferred to the private partner.

Why do construction risks remain un-priced in traditional public procurement? Following the argumentation by Klein (1997) and Grout (1997), the fundamental reason is that the public sector can transfer risks to taxpayers and end users of the infrastructure service without remunerating them. In traditional public procurement, the public sector assumes construction risks only to pass them on to the population, who are the final financiers as well as consumers of the infrastructure service to be supplied. Construction cost and time overruns thus hurt taxpayers and end users, who carry the risk of them materialising without receiving any compensation by the public sector.

In sum, the transfer of construction risks to the private sector partner in a PPP, as opposed to the population in traditional public procurement, allows them to be explicitly recognised and priced into the construction contract. Construction risk transfer therefore should make construction costs in a PPP higher than in traditional public procurement.

2.5 Conclusions

Our review of economic theory as applied to PPPs suggests that there are several reasons to expect that the cost of constructing an infrastructure asset should be higher in a PPP than in traditional public procurement. Such reasons include the control over the asset by the private sector partner (which incentivises him to undertake cost-saving investments in general); bundling of asset construction and operation into one contract (which incentivises the private sector partner to make extra outlays in the construction phase to achieve life-cycle cost-savings); and transfer of construction risks to the private sector partner and its sub-contractors (who want to be compensated for carrying them).

Set against these factors is the potentially cost saving impact of innovation when contractors can work with designers to respond to output based specifications. In practice, the scope for substantial cost savings is limited for standard infrastructure such as a road.

All these reasons suggest higher construction costs in a PPP than in traditional public procurement. It is therefore not of particular concern for our study that the theoretical literature has yet to formalise the causes and consequences of risk transfer on productive efficiency. Suffice it to conclude at this point that the reviewed literature suggests as our prior, to be tested in the empirical analysis, that PPPs should exhibit higher construction costs, or what we call the "PPP Premium".

3. Empirical analysis of the PPP premium in European road construction

The objective of the empirical analysis is to test the null hypothesis that construction prices (*ex ante* costs to the public sector) in PPP projects are higher than in traditionally procured, unbundled projects. To this end, we specify a reduced-form empirical model of the determination of construction prices, with the procurement method as one of the exogenous variables.

The road sector dominates European PPPs, especially outside the UK, both in terms of number of projects, number of countries, investment volume, and the length of time that such contracts have been used (see Riess 2005). The EIB funds major roads projects with public or private promoters throughout the EU. We concentrate the empirical analysis on the estimation of the PPP premium using an *ex-ante* unit cost database of EU roads sector projects between 1990 and 2005, derived from EIB appraisal files.

3.1 Model specification and estimation strategy

In the absence of directly applicable formal theoretical models on the determinants of construction costs (contract prices) in the road sector, we resort to specifying a reduced-form empirical model. The challenge in so doing is to ensure the robustness of the estimation results to alternative samples and model specifications. Therefore, special emphasis is placed below on robustness testing.

In our reduced-form empirical model we employ as the dependent variable the natural logarithm of *ex ante* unit construction costs, in millions of Euros (in real terms, using the CPI as deflator) per kilometre, of physically distinct roads sections. Included in the unit construction costs are the price of construction works, design, engineering, and supervision. Excluded are all other costs, in particular, the price of land, technical and price contingencies, taxes, start-up costs and fees, as well as interest payments during the construction phase. These latter costs are excluded because they are not directly related to the specifications of the project but, rather, depend on other factors such as the duration of negotiations, real estate prices, interest rates and so on. In addition, they are not directly related to the economic phenomena we seek to observe.

The explanatory variables can be divided into three broad groups. The first one consists of economic determinants of construction costs, including the procurement method and labour costs. The second set of explanatory variables includes technical determinants of road construction costs, aimed to capture technical characteristics such as the type of carriageway (single or dual); number of lanes; terrain (if urban or mountainous); the proportion of tunnels and bridges, and length of road to allow for the presence of economies of scale in road construction, with longer sections *a priori* relatively cheaper to build.[9] The third group of explanatory variables comprises country dummies, meant to capture any additional unspecified country-specific effects, be they political, institutional, or other.

To summarise, the explanatory variables include:

- PPP dummy, assuming value 1 for projects procured on a Design-Finance-Build-Operate (DFBO) basis;
- Real (CPI-deflated) unit labour costs in the country of the project;
- (Logarithm of) the length of the road section to be constructed, accounting for the possibility that there are economies of scale in road construction;
- Dummies for single and dual carriageways in the case of non-motorway roads;
- Dummies for the number of lanes (2, 4, 6, and 8)[10] for motorways;
- Dummies for urban and mountainous terrains;
- The length of tunnels and bridges, relative to the total length of the section;
- Country dummies[11].

As regards the expected signs of the coefficients for the economic explanatory variables, we would expect the coefficient for the PPP dummy to be positive (based on section 3); for the real labour cost variable positive; and for the (log) length negative (assuming economies of scale).

Our estimation strategy is in principle "general to specific"; that is, we start with a specification including all explanatory variables (while avoiding the dummy trap) and then gradually exclude the insignificant ones one by one, using 10 percent significance as the threshold

[9] Our sample only comprises new roads, so we do not need to control for different types of works, such as road rehabilitation or upgrade.
[10] At least one of the dummy variables has to be excluded to avoid a situation of perfect collinearity ("dummy trap"). The constant term is a form of "benchmark" in our model and captures the effect of the omitted dummies.
[11] A number of other explanatory variables were investigated to address institutional issues, including the Transparency International Corruption Index for the country year of contract award, and Government Effectiveness indices, but none was found to have significant explanatory power.

value. The specification thus obtained is then subjected to diagnostic testing. To test the robustness of our findings, we repeat the estimation procedure for a number of different samples and models specifications.

3.2 Data

Apart from the labour costs, which originate from the European Commission's Ameco database, all data come from project appraisal files of the European Investment Bank (EIB). While such data are confidential and cannot be reproduced in all detail, including the identification of individual projects included in the sample, a significant advantage of the data is that they have been collected and compiled following a coherent and uniform methodology by sector experts as part of the Bank's appraisal of the project.

The sample comprises road projects financed by the EIB between 1990 and 2005 in all EU-15 countries plus Norway, covering some 6,400 kilometres of roads. The sample includes 227 separate new road sections[12]. The Bank collects data for each separate road section[13], for which contractors provide a separate price. For the empirical analysis, each project is divided into physically distinct road sections, which constitute our individual observations. Thus, if a project consists of one stretch of road to be tendered alone, it will be recorded as one observation. In contrast, if a project consists of several connecting roads, each road section will be recorded as a separate observation. This leads to a sample of 227 observations, of which 65 are PPPs. Of these, 157 observations are motorway sections of which 57 are PPPs. The sample also contains 6 large fixed-link projects, which normally include a length of associated road. The average length of road sections is 28.1 km.

[12] The sample is taken from a larger database of 304 road sections, which also includes rehabilitation and upgrade projects.
[13] Road construction contracts are split depending on the size and scope of works into "Lots" or individual sections for which contractors provide separate prices. In the case of PPPs, a number of lots may be bundled into a single contract, but the individual lots are usually priced as part of the tender procedure. The Bank uses the cost of these individual road sections as the basis for its cost benefit analysis.

As regards our dependent variable, the data source gives us the appraisal team's best estimate of what the project should cost to build at the moment the winning bidder has been awarded the contract for the project. Thus, we observe the *ex ante* costs, or bidders' construction prices, not how much the projects have actually (*ex post*) cost to build. Where known, for TP this is the contracted price to the public authority to build the road. For a PPP, this is the EPC construction contract price between the private construction consortium and the SPV.

There are two important caveats to note about the original data. First and most importantly, the timing of the cost estimate is not systematically recorded in the database. The stage in the project cycle when the cost estimate is made varies between projects and varies systematically between PPP and TP projects. In the case of TP projects, the EIB appraisal report is prepared based on a mission to meet the project promoter that typically occurs between six months to one year before the start of construction. Cost estimates are based either on updated feasibility studies, detailed design or, whenever available, the contract price. To this estimate the Bank adds technical and price contingencies, which can vary from 5 to 15% depending on the status of the cost estimate. The data in our sample are the base cost estimates without technical contingencies.

In the case of PPP projects, the EIB will be lending to the SPV. The final appraisal mission usually takes place later in the project cycle either once the winning bidder is known or at BAFO stage[14]. So the recorded construction cost estimate is based on the price of the EPC contract with the construction consortium. Although this may change slightly following contract negotiations, it is subject to far less uncertainty than typical TP data.

We can conclude that there is a known, systematic bias in the data, which, due to optimism bias and timing of the cost estimate, would tend to make TP observations lower than the

[14] At Best and Final Offer (BAFO) stage, there are usually two identified preferred bidders who must give their final price to win the contract.

final contractual construction price at the moment works start on site. We consider this bias to be in the range of 5 to 15%.

The second caveat relates to the fact that the form of contract for TP projects is not recorded. As noted above, this may have a significant impact on the risk transfer and hence pricing. This will result in some noise within the TP observations[15]. Thus strictly, our data set consists of PPP and non-PPP observations, with a certain heterogeneity of contract form within the non-PPP data.

A scatter plot of the dependent variable (full sample), plotted against the (log) length of the road section (which constitute our individual observations), is shown in Figure 1. Note that we use a (natural) logarithm of the unit cost variable, as the possibility that the road sector features economies of scale (see below) suggests that the relationship between unit prices and their determinants is non-linear. To further illustrate the dependent variable, Figures 2 and 3 show histograms of the log of unit construction costs in the PPP sub-sample and in the non-PPP sub-sample, respectively.

[15] Discussions with roads sector specialists familiar with the projects confirm that the vast majority are either FIDIC Red Book type contracts, based on a reference design and unit rates, or FIDIC Yellow Book type contracts for design-build. The Federation International des Ingénieurs Conseils (FIDIC) is the leading body for the development of model standard forms of contract for use in the international construction industry. FIDIC publishes a range of standard forms of contract referred to by their colour. Both red and yellow book contracts have balanced risk sharing and provide fair procedures for administration of contracts. Red is a traditional ad-measurement contract based on a reference design. Yellow book contracts are design-build type contracts with the contractor responsible for final design.

Figure 1. Scatter plot of the dependent variable, full sample, plotted against log length of each road section (observation)

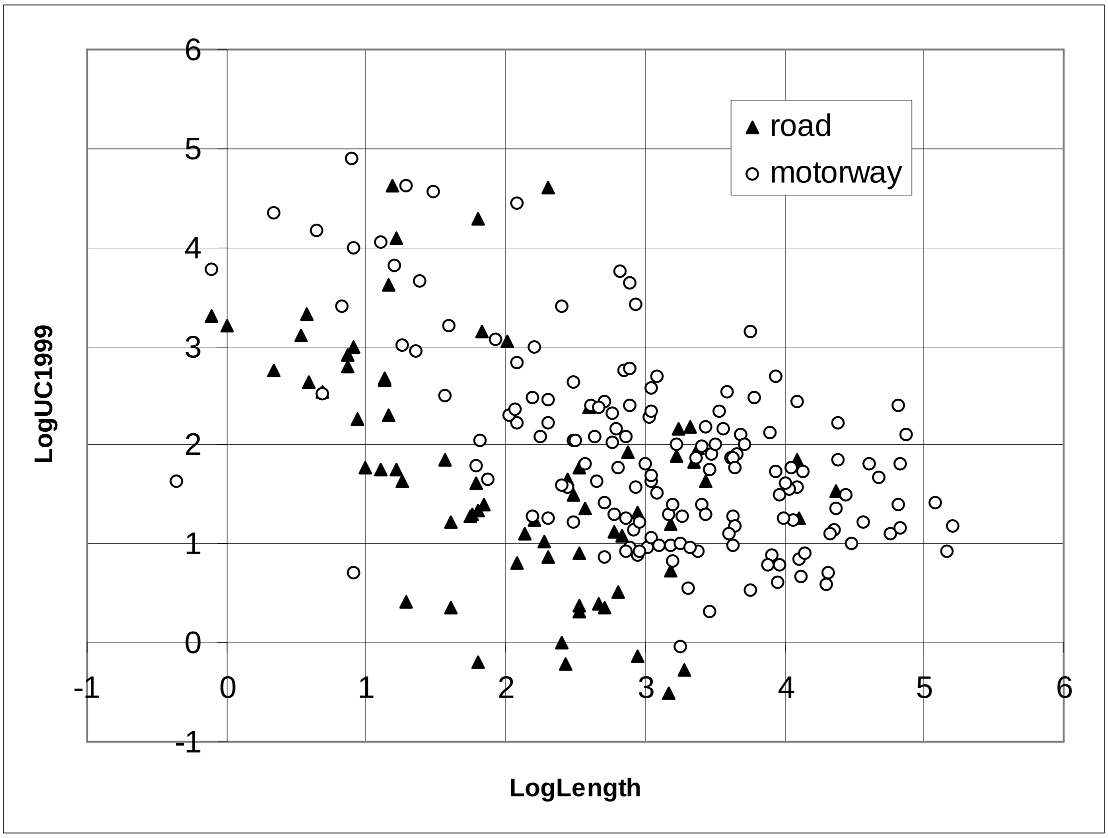


Figure 2. Histogram of the dependent variable, PPP sub-sample

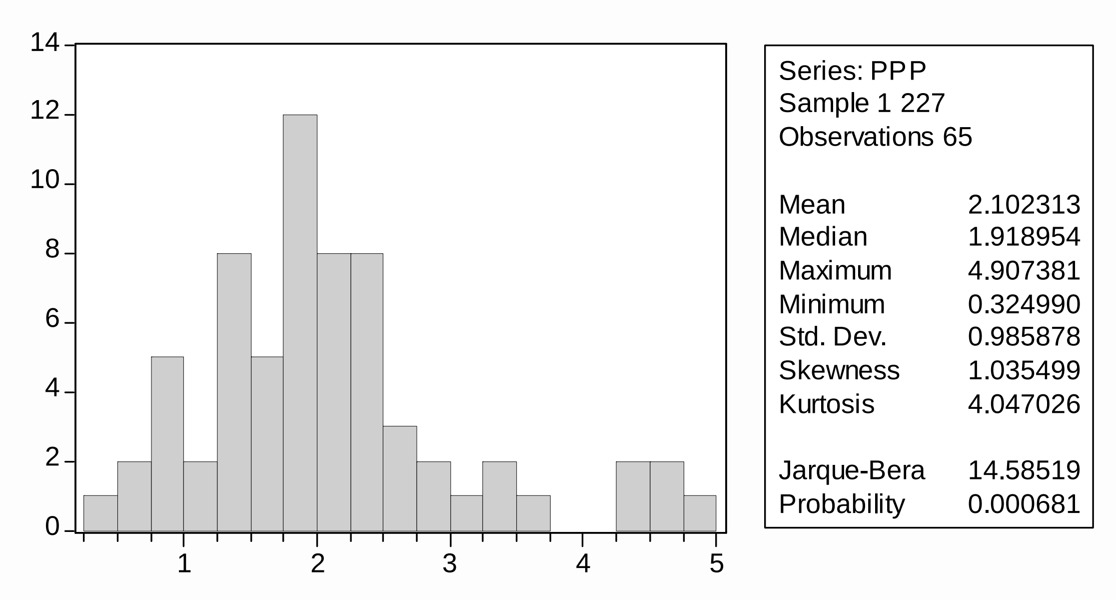


Figure 3. Histogram of the dependent variable, non-PPP sub-sample

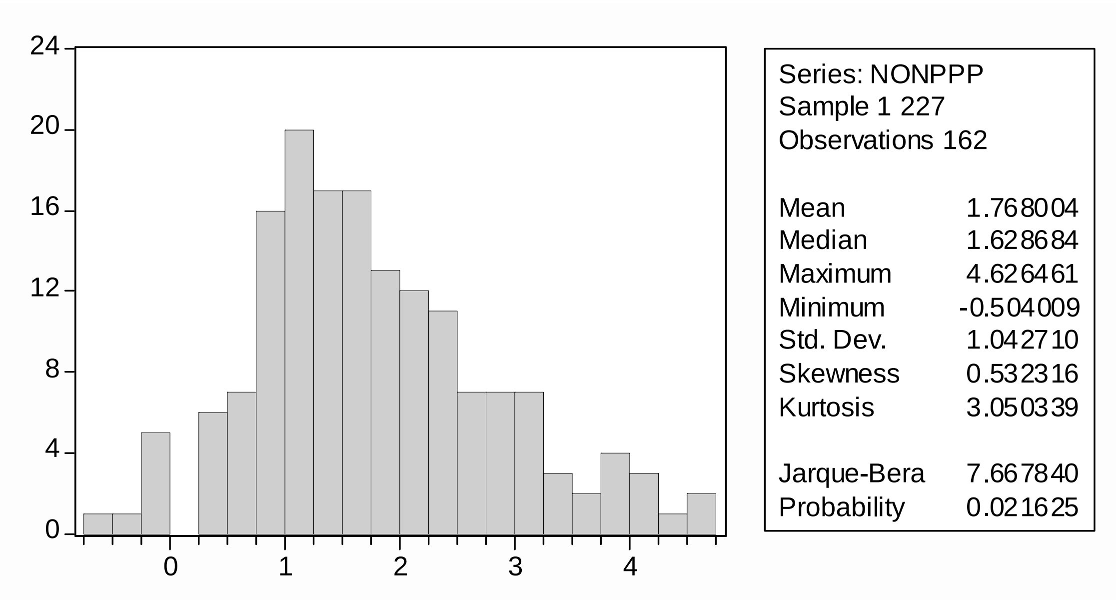


Figure 1 shows a negative relationship between the unit cost and road length, with a higher unit cost for a given length of motorway than for a road. We will discuss and model this relationship below. Figures 2 and 3 suggest that PPP projects are indeed more expensive in terms of unit construction costs, with the mean (median) for the PPP sub-sample some 19 per cent (18 per cent) above that for the other projects, although this is in part explained by the higher proportion of PPPs in the motorway sub-sample[16].

For the purpose of robustness testing the sample is divided into 8 partly overlapping sub-samples. In addition to the full sample, we estimate the model for motorways only, both with and without fixed link projects[17]. Within the full sample and the motorway sub-sample, we run the estimation also with the following sub-samples:

- Including only projects whose total value is not below €20 million or above €300 million;
- Including only observations with the value of the dependent variable within 1.5 standard deviations from the sample mean;
- Including only observations from countries that had both PPPs and traditionally procured road projects in our sample.

3.3 Estimation results

The detailed Ordinary Least Squares (OLS) estimation results of the preferred model specifications, obtained using the estimation strategy described above, for all 8 samples can be found in Appendix Tables A1-A8. Note that in the detailed tables we show all estimated coefficients for the economic and technical explanatory variables even when they turn out insignificant. We do this because the significance of the coefficients for two or three technical variables varies from one sample to another. Besides, dropping the insignificant economic and technical variables would not change the estimation results for the PPP dummy materially.

We note that all estimated coefficients for the economic explanatory variables have the expected sign in all specifications where they are statistically significant from zero, with the exception of the Mountain terrain dummy, which is not significant at the 10% level in any specification and has the wrong sign in Table A6. In other words, unit construction costs are

[16] Motorways are more expensive in unit cost terms; the mean (median) for motorways is 9(8) per cent higher for the motorway sub-sample.
[17] All observations with bridges or tunnels representing more than 50 percent of the section length are included, which includes all fixed-link projects.

higher for PPPs than traditionally procured roads; increase with labour costs; and decrease with the length of the road, confirming the presence of scale economies in road construction.

As regards the technical explanatory variables in the all road samples (i.e. including motorways and non-motorway, Tables A1 – A4), we note that the parameters have their expected signs, but that the dual carriageway dummy and the 2-lane dummy are not robustly significant. The single carriageway dummy is significant and negative. Roads with 6 lanes are more expensive than roads with fewer lanes (2, or 4)[18]. Whilst this analysis is useful for confirming the robustness of the PPP parameter estimate, the sample mixes normal roads and motorways, which have completely different technical specifications and expected unit costs. The regression equation does not, therefore, have a meaningful real world interpretation.

In the motorway samples (Tables A5 – A8) the technical explanatory variables behave similarly. 2 lane motorways are relatively cheaper to construct, while 6 lane motorways are relatively more expensive. Motorway construction on urban terrain raises construction costs, as do tunnels and bridges. Construction on urban terrain is more expensive than elsewhere, even excluding the price of land due, among other things, to a need to displace utilities and other additional costs of working in a dense urban environment. Mountainous terrain does not affect construction costs significantly (the coefficient is insignificant throughout); rather, the higher cost of road construction in the mountains is reflected in a higher proportion of tunnels and bridges, which is captured by the variables “tunnel/road” and “bridge/road”. The coefficients for these two variables turn out positive and significant in all specifications.

Country dummies that proved significant were kept in the model while others were dropped.[19] These variables capture aspects of the difference in unit costs between European countries that are difficult to observe otherwise. They can be driven by various aspects of local market conditions that are not captured by our control variables, including economic, technical

[18] The omitted dummy in this case is a 4-lane standard motorway, which acts as a benchmark.
[19] In testing the stability of estimated coefficients in recursively larger sub-samples, it turned out that the inclusion of the significant country dummies is key to coefficient stability. In other words, unobserved country-specific factors cause significant variation in the estimated coefficients of the model across countries.

and institutional factors, such as the cost of supplies, national contractor market conditions, technical standards for roads, or the quality of public procurement. We note from Tables A1 – A8 that country dummies play a more important role in the all roads samples than in the motorway samples and that the significant coefficients tend to be negative.[20]

Turning to the estimated magnitude of the PPP dummy coefficient, Table 1 summarises key characteristics of the estimation results for the various sub-samples. The column "N" shows the number of observations in each sub-sample; the column "PPP coefficient" shows the estimated value of the coefficient for the PPP dummy; the column "Adjusted R2" is self-evident; and the last column indicates that only in the last sub-sample does diagnostic testing raise some concern.

[20] We also tested the significance of a dummy variable denoting privatised motorway operators in Italy and Portugal and found the estimated coefficient insignificant. This test was warranted, as road projects in these countries are contracted with a privatised operator but without a DFBO structure to them.

Table 1. Summary of estimation results

Sample	N	PPP coefficient	Adjusted R2	Diagnostics
All roads				
full sample	227	0.31	0.82	OK
Total cost (20, 300) Eur million	168	0.33	0.80	OK
Dependent variable w/in 1.5 stdev	201	0.27	0.69	OK
Only countries with both PPP and trad projects	175	0.28	0.79	OK
Motorways				
full sample	156	0.29	0.74	OK
Total cost (20, 300) Eur million	117	0.33	0.76	OK
Dependent variable w/in 1.5 stdev	138	0.29	0.64	OK
Only countries with both PPP and trad projects	120	0.23	0.77	1/

1/ There is evidence of residual non-normality at 5% level.

Table 2. The estimated coefficient for the PPP dummy across sub-samples and model specifications

	Country dummies			Fixed links 3/	
Sample	Only significant ones included 1/	Unrestricted specification 2/	None included	N	Excluded from sample 4/
Motorways					
full sample	0.29	0.26	0.29	9	0.32
Total cost (20, 300) Eur million	0.33	0.32	0.30	4	0.37
Dependent variable w/in 1.5 stdev	0.29	0.24	0.31	0	--
Only countries with both PPP and trad projects	0.23	0.24	0.21	4	0.24
All roads					
full sample	0.31	0.34	0.32	18	0.29
Total cost (20, 300) Eur million	0.33	0.38	0.29	12	0.31
Dependent variable w/in 1.5 stdev	0.27	0.28	0.28	8	0.26
Only countries with both PPP and trad projects	0.28	0.29	0.23	10	0.27

1/ As shown in Tables A1-A8.
2/ Including all economic and technical regressors and all country dummies except one.
3/ Defined as projects comprising > 50% bridges or tunnels.
4/ Estimate of the coefficient for the PPP dummy excluding fixed links, using the specification with the significant country dummies.

Table 3. Summary of diagnostic test results

Sample	Jarque-Bera	Prob. 1/	White	Prob. 2/	Condition number 3/
Motorways					
full sample	0.277	0.871	11.143	0.599	18.364
Total cost (20, 300) Eur million	0.826	0.662	12.474	0.568	26.0782
Dependent variable w/in 1.5 stdev	0.978	0.613	13.383	0.710	21.1169
Only countries with both PPP and trad projects	8.504	0.014	13.301	0.503	19.8105
All roads					
full sample	2.103	0.349	20.980	0.694	20.771
Total cost (20, 300) Eur million	3.940	0.139	13.889	0.790	24.685
Dependent variable w/in 1.5 stdev	0.036	0.982	21.424	0.433	26.853
Only countries with both PPP and trad projects	2.697	0.260	12.009	0.885	27.214

1/ Should be > 0.1 for residual normality at 10% significance level.
2/ Should be > 0.1 for residual homoskedasticity at 10% significance level.
3/ Should be < 30 for unlikely collinearity among explanatory variables.

As shown in Table 1, the coefficient for our key variable, the PPP dummy, is estimated at about 0.3, varying between 0.23 and 0.33. The average coefficients in the all roads and motorways samples are 0.298 and 0.285, respectively.[21] Since we are using a log transformation of the dependent variable, the interpretation of the magnitudes of the estimated coefficients is not straightforward. We can obtain a semi-elasticity for a dummy regressor by taking the antilog (base e) of the estimated coefficient, subtracting 1, and multiplying the result by 100. This gives us the median predicted value (not the mean) (Halvorsen and Palmquist, 1980). By this transformation we conclude that the estimated PPP premium across all samples and specifications is about 35 percent.

3.4 Robustness Testing

To test the robustness of the estimated PPP premium not only across samples but also across model specifications, we use all 8 sub-samples in Table 1 to estimate a model specification with all economic and technical explanatory variables as well as all country dummies (bar one to avoid the dummy trap) regardless of their significance, and we also estimate another specification including only the economic and technical explanatory variables, thus dropping all country dummies.

As a further robustness test, we eliminate all fixed-link projects from each sub-sample. Fixed-links projects have a very high proportion of bridge or tunnel in the section length. The presence of these observations may help in estimating the coefficients for the bridges and tunnels variables, but they also have very high unit costs, which are more to do with the construction of major structures than roads or motorways. The models were therefore estimated with no fixed-links and no observations where the tunnel or bridge proportion is greater than 50% of the length. It should be noted that the model including only observations within 1.5 standard deviations from the sample mean (Table A7) automatically excludes the fixed links due to their high unit costs.

[21] Running the same analysis for all roads that are not motorways (N = 71) yields an estimated coefficient for the PPP dummy of 0.34.

Table 2 summarises the estimated coefficient for the PPP dummy in these specifications for all sub-samples.

We see that the estimated coefficient for the PPP dummy stays in the range 0.23 – 0.38 regardless of the model specification. However, the unrestricted specification and the specification without any country dummies have not been subjected to the same rigorous diagnostic testing as the preferred specifications, so their results should not be considered as solid as those of the preferred specifications. Nevertheless, the robustness of the PPP premium across different samples and model specifications is reassuring, suggesting that our PPP dummy does indeed capture the impact of procurement method on the dependent variable and nothing more than that.

To conclude, the key diagnostic test results for the different specifications are summarised in Table 3.[22]

- The OLS residuals appear normally distributed, with the Jarque-Bera test unable to reject the null hypothesis of normality at 10 percent level for any sub-sample, except the one indicated in Table 1.
- The White test cannot reject the null of no heteroskedasticity at 10 percent level for any sub-sample. This test also tests for the appropriateness of the linear model specification and for correlation between the explanatory variables and the residuals, so it also confirms that our linear specification is correct and that omitted variables are unlikely (as evidenced by the absence of correlation between the explanatory variables and the residuals).
- The condition number tests confirm that collinearity is unlikely for all specifications and samples.

Overall, the preferred model appears thus well specified, and the R^2 exceeds 60 percent for all sub-samples.

[22] We do not present any test results for serial correlation in residuals, as our sample consists of cross-section data and serial correlation is thus dependent on the ordering of the observations. We have run Durbin-Watson and higher-order Lagrange multiplier tests for different ordering of the observations and found ways to order them so as to eliminate any serial correlation.

3.5 Preferred model

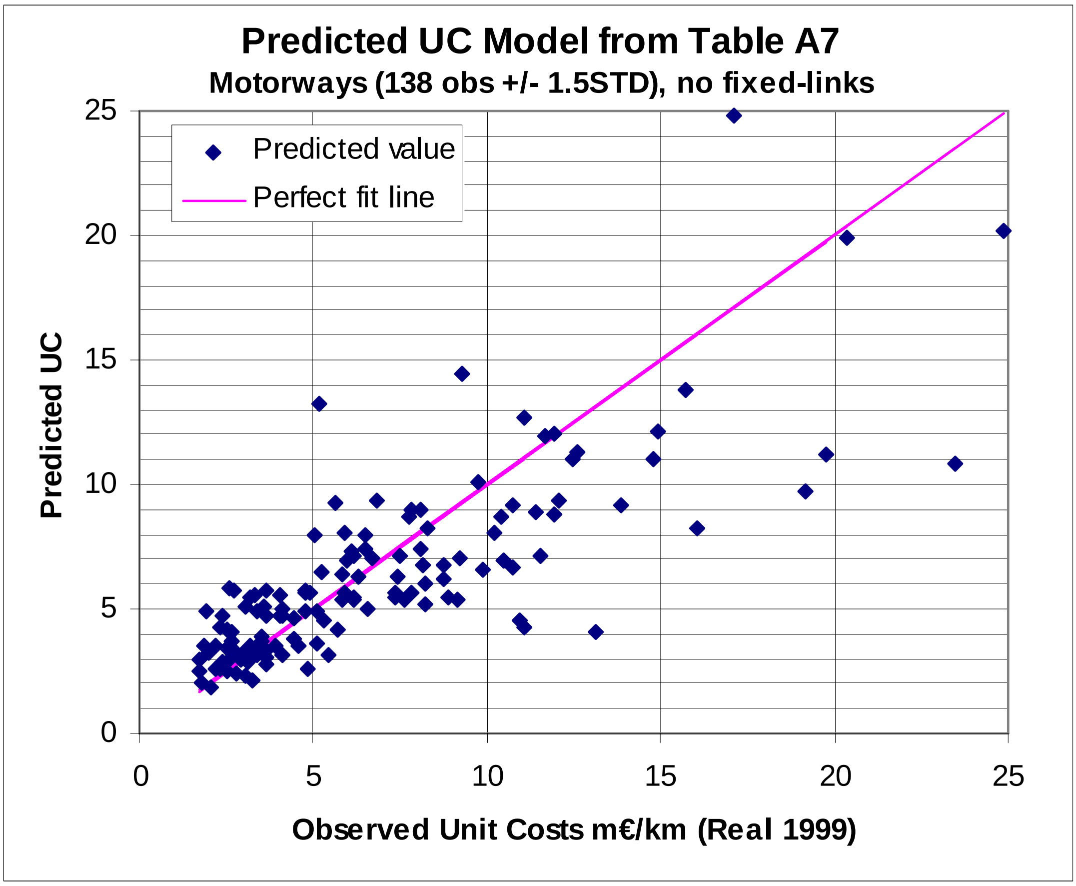
The final, informal robustness check is that the identified model should make sense to a sector specialist. Lumping together observations that include motorways, normal roads and fixed-links to estimate unit costs would be an anathema to any transport engineer or economist. Building a bridge is simply not the same economic activity as building a road. Furthermore, Flyvbjerg (2002) documents that the average cost overruns for these different categories of infrastructure are very different, so that risk pricing would be expected to vary in each case. Thus, whilst many of the samples and specifications summarised in Table 2 are useful for confirming the robustness of our PPP coefficient, they have no meaningful real world interpretation.

Only the model estimated for the motorway sample excluding fixed links, summarised in Table A7, is a sensible model of the real world. The model coefficients have the correct sign and their magnitudes are plausible. Figure 4 shows how well the model fits the untransformed unit cost data. The fit of the model is worse at higher unit costs. But in the range 0 to 15 million euros/km, the mean absolute deviation is 1.6 million euros/km. In the preferred model, the omitted dummy variable is a standard 4-lane (or 2x2) motorway. Because of the way the model is specified, the constant term does not have a simple interpretation. However, by substituting values into the model we can calculate a benchmark. For a 25km long, 4-lane motorway section, in non-urban and non-mountainous terrain, with no tunnels or bridges, not procured as a PPP, in an EU country with average labour costs, the model estimates a unit cost of 4.9 million euros/km in 1999 prices. This value compares well with international standards seen by the Bank[23]. The same motorway built in an urban context is 42% more expensive. A 6-lane motorway is 33% more expensive. A similar motorway with 10% of its length in tunnels is 23% more expensive. Unit costs are significantly lower in Spain, Denmark, Germany and Norway compared to other

[23] As part of the due diligence technical reporting for many PPP motorway projects, international consultants prepare comparisons of construction costs with benchmarks derived from other projects. For example, the Spon's database gives a unit cost of 4.5 million euro/km in 2005 for a 2x2 UK motorway in rural, non-mountainous terrain with a normal level of structures. A commonly cited benchmark for traditionally procured EU motorways is 5 million euros/km.

EU countries[24]. The magnitude of some of these coefficients may be questioned, but the benchmark and general relationships are reasonable.

Figure 4. Predicted unit costs from preferred motorway model



4. Interpretation of the results

4.1 The magnitude of the PPP premium

For the preferred model, the coefficient of the PPP dummy for EU motorways is 0.29. This corresponds to a premium of 33% with a standard error of ± 10%. However, as noted in section 4 above, there is a systematic bias in the TP data of between 5 to 15%. Thus, the corrected median PPP premium for EU motorways is estimated at 23% with a confidence range of 13 to 33%.

[24] The lower unit costs in Spain are well known. However, the lower costs in the other 3 countries are surprising and may indicate problems with small samples from those countries. This requires further investigation.

At first glance such a premium may seem high, but in fact it fits well with other evidence. Edwards et al (2004) calculated that the average premium on construction costs for the first four DBFO roads projects in the UK was 25%. In certain projects, the EIB sees tendered costs for directly comparable TP and PPP contracts, for instance where a section of a project is first procured traditionally and then adjacent sections are procured under a PPP. In such cases, the difference in unit costs for the PPP contracts is typically an additional 10 to 30%.

The magnitude of the estimated PPP premium is also directly comparable to the reported optimism bias of TP projects. Firstly, it must be noted that there are always issues about the comparability of PPP and non-PPP cost estimates due to differences in timing of when the data is collected. For large capital projects (greater than 150 million Euro), the study by Mott MacDonald (2002) identified an average cost escalation from the date of contract award of 21%. The Motts study also compared optimism bias for TP and PFI/PPP roads/bridge projects. The average optimism bias was 0% for 4 PPP/PFI projects compared to 44% for 3 TP projects. Using a global sample of major projects, Flyvbjerg (2002) found average cost escalation during construction of 28% overall and significant differences between sectors and regions. The average cost escalation for the EU roads sector was 22%.

The close correspondence between optimism bias and PPP premium suggests that contractors are behaving entirely rationally when pricing construction risks. Although for any individual project there will be specific technical and strategic corporate factors influencing bids, on average, it appears that contractors are seeking to be compensated for the known cost overruns for the particular category of infrastructure concerned.

4.2 Drivers

This study has confirmed that a systematic premium in the *ex-ante* construction costs of EU15 PPP Roads can be identified and that it is statistically significant and robust. For our preferred model of EU motorways, the PPP Premium is estimated at 23 per cent. What do these 23 per cent represent?

There are a number of factors that could potentially explain the magnitude of the PPP Premium, some of which have already been discussed. These are considered to be:

- risk pricing **-** the effect of risk transfer causing contractors to explicitly price the expected additional cost to minimise the likelihood of cost overruns and delays to schedule;
- quality enhancement **-** the effect of contract bundling leading to higher construction costs in order to optimise lifecycle costs;
- additional bid costs – the need for contractors to recover the higher transaction costs of bidding for PPPs must be factored into their pricing of bids[25];
- market failure – the impact of inadequate competition or overheated demand allowing contractors to raise prices above market norms;
- corruption – the effect of a specific bidder being able to influence the award of a contract and capture excess profits.

The issues of quality enhancement costs and risk pricing were discussed from both a theoretical and practical perspective in section 2. It is impossible to disaggregate these factors on the basis of our study, but the practitioners view is clearly that risk transfer is the dominant component of the premium.[26]

[25] Bidding costs are very significant for PPP projects. Dudkin and Välilä (2005) estimate overall PPP transactions costs related to the procurement phase to be above 12% of construction costs. For EU roads sector PPPs, average bid costs for the winning bidder are about 3%, but that this includes costs in addition to the construction consortium costs such as the high cost of financial/legal advisors.

[26] Ex-post evaluation reports from PPP projects (EIB, 2005) and other anecdotal evidence suggests that whole-life costing does indeed prompt developers to increase the quality of construction. For instance, a DBFO motorway project in Greece was built to a higher

4.3 The Benefits of the PPP Premium

So what does the public sector get for the PPP premium? The key benefits of procuring projects via PPPs are: (i) certainty in project cost and delivery and (ii) lower life-cycle costs. Thus it is no surprise that the construction cost of a PPP should be higher than the initial contract price under traditional procurement. The transfer of risk and incentives to enhance quality and reduce lifecycle costs comes at a price. The advantage for the public sector is that delays are eliminated and the cost is contractually committed upfront through the unitary payment. If the private partner fails to deliver the project or fails to perform as required under the contract then the public sector pays less. From a public policy perspective this provides greater certainty in budgeting future expenditures.[27]

One of the main success stories of PPP programmes to date is delivery on time and budget. The UK's HM Treasury (2003) reported that 88% of PFI schemes were built on time or early, compared to only 30% of traditionally procured projects and that changes to the unitary charge only occurred in 21% of PFI projects, whereas 72% of traditionally projects experienced cost overruns. The performance of the PFI roads sector was particularly impressive, with 100% being delivered early. The ex-post review by EIB (2005) based on a sample of 10 in-depth PPP case studies, mainly from the transport sector, found that "…the underlying [PPP] physical projects evaluated in-depth were largely completed on-time, on-budget and to specification…. There was also evidence on some projects that the standard of the works was better than would have been found on a public procurement project." The more recent UK review of the PFI (HM Treasury, 2006) focusing on the operational phase found a high level of satisfaction with the PFI programme overall. So in the construction and early operations phase, PPP seems to be delivering.

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standard than normal motorways in the opinion of the Transport Ministry. The same contractor now maintains and operates the motorway under a 20 year contract. Likewise, when building a DBFO motorway in Norway, the main contractor chose to drill an extra 400 metres of tunnel in order to avoid steep slopes that were considered difficult and risky to maintain. However, whole-life costing is more likely to be reflected in design options involving very limited additional costs and in greater attention to quality during construction than in significant upfront additional investment. Higher upfront capital investment costs have a larger weighting in the discounted cash flow of the project. Thus, in practice, cost increases due to the whole-life cost optimisation are unlikely to be very significant.

[27] Strictly, this argument does not apply to real toll motorway concessions as revenue risk is passed to the private party.

Will this promise be held over the longer term, particularly as projects move into the later operations phase requiring major maintenance and renewals to maintain performance? A number of authors have expressed doubts about this. Grout (1997) for instance, contends that “[PPPs] will probably lead to problems at the service provision stage. Public and private sector suppliers may have different incentives at this stage. Another problem is that the service needs to be determined in advance, which is likely to be sub-optimal, even with renegotiations. Within a PFI there are beneficial incentives to avoid cost overruns but not to reduce costs where they affect long run services.” Likewise, Standard & Poor’s (Manley et al, 2006) remains cautious about whether operations phase risks should automatically be treated as lower than those in the construction phase.

Over the long term, the additional cost identified in the PPP premium for constructing the asset will have to be weighed against the benefits of timely delivery, contracted service levels and committed lifecycle operations and maintenance costs. Only then can an objective assessment be made of whether PPP procurement represents value-for-money. Ex-ante risk assessment and pricing involves a contingent judgment about an outcome that then only has one ex-post realization for any individual project. It is only by looking at this phenomenon from a large sample perspective, using both ex-ante and ex-post data, that any conclusions might eventually be drawn on the relative merits of different procurement routes for public infrastructure.

5. Conclusions

Both theoretical and practical arguments would lead us to expect higher construction contract costs for assets procured through PPP contracts compared to more traditional forms of procurement. The empirical analysis presented in this paper confirms that such a PPP premium exists and that it can be estimated using a large sample of ex-ante observations for PPP and non-PPP projects. The PPP premium parameter is both significant and robust.

After allowing for a systematic optimism bias in the cost data for non-PPP projects, the net PPP Premium for EU Motorways is estimated at 23% with a confidence interval of 13 to 33%. The magnitude of the PPP Premium corresponds well with reported average cost escalation for traditionally procured projects. This suggests that, on average, contractors are behaving entirely rationally when required to fully assume construction risks.

The existence such of a PPP premium should not be interpreted as an argument for or against PPP *per se*, but can rather be explained as (i) the explicit pricing of risks associated with cost overruns and delays; and, to a far lesser extent, (ii) additional costs of investment optimisation to minimize lifecycle costs; (iii) recovery of higher bid costs.

The expected benefits of paying this premium are greater certainty in project delivery and, in the case of non-toll motorways, payment based on asset service delivery performance rather than upfront construction costs. From a public policy perspective, whether this premium represents value-for-money can only be determined ex-post by evaluation over the project lifecycle for a large sample of projects. This question is the subject of on-going research.

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Appendix: Estimation results

Table A1. Estimation results for all roads (full sample)

	Coefficient	Prob.
(Constant)	1.432	0.000
PPP	**0.313**	0.000
Labour	0.043	0.000
Dual carriageway dummy	-0.101	0.239
Single carriageway dummy	-0.415	0.097
2 Lanes	-0.504	0.032
6 Lanes	0.401	0.000
Urban Terrain	0.331	0.001
Mountain Terrain	0.129	0.301
Log(length)	-0.241	0.000
Tunnel/road	0.019	0.000
Bridge/road	0.017	0.000
Denmark	-0.990	0.000
Finland	-0.428	0.025
Germany	-0.427	0.012
Ireland	-0.355	0.058
Italy	-0.499	0.047
Netherlands	-0.730	0.005
Norway	-1.016	0.000
Spain	-0.539	0.000
Sweden	-0.258	0.094
UK	-0.247	0.060
N	227	
Adjusted R2	0.82	

Table A2. Estimation results for all roads, including only projects worth between €20 and €300 million

	Coefficient	Prob.
(Constant)	2.196	0.000
PPP	**0.330**	0.000
Labour	0.024	0.000
Dual carriageway dummy	-0.172	0.049
Single carriageway dummy	-0.564	0.039
2 Lanes	-0.302	0.215
6 Lanes	0.278	0.012
Urban Terrain	0.294	0.002
Mountain Terrain	-0.100	0.464
Log(length)	-0.407	0.000
Tunnel/road	0.015	0.000
Bridge/road	0.011	0.000
Denmark	-0.674	0.000
Netherlands	-0.406	0.078
Norway	-0.561	0.004
Spain	-0.294	0.001
N	168	
Adjusted R2	0.80	

Table A3. Estimation results for all roads, including only observations with the dependent variable within 1.5 standard deviations from the full sample mean

	Coefficient	Prob.
(Constant)	1.855	0.000
PPP	**0.268**	0.000
Labour	0.016	0.023
Dual carriageway dummy	-0.090	0.302
Single carriageway dummy	-0.245	0.305
2 Lanes	-0.443	0.042
6 Lanes	0.329	0.001
Urban Terrain	0.177	0.049
Mountain Terrain	-0.027	0.818
Log(length)	-0.165	0.000
Tunnel/road	0.019	0.000
Bridge/road	0.017	0.000
Denmark	-0.742	0.000
Finland	-0.324	0.060
Norway	-0.386	0.048
Portugal	-0.263	0.055
Spain	-0.532	0.000
Sweden	-0.294	0.061
N	201	
Adjusted R2	0.69	

Table A4. Estimation results for all roads, including only observations in countries with both PPP and traditionally procured road projects

	Coefficient	Prob.
(Constant)	0.517	0.074
PPP	**0.280**	0.001
Labour	0.054	0.000
Dual carriageway dummy	-0.082	0.388
Single carriageway dummy	-0.813	0.017
2 Lanes	-0.092	0.773
6 Lanes	0.337	0.001
Urban Terrain	0.283	0.004
Mountain Terrain	0.061	0.625
Log(length)	-0.187	0.000
Tunnel/road	0.021	0.000
Bridge/road	0.018	0.000
France	0.337	0.026
Greece	0.698	0.000
Portugal	0.556	0.000
UK	0.299	0.015
N	175	
Adjusted R2	0.79	

Table A5. Estimation results for motorways

	Coefficient	Prob.
(Constant)	1.310	0.000
PPP	**0.293**	0.001
Labour	0.021	0.000
2 Lanes	-0.915	0.011
6 Lanes	0.389	0.001
Urban Terrain	0.567	0.000
Mountain Terrain	0.109	0.440
Log(length)	-0.159	0.002
Tunnel/road	0.021	0.000
Bridge/road	0.027	0.000
N	156	
Adjusted R2	0.74	

Note: The specification with significant country dummies does not pass diagnostic tests.

Table A6. Estimation results for motorways, including only projects worth between €20 and €300 million

	Coefficient	Prob.
(Constant)	2.430	0.000
PPP	**0.331**	0.001
Labour	0.006	0.313
2 Lanes	-0.531	0.261
6 Lanes	0.316	0.008
Urban Terrain	0.393	0.002
Mountain Terrain	-0.020	0.903
Log(length)	-0.421	0.000
Tunnel/road	0.017	0.000
Bridge/road	0.025	0.000
Sweden	0.344	0.042
N	117	
Adjusted R2	0.76	

Table A7. Estimation results for motorways, including only observations with the dependent variable within 1.5 standard deviations from the motorway sample mean

	Coefficient	Prob.
(Constant)	1.426	0.000
PPP	**0.285**	0.000
Labour	0.029	0.000
2 Lanes	-0.858	0.004
6 Lanes	0.286	0.003
Urban Terrain	0.356	0.002
Mountain Terrain	0.103	0.436
Log(length)	-0.178	0.000
Tunnel/road	0.020	0.000
Bridge/road	0.031	0.000
Denmark	-0.745	0.000
Germany	-0.547	0.011
Norway	-0.674	0.002
Spain	-0.429	0.000
N	138	
Adjusted R2	0.64	

Table A8. Estimation results for motorways, including only observations in countries with both PPP and traditionally procured motorway projects

	Coefficient	Prob.
(Constant)	1.161	0.000
PPP	**0.232**	0.006
Labour	0.035	0.000
6 Lanes	0.359	0.001
Urban Terrain	0.386	0.002
Mountain Terrain	0.129	0.329
Log(length)	-0.130	0.010
Tunnel/road	0.024	0.000
Bridge/road	0.026	0.000
Germany	-0.304	0.113
Spain	-0.482	0.000
N	120	
Adjusted R2	0.77	

Note: Specification only passes diagnostic tests if the dummy for 2 lanes is dropped and the dummy for Germany, even though insignificant at 10% level, is included. Even so, the Jarque-Bera test suggests non-normality of residuals at 5% level.