# Financial analysis of road project delivery systems

Pertti Lahdenperä
*VTT Technical Research Centre of Finland, Tampere, Finland, and*
Tiina Koppinen
*Skanska Oy, Helsinki, Finland and*
*VTT Technical Research Centre of Finland, Helsinki, Finland*

## Abstract

**Purpose** – A project delivery system (PDS) refers to the organizational framework of a project that defines the control mechanisms and the relationships between actors and their incentives. It is of major importance to the project owner as it, for instance, contributes to the project's level of efficiency. This paper aims to define indicative, relative cost performances of different PDSs in a road management context to support the road owner's strategy development.

**Design/methodology/approach** – This study compares the costs of design-bid-build, construction management at-fee, design-build, design-build-operate and design-build-finance-operate based on an international data capture focusing on the operational performance of these PDSs. A financial analysis was made to determine the systems' present costs to a road authority based on relevant market estimates. Moreover, a step towards understanding their overall efficiency was taken by focusing also on differences in speed of delivery which result in expenses or savings to the user community.

**Findings** – Although the applicability of a PDS depends on project properties and constraints, the study concludes that, in general, the broader the scope of services supplied by a single contract, the lower the system's present cost to the owner. The inclusion of private finance and early commissioning advantage, however, change the ranking so that universal conclusions cannot be drawn. DBFO seems to be commonly in the middle category.

**Research limitations/implications** – Here, PDSs are applied to a relatively large project, minimum size €30-60m, in well-known conditions and involving no factors of uncertainty due to third parties. The results are not valid in smaller and/or more constrained projects.

**Originality/value** – The study provided new knowledge of the owner's and society's average comparable cost performances in the case of five different PDSs. Since a single-value, exclusive solution hardly exists, the study on the sensitivity of different PDSs to key financial parameters is also valuable.

**Keywords** Roads, Project management, Project finance, Financial analysis, Finland

**Paper type** Research paper

## 1. Introduction

### *1.1 The project efficiency dilemma*

Road management in Finland is the responsibility of the public sector. Road projects involve manifold activities, some of which owners have traditionally performed in-house, while at least construction has been procured through conventional design-bid-build (DBB) contracts. Over time broader service packages have been introduced which include, besides construction, also technical design and often maintenance for a certain period – sometimes even financing – under a single contract. As a result, the owner has available many options to organize road management.

Journal of Financial Management of Property and Construction
Vol. 14 No. 1, 2009
pp. 61-78

1366-4387
DOI 10.1108/13664380910942644

This raises the issue of the usability and actual effectiveness of various project delivery systems (PDSs). Which PDS should the owner (client) select? Various decision making and expert systems have been developed to aid in the selection (Alhazmi and McCaffer, 2000; Mahdi and Alreshaid, 2005; Oyentunji and Anderson, 2006). They are usually qualitative systems that consider various features of a project but do not indicate actual cost performance of the PDSs. Besides, such systems/studies mainly focus on the investment phase excluding the so-called life cycle forms of contract.

Studies on actual cost performance, again, usually compare only two PDSs (AECOM Consult, 2006; Ernzen *et al.*, 2004) or variations and/or performance of a certain PDS (Molenaar *et al.*, 1999; Construction Industry Council, 2000; Salmela *et al.*, 2003; NAO, 1998; Hall *et al.*, 2000) which does not allow formulating a general view on the cost efficiency of a number of different PDSs. Especially, studies covering the life cycle of an asset, just compare life cycle contracts with conventional ones without differentiating between the many existing alternatives. Moreover, these studies tend to draw conclusions on the basis of comparing actualized project data with pre-project expectations which, despite the credibility of the actual research work, is also problematic due to the usual bias in estimates (MacDonald, 2002; Committee of Public Accounts, 2003). Thus, it would be helpful to have more evidence on the performance and true costs of various PDSs.

### *1.2 Objectives and approach of the study*

This paper aims to clarify the cost efficiency dilemma by examining the cost performance of different road PDSs by defining their indicative, relative cost performances. The foundation formed through the earlier research and the role of this effort can be examined by considering the difference between operational and financial performance:

- Operational performance is indicated by costs of different key project activities at the time the costs occur and/or as work progresses. This means that the performance data consists of timed cost cash flows of key road management activities and there is a known fixed current cost, and start and end dates, for each activity of all studied PDSs. For the definition of specific values, data are collected from numerous projects in various countries.
- Financial performance depends also on the financial arrangement and corresponding payment system (in addition to the cost and timing of activities) and, once the time values of money have been determined, results are calculated for PDSs as explicit index numbers (relative present costs). Since the regulations and markets differ, Finland has been selected as the application environment as to financial estimates and accounting constraints.

Thus, financial performance is not evaluated separately but rather as an additional feature by reprocessing the different operational performance data of an earlier study (Koppinen and Lahdenperä, 2007). In that study, approximations of PDSs' cost performances were calculated through direct discounting – the private-financed option and financing issues in general were excluded. The cost to the user community was also ignored. In addition to correcting these deficiencies, the paper also focuses on the significance of various financial parameters by means of a sensitivity analysis.

*1.3 Delivery methods compared*

The number of PDSs, including all variations, is substantial, but only a limited number can be included in the study. Therefore, the PDSs included in the research are (Koppinen and Lahdenperä, 2004b):

- Construction management (CM), where, in addition to a designer, a manager is hired by the owner to manage the overall project and implementation is realized through numerous partial construction contracts held by the owner (the study examines CM-at-fee excluding CM-at-risk). Periodic maintenance is commissioned separately.
- DBB, where the owner has contracts separately with a designer and a contractor. Design is completed prior to procuring construction and a contractor is typically selected based on the bid price (since quality is already defined by the design). Periodic maintenance is commissioned separately.
- Design-build (DB), where a (DB) contractor under a contract with the owner is responsible for the project's design and implementation as a whole. The quality/features of a design proposal may be a selection criterion in addition to price. Periodic maintenance is commissioned separately.
- Design-build-operate (DBO), where the responsibility is assigned through a single contract to design, build and maintain the asset for the contract period. The means of competition are varied. The owner arranges the financing and pays for the investment in due time (as in CM, DBB and DB).
- Design-build-finance-operate (DBFO), where the responsibility is assigned through a single contract to design, build and maintain the asset for the contract period. The service provider arranges the financing and the owner repays the investment as part of the service fee starting after commissioning.

For the sake of comparison, all work is assumed to be out-sourced (i.e. commissioned to industry) in all PDSs (instead of being partially performed in-house by the owner). Daily maintenance is excluded from the study.

## 2. Reviewing the earlier performance data

To define PDSs' operational performances, the earlier study charted the performance of different PDSs in actualized road projects in England, Australia, New Zealand, the USA, and Finland. This was necessary since a recent procurement portfolio of a single country does not usually cover all the PDSs, or their use has been limited. For instance, at the time of the study only one DBFO project (but no DBO projects) had been implemented in Finland while the UK had given up the use of DBB.

A total of 66 persons were interviewed which generated a large volume of performance information (Koppinen and Lahdenperä, 2004a). In order to improve the generalizability of results, the interviewees were asked to give "average" actualized values of cost and schedule items based on numerous projects or to give evaluations based on one or a few cases, where the effects of potentially unique circumstances were eliminated.

The interviewees' statements were to cover achieved activity-specific percentage savings or additions (separately in owner and industry activities) and schedule effects in different project phases (procurement, design, construction and maintenance) in different PDSs compared to DBB. About 14 projects were also examined in more detail (in addition to cases described in literature).

For the determination of PDS-specific operational performances, reference project data were analyzed resulting in comparative costs (monetary values) and timing of main project activities (design, construction, etc.) in a project utilizing a certain PDS. It formed the basis for calculating the costs of the other PDSs based on the relative (percentage) differences on the activity level.

Comparative PDSs' operational performance was calculated separately for two reference projects while only the costs of the bigger one are presented in this paper; the smaller project is only used for verification and commenting. Both reference projects were extensions and improvements of existing roads with investment value of €40-60m.

DBO and DBFO projects were included in the same data sample for defining their common operational performance. Different financing solutions were excluded from the study phase in order to eliminate the likely bias from diverging tax codes, financial arrangements, etc. in different countries. Surveyed performance data should not be sensitive to such issues.

Since the figures were based on an actual project, inflation was inherent. Therefore, the costs were first converted to the price level of the launch of the primary reference project prior to the analysis based on the average change in civil engineering costs during the design and construction period (i.e. 4.0 percent; Statistic Finland, 2006). This procedure resulted in constant costs of different phases which are presented in Table I. The programming phase and other general planning activities that precede procurement are similar for all PDSs and excluded from the comparison as a sunk cost item.

While the approach includes usual PDS-specific administrative costs caused by the implementation of a physical project, it also presupposes that there exist no external legislative or other procedures which would introduce an additional burden to one of the PDSs over the others. If, however, this is the case in some targeted applications, this additional burden has to be taken into account separately.

For the analysis, the costs of activities are divided into uniform monthly costs for the overall duration of the activity (which is naturally only an approximation). A graphic illustration of the operational performances of this phase including all the PDSs is provided in Koppinen and Lahdenperä (2007), which also describes this study phase in more detail.

## 3. Research premises and methodology

### *3.1 Methodology overview*

The analysis follows the discounted cash flow method and results in PDSs' present costs (PCs). Two complementary analyses were made: cost to the owner (Analysis 1) and comparative costs to the society (Analysis 2). The analyses are based on the operational performance data which means that all actual cash flows (cost to the owner/society) are not available. Activity costs of various PDSs generate different costs to the owner due to the diverging financial arrangements and speed of production. Therefore, this section focuses on financial arrangements, formulation of comparative cash flows, and the justification for including the time of commissioning in the analysis.

| Project delivery system | Activity | Start (month) | Finish (month) | Cost (€) |
|---|---|---|---|---|
| Construction management | Procurement[a] | 0.0 | 2.5 | 29,824 |
| | Design[b] | 2.5 | 18.5 | 3,289,786 |
| | Construction[b] | 6.5 | 47.5 | 52,400,021 |
| | Client administration[a] | 2.5 | 47.5 | 1,006,051 |
| | Maintenance[b] | 47.5 | 360.0 | 10,755,325 |
| | Client administration[a] | 47.5 | 360.0 | 430,213 |
| | External advice[b] | 2.5 | 47.5 | 5,589,173 |
| Design-bid-build | Procurement[a] | 0.0 | 2.5 | 29,824 |
| | Design[b] | 2.5 | 18.5 | 3,462,932 |
| | Client administration[a] | 2.5 | 18.5 | 138,517 |
| | Procurement[a] | 18.5 | 21.0 | 28,083 |
| | Construction[b] | 21.0 | 62.0 | 55,527,283 |
| | Client administration[a] | 21.0 | 62.0 | 2,221,091 |
| | Maintenance[b] | 62.0 | 360.0 | 10,256,277 |
| | Client administration[a] | 62.0 | 360.0 | 410,251 |
| | External advice[b] | 21.0 | 62.0 | 1,539,662 |
| Design-build | Procurement[a] | 0.0 | 10.5 | 52,995 |
| | Tender award[b] | 10.5 | 10.5 | 86,822 |
| | Design[b] | 6.5 | 41.3 | 2,785,629 |
| | Construction[b] | 10.5 | 51.5 | 51,719,425 |
| | Client administration[a] | 10.5 | 51.5 | 222,100 |
| | Maintenance[b] | 51.5 | 360.0 | 10,617,656 |
| | Client administration[a] | 51.5 | 360.0 | 424,706 |
| | External advice[b] | 10.5 | 51.5 | 377,389 |
| Design-build-(finance-)operate | Procurement[a] | 0.0 | 18.0 | 209,426 |
| | Tender award[b] | 18.0 | 18.0 | 169,716 |
| | Design[c] | 14.0 | 46.0 | 3,087,927 |
| | Construction[c] | 18.0 | 55.3 | 43,153,060 |
| | Client administration[a] | 18.0 | 55.3 | 218,015 |
| | Maintenance[c] | 55.3 | 360.0 | 9,439,029 |
| | Client administration[a] | 55.3 | 360.0 | 188,781 |
| | External advice[b] | 0.0 | 55.3 | 2,854,028 |

**Notes:** [a]Internal cost to the owner; paid promptly, [b]external cost to the owner; paid promptly, [c]external costs to the owner; paid promptly in DBO and as a part of the use time service fee in DBFO

**Table I.**
Activity timing and constant costs in PDSs

*3.2 Financial arrangements*

DBB, CM, DB, and DBO are public-financed options, and the owner is supposed to pay for the work as it progresses. In DBFO, again, it is the duty of the service provider to arrange the required financing for the investment, and the owner amortizes the investment only as a part of the subsequent uniform, monthly service fee, provided that no imperfections exist in the delivered services.

In DBFO, the service provider is usually a company established specifically to carry out the contract (National Treasury, 2001), generally called a special purpose vehicle (SPV). The SPV's equity ensures adequate risk carrying capacity and entices debt financiers. The constructed asset and the long-term contractual incomes from a public body (with a power to levy taxes) serve as collateral for the creditors. The equity remains in the SPV until the end of the concession while the debt is paid back in the form of (equal) annuities (interest plus principal). Compensation is also needed for the maintenance and repair due to the wear and tear during the long usage period.

The SPV is often a type of flow-through unit as taxes are paid by actual service companies and financiers. Thus, tax consequences are roughly identical for different PDSs and therefore excluded here. Only the minimum amount of equity required by law is invested into the SPV while the remaining "equity" is debt subordinated to senior debt (Finnish Government, 2006a) which is also paid back before payment of taxes, and if there is no surplus, there is no difference in taxes either.

As far as government projects are concerned, the calculation procedure is also consistent with the current Finnish tax law (Finnish Government, 2006b, c). The law allows straight-line depreciation over the concession period whereby the amortized amount (roughly) becomes tax deductible. The law presumes that the SPV's income is dependent on vehicle mileage. In other words, the usage risk and the related risk of increased maintenance is carried by the owner and the service providers are compensated accordingly which makes all PDSs comparable in this regard. Value-added taxation, again, treats all (but financing) costs similarly and is, thus, excluded from the calculations.

*3.3 Comparative cash flows*

Calculation of PC means discounting future costs into the present by using a social time preference as a time value of money. Often this is made by comparing cash flows that have totally different profiles, which causes a problem: there exists no generally accepted level for social time preference, and in many cases the value has been selected purposefully in favour of a certain system, which according to Shaoul (2005) has usually been DBFO.

Comparable cash flows can be (and are) created by assuming that the owner will fund the investment in public-financed options with new debt and amortize the debt during the very same period as the service fee is being paid to the SPV in DBFO. Even if the client does not need debt, the opportunity cost approach requires similar measures. An opportunity cost is defined as a cost of something we have to forgo or give up in order to obtain the desired (Snell, 2002); here it is the lost return from an alternative investment made during the construction and maturing during the maintenance period.

The aforesaid concerns, however, only external costs to the client. There are always also internal costs, consisting of procurement and administration, whose amount and timing differ between PDSs. The client's organization and its general budget are supposed to absorb the cost and time changes, and these costs are discounted directly without applying the comparable cash flow approach.

*3.4 Timing of commissioning*

As a public body the road authority should apply economic criteria for the best of society which means that other tangible and intangible benefits and drawbacks to society should be included whenever possible (Road Administration, 2003).

The only major difference between the PDSs is the time required for construction. Early commissioning produces savings for the user community in traffic costs such as vehicle, driving time and accident costs, and is taken into consideration in the study (in Analysis 2) while other influences of time are only marginal. Since the study, at first, looks at the owner's PCs, and savings in traffic costs do not reduce the client's payments, an approach is adopted where delay is considered an additional burden: the fastest PDS is burdened only by its actual cost to the owner while others bear the actual costs and additional traffic costs for the extra duration of the delivery compared to the fastest PDS.

This method is necessary to emphasise the road availability for use: when PC is calculated by discounting future project costs to the present, the later the cost is incurred, the smaller its PC. Thus, when two PDSs have identical cost structures, the one with the slower construction process would have the lower PC and be considered better choice based on the cost to the owner alone. Yet, it may not be more cost efficient from the society's viewpoint, since the investment turns profitable on the basis of road availability.

Owing to the inclusion of extra traffic costs into the examination (in Analysis 2), it is not reasonable to compare the PDSs based on an identical use period, but rather based on a fixed period from the beginning of procurement.

### *3.5 Methodological summary*

As a result of the above, especially considering the manifold characteristics of DBFO, different approaches are applied to different project costs in the calculation model (Table I, Figure 1):

- All internal costs of the owner (i.e. from administration) are paid in all PDSs by the owner as they occur. These costs are not converted to the value of the cash flow, whose timing is common to all PDSs (virtual service fee), but is rather discounted directly by using the same social time preference used also for all other costs. Additional traffic costs due to delayed commissioning are treated in similar fashion: they are discounted directly.
- External costs to the owner in public-financed PDSs, as well as the client's consultancy and tender awards in DBFO, are compensated to service providers promptly. Therefore, these costs are converted to the value of the cash flow whose timing is determined by the DBFO service fee using the social opportunity cost rate before discounting them with the generally applied social time preference.
- In DBFO, external costs of design and construction are financed by the service provider (or SPV) with debt and equity. Thus, the actual cost of capital is used to transform these costs (plus-related financing fees in DBFO) into a unitary service fee, which includes also maintenance costs. This is then discounted by using the same social time preference used for other cost items.
- The actual cost of capital consists of the required return on equity and the senior debt interest to industry (risk-free rate plus industry margin). The required share of equity is calculated from design and construction costs (plus related fees in DBFO) while the rest is financed by debt. The equity remains in the SPV until the end of the concession and pays an annual yield during the maintenance period. The debt is amortized in the form of annuities during the very same period.

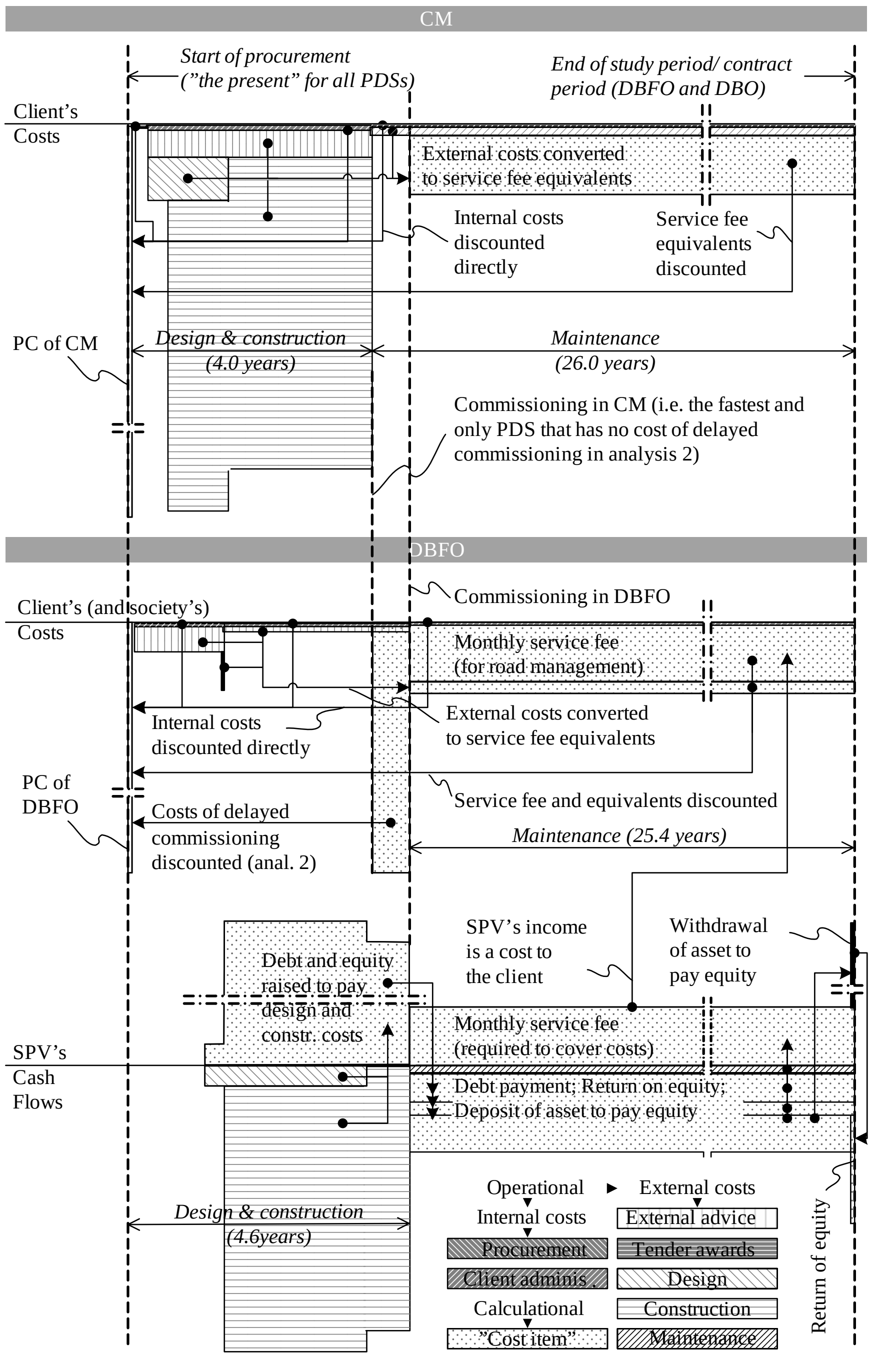



**Figure 1.**
Calculation of financial performance based on operational performance

All costs of all PDSs are supposed to increase annually in accordance with the cost escalation figure. A step-by step introduction to computations is given by Lahdenperä (2008).



## 4. Definition of comparison estimates

### 4.1 Financial estimates

The financial estimates used for the analyses are determined here. They represent the state of the market in the turn of year 2006/2007 before the more recent unstable situation. It is supposed that such values serve the long-term strategic decision making better. The parameters are summarized in Table II:

- *Risk-free rate.* The risk-free rate, while being a conceptual rate, is often defined on the basis of government bonds. At the time of the financial close of the E18 (in autumn 2005), the rate was 3.7 percent (Road Administration, 2006). Soon thereafter corresponding rates were a few decimals below 4.0 percent in Finland (Bank of Finland, 2006) and in order to emphasize the selected Finnish viewpoint, a round 4.0 percent was selected as the basic rate for the analyses.
- *Industry margin.* The private sector has to pay a higher rate of interest than the public sector. This margin in relation to the Euro Interbank Offered Rate has been, according to a survey, 0.25-1.5 percent (Lehtinen, 2005) which has led to the application of 0.5 percent in practical decision making (Kaleva and Leiwo, 2006). As actual margins have been decreasing, the same rate is selected for the analyses and is used for the entire contract period for simplicity. That margin is also supported by the yield spreads of outstanding bonds of the construction industry which have been even lower (Reuters, 2006).
- *Cost escalation.* Average inflation in the Euro Zone has been just above 2 percent while in Finland the annual rate has been around 1 percent (Bank of Finland, 2006). The cost of civil engineering works has risen much faster: the pace was 2-3 percent per year before it accelerated to 5-6 percent (Statistic Finland, 2006). A partial reason is the heated market, and the price level is likely to level off in the future. A round 2.0 percent was selected.
- *Social time preference.* Commonly used discount rates in practical net present cost comparisons in different countries have been 6-8 percent (Shaoul, 2005;

| Parameters | Value for the comparison |
|---|---|
| Risk-free rate (per annum) | 4.0 percent |
| Industry margin (per annum) | 0.5 percent |
| Cost escalation (per annum) | 2.0 percent |
| Social time preference (per annum) | 4.0 percent |
| Social opportunity cost (per annum) | 4.0 percent |
| Share of equity (per annum) | 10.0 percent |
| Return on equity (per annum) | 8.0 percent |
| Fees in DBFO (of raised debt) | 0.5 percent |
| Total study period[a] | 30 years |
| Early commissioning advantage (per month)[b] | €1.0m |

**Notes:** [a]From the start of procurement; [b]considered in analysis 2 only

**Table II.** Summary of estimates used for different analyses

Grimsey and Lewis, 2005). This paper compares pure costs and takes risks and commissioning into account separately, which means that the corresponding components are not relevant as such. Therefore, there is no reason for the social time preference rate to differ from the market price for money, i.e. the risk-free rate of 4.0 percent defined above.

- *Social opportunity cost.* An opportunity cost is the cost of pursuing a certain course of action measured in terms of a foregone return offered by the most attractive alternative investment (Esty, 2004). Considering the fact that the alternative should be equal as to risk, a rate close to the private sector's cost of capital in DBFO might be justifiable. It would factor in the risks related to the project (Grout, 1997; Klein, 1997). Since the risks between public-financed PDSs are different in any case, and there is a debt option available to the public client as well, this study takes a more practical point of view: it uses 4.0 percent (the risk-free rate) as the basic social opportunity cost.
- *Share of equity.* In an investment involving project finance, equity may represent 5 ~ 30 percent of the financing while the rest is debt; the share of equity depends on expected profitability and operating risks as well as the adequacy of the project's security arrangements (Finnerty, 1996; Merna and Njiru, 2002). Despite the variation, practice has shown that the share is typically 10 percent of project financing (NAO, 2006; Manley *et al.*, 2006; Kaleva and Leiwo, 2006) and this share is consequently applied also here.
- *Return on equity.* According to the capital asset pricing model (CAPM), the expected return on a security equals the rate of a risk-free security plus a risk premium (adjusted by case-specific beta). The latter has been estimated to been, on average, 4.0 ~ 4.5 percent in the last few decades (Fama and French, 2001). Since then expectations have been both higher (Welch, 2001) and lower (Graham and Harvey, 2005) while the risk premium applied in Finland has remained around 4.0 percent (Price Waterhouse Coopers, 2005). This results in a 4.0 percent unadjusted risk premium for the study.

  As regards beta, i.e. the CAPM risk factor for the risk premium, the uncertain revenue is usually the main source of market risk (Grout, 1997). This has here been replaced by the contract-based fixed cash flow. Therefore, the usual business betas are not applicable and Leviäkangas (1998), for instance, reports a $\beta$ just above zero. Based on formulas provided by Copeland and Weston (1988), for instance, this low figure increases nine-fold with a high debt-equity ratio. Therefore, the basic case of this paper is built on a risk premium of 4.0 percent (with levered beta equal to 1), which added to the 4.0 percent risk-free rate results in a required return of 8.0 percent on equity (over the entire contract period).
- *Fees in DBFO.* Consulting fees for lawyers and financial consultants in DBFO are included in the cost of external advice which does not, however, cover the financing fees likely associated with private-financed solutions. These are around 0.5 percent of the debt raised (which here equals the investment costs). No financing fee is included in public-financed solutions although it might well be reasonable if the client finances the project by debt.

*4.2 Other estimates*

A financial analysis requires also defining the concession period. That is done here. The likely savings to society due to early commissioning of the road are also discussed:

- *Total study period.* The study period is 30 years (from the start of procurement) mainly since that is close to the stated economic life cycle of a road (Tervala *et al.*, 1996). In fact, a concession of exactly 30 years seems to be the most common in UK-based private finance initiative (PFI) projects (PartnershipsUK, 2006).
- *Early commissioning advantage.* The completion of the first DBFO road in Finland, motorway VT4 Helsinki-Lahti, was accelerated by a year compared to traditional project delivery. Based on an *ex post* examination the savings in vehicle and driving time costs were €8.4 ~ 9.3m and in accident costs €2.5 ~ 10.9m (Murto *et al.*, 2002). This means €1.0 ~ 1.7m per month in savings from an investment 1.5 times that of the reference project. Considering the size difference and the general inflation thereafter, the monthly cost of delayed commissioning is €1.0m.

## 5. Relative advantageousness

*5.1 Expected performance*

Based on the financial modelling described above, and the estimates presented in Table II, the reference project's PCs for various PDSs were calculated. Table III presents actual costs to the owner and their differences as percentages. Table IV presents the corresponding figures when the late delivery cost to the society is also taken into account in addition to the costs to the owner.

The results of the financial analysis indicate clearly that DBO is the most efficient system in terms of the owner's costs. The private finance of DBFO increases its costs

| Quantity | CM | DBB | DB | DBO | DBFO |
|---|---|---|---|---|---|
| PC (million €) | 67.8 | 66.6 | 60.5 | 53.8 | 59.6 |
| Percentage of difference | Reference | −2 | −11 | −21 | −12 |
| | +2 | Reference | −9 | −19 | −11 |
| | +12 | +10 | Reference | −11 | −2 |
| | +26 | +24 | +12 | Reference | +11 |
| | +14 | +12 | +2 | −10 | Reference |

**Notes:** Analysis 1; w/o late delivery costs to the society

**Table III.** PDSs' actual PCs to the owner

| Quantity | CM | DBB | DB | DBO | DBFO |
|---|---|---|---|---|---|
| PC (million €) | 67.8 | 79.9 | 64.2 | 61.0 | 66.8 |
| Percentage of difference | Reference | +18 | −5 | −10 | −2 |
| | −15 | Reference | −20 | −24 | −16 |
| | +6 | +24 | Reference | −5 | +4 |
| | +11 | +31 | +5 | Reference | +10 |
| | +2 | +20 | −4 | −9 | Reference |

**Notes:** Analysis 2; including late delivery costs to society

**Table IV.** PDSs' comparative PCs to society close to those of DB but not to the levels of DBB and CM, which appear to be operationally the two most inefficient PDSs. All in all, disregarding the financing component, the fewer contracts the client enters into to purchase an entire road management package, the more cost efficient the project becomes.

Consideration of the early commissioning advantage improves the most the standing of CM with respect to the others, but it is likely to match DB and DBO only in cases where the speed of construction is critical. This does not apply to a case based on the above set of estimates but may be of importance in some projects. The advantage makes DBFO lose ground to CM and DB, but moves it even more clearly ahead of DBB.

The analysis of the other reference project data (not presented in the paper) supports the validity of the results. Percentage of differences between these two projects are clearly within a 2 percent margin although their cost structures diverge: external advice (from a management consultant) was not actually sought in the other project. In fact, all but one figure describing relative differences are within a 1 percent margin.

### *5.2 Sensitivity analysis*

Since the financial and other estimates used for the calculations are not exclusive and also likely to change over time and between projects, sensitivity analyses are performed resulting in the graphs of Figures 2 and 3. The basic case of the latter includes the costs of delayed commissioning not included in the former and is likely a more important result than the other one. The point of comparison in all examinations is the performance of DBB in the basic case which represents the 100 percent level of performance in terms of PCs with or without the costs of delayed commissioning.

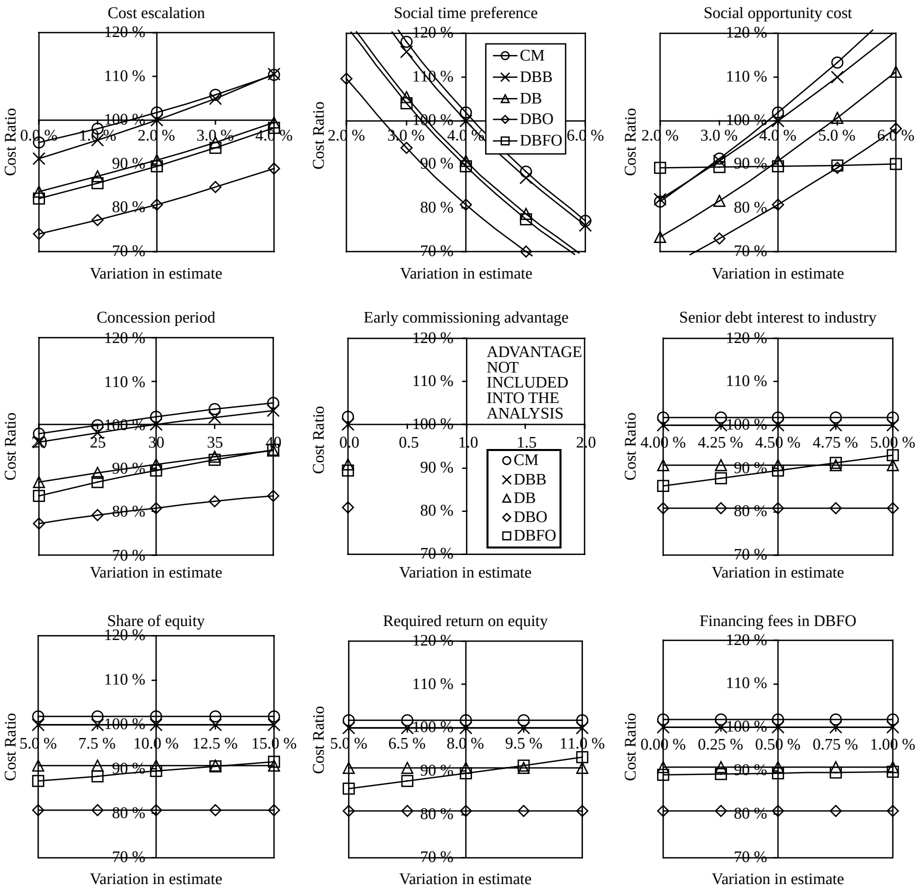
The figures show that changes do not usually affect the ranking order of the public-financed PDSs, DBB, CM, DB and DBO, since any alteration affects them much the same. Still, especially the lines representing CM and DBB, are not completely parallel when variations occur in cost escalation and social opportunity cost due to differences in speed of construction. DBFO is affected differently than the other PDSs by most variations in the estimates. This is obvious due to the different financial arrangement. Increases in senior debt interest to industry, share of equity, required return on equity, and concession period are detrimental to DBFO's competitiveness. Social time preference, again, has no effect, since the cash flows were made comparable. Social opportunity cost, which is related to the valuation of risk in public-financed PDSs, seems critical.

It has to be noted, however, that in most cases the change is not as dramatic in practice as it appears in the figures. Many interest rates dealt with as independent factors here are actually derivatives from the market rate and, thus, change in parallel. This weakens the sensitivity of PDSs' relative advantageousness compared to the situation in Figures 2 and 3. Also, the share of equity, return on equity and senior debt interest to industry rate are interrelated, and tend to, at least partially, minimize the sensitivity to any changes.

## 6. Discussion

### *6.1 Current validity of the results*

As usual, the results are not beyond dispute. The operational performance data were based on the earlier study by Koppinen and Lahdenperä (2007) concluding that the congruence between the numerous respondents and other studies supports their




**Note:** Analysis 1

**Figure 2.**
Sensitivity analysis of actual PCs to the owner

validity. The used study paradigm involving qualitative features is recognized as imperfect, but it was found to be the only way by which a wide variety of experiences could be included in the study to improve its generalizability. The operational performance of CM was based on limited data from Finland since it is seldom used in road construction.

From the viewpoint of this analysis, one issue still needs examination: operational performance was defined as a common basis for both DBO and DBFO. According to the interviewees, more external advice is required in DBFO while in DBO the owner's administrative burden is slightly heavier. More scope changes also tend to occur in DBO. These differences are easily accepted as a result of motivational and structural differences between the PDSs while, on the basis of the survey, it is likely that those differences largely offset each other on the overall level.

Financial modelling and estimates are of major interest here. The model was constructed on the basis of a real-life solution with some adjustments and simplifications. For instance, the cost of collateral increases the costs of

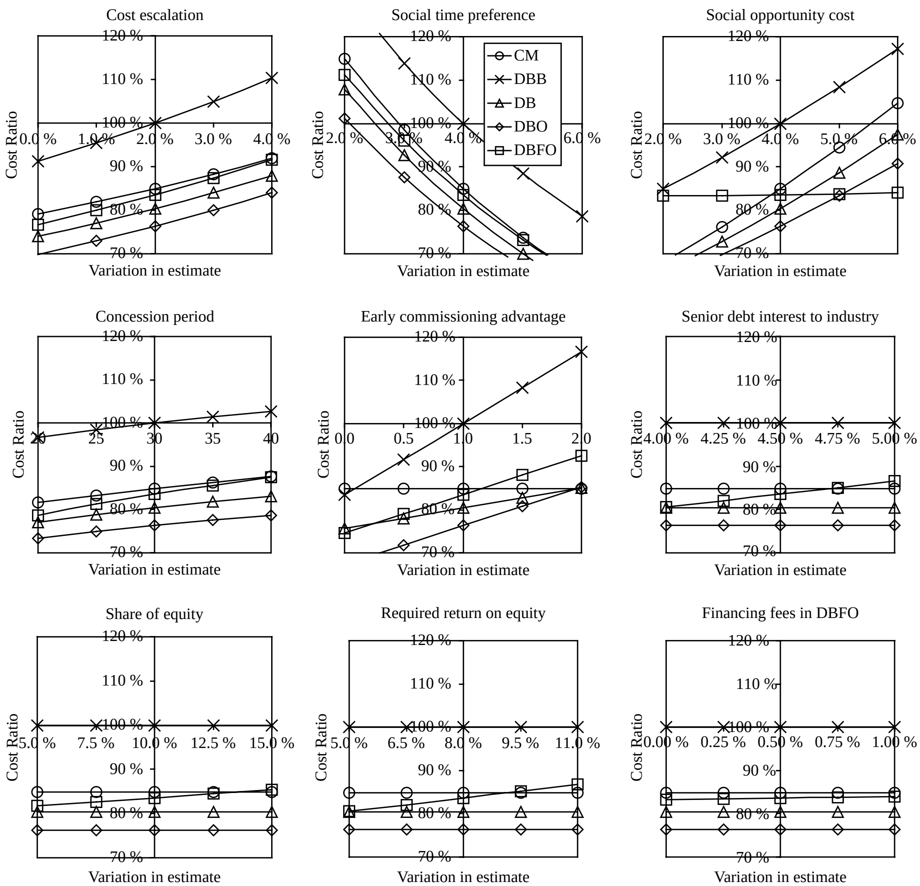



**Figure 3.**
Sensitivity analysis of comparative PCs to society

**Note:** Analysis 2

public-financed PDSs to some degree but was excluded from the calculations. Furthermore, the cost of capital of a private-financed option constitutes a profit to the investor and, therefore, returns partially to the public sector through taxation. These characteristics might even make DBFO relatively more advantageous than found in this study, unless offset by the possibly slightly higher than estimated construction phase financing costs of DBFO due to higher than suggested risk premiums. With special arrangements (e.g. credit guarantee finance, de-risking) the owners are, however, searching for lower financing costs in DBFO (HM Treasury, 2006; Kerr, 2006; Bliss, 2007) and therefore, a moderate return on equity rate used seems appropriate.

The results describe the situation in a relatively large project with no strict constraints. Such a project is supposed to create economies of scale, entice financiers and offer the leeway needed for design development. Thus, it makes sense to incorporate maintenance and finance into the construction contract. If the above conditions do not apply, less comprehensive PDSs like DB, DBB and CM may well be preferred depending on the project.

*6.2 Anticipated future validity of the result*
The value of financial analysis of this kind is largely based on its ability to serve decision making on the future use of different PDSs. As to operational performance, the interviewees considered DB, and especially DB(F)O, to have substantially more development potential than the less comprehensive DBB and CM. On the other hand, the tradition of the governments' budget-based annual authorization may have affected the interviewees' estimates on DBB (and CM) in some cases, although comparable figures on all PDSs were asked for.

Other studies have also shown that especially DBFO still lacks the organizational structures and incentives required for optimal performance (Rintala, 2004; Eaton *et al.*, 2006) while HM Treasury (2006) has recognized a number of ongoing developments in the provision of private finance to support DBFO's competitiveness. Therefore, there is no reason to suppose that DBFO's cost competitiveness would become weaker than suggested above.

## 7. Conclusions
This paper compared the cost efficiency of DBB, CM-at-fee, DB, DBO and DBFO in road management based on an international data capture that revealed the operational performances of the PDSs. The financial analysis was executed to define the PDSs' PC to the road authority (i.e. the financial performance). As a public body, the road authority is, however, obliged to work for the best of the nation and, therefore, another analysis was performed where differences in speed of delivery and corresponding cost consequences to the society were also taken into consideration.

The financial analysis of the costs to the owner revealed that, apart from the evenly matched DBB and CM, the broader the scope of services supplied by one contract in the case of public-financed systems (DBB, CM, DB and DBO), the more cost efficient the PDS. As to CM, DB and DBO, this rule applies even if the early commissioning advantage is included in the analysis, but the differences between the PDSs become smaller or even marginal, if these benefits become very large. Consideration of the early commissioning advantage puts DBB clearly in the last place. The variation in the financial estimates has no influence on the ranking of public-financed PDSs in practice.

DBFO's competitive position is not absolutely clear, but it seems to be in the middle category with DB on the basis of the owner's PCs of a 30 year contract. Consideration of the early commissioning advantage, however, makes CM (that enables the fastest commissioning) nearly equal or in some cases even better than DBFO, which, on the other hand, increases its superiority over DBB. It must be remembered though that the scheme is, in general, sensitive to project properties and constraints, and fluctuations in the financial and construction markets.

In fact, as numerous variables are handled in the study, the results from the applied deterministic single-valued examination based on most likely estimates may not best serve the decision maker in manifold decision situations. Thus, a probabilistic approach, which exploits simulation as a means to take into account the likely variation in estimates, is recognised as a potential enhancement in future research. The consideration of the different costs of financing in the construction and operation phase would also improve the accuracy of the results. Correspondingly, the presumption of a pure flow-through SPV may be daring in some cases.

The study focuses on comparative costs while only touching on economic efficiency which also covers differences in risk-transfer and value generation. It seems obvious, however, that the relative ranking order of public-financed options remains the same based on economic efficiency criteria since the PDSs' risk-transfer and value generation ability correspond to their cost efficiency. DBFO, again, seems to be a challenger in terms of costs, but its superior risk transfer and good value generation ability balance the situation based on economic efficiency criteria.

All in all, in light of the study, it is obvious that road owners should increasingly select DBO or maybe DBFO procurement for their major green-field projects. The profitable use of the latter may, however, require consideration of a special joint financing arrangement, which decreases the financing costs without actually affecting the risks transferred to the private service providers. Thus, in addition to project properties, the results are also sensitive to the situation in the financial market and the arrangement entered into.

## References


AECOM Consult (2006), *Design-Build Effectiveness Study*, US Department of Transportation, Federal Highway Administration, Washington, DC.

Alhazmi, T. and McCaffer, R. (2000), "Project procurement system selection model", *Journal of Construction Engineering and Management*, Vol. 126 No. 3, pp. 176-84.

Bank of Finland (2006), "Economic outlook", *Bank of Finland Bulletin*, Vol. 80 No. 3.

Bliss, N. (2007), "Basel II: capital management strategies for project finance loans", *Freshfields Bruckhaus Deringer Briefing*, February.

Committee of Public Accounts (2003), "Delivering better value for money from the private finance initiative", *Twenty-eighth Report of Session 2002-03*, House of Commons, London.

Construction Industry Council (2000), *The Role of Cost Saving and Innovation in PFI Projects*, Thomas Telford, London.

Copeland, T.E. and Weston, J.F. (1988), *Financial Theory and Corporate Policy*, 3rd ed., Addison-Wesley, Reading, MA.

Eaton, D., Akbiyikli, R. and Dickinson, M. (2006), "An evaluation of the stimulants and impediments to innovation within PFI/PPP projects", *Construction Innovation*, Vol. 6 No. 2, pp. 63-77.

Ernzen, J., Williams, R. and Brisk, D. (2004), "Design-build vs. design-bid-build: comparing cost and schedule", paper presented at Annual Meeting, Transportation Research Board, Washington, DC.

Esty, B. (2004), *Glossary of Project Finance Terms and Acronyms*, Harvard Business School Publishing, Boston, MA.

Fama, E. and French, K. (2001), "The equity premium", Working Paper No. 522, The Center for Research in Security Prices, University of Chicago, Chicago, IL.

Finnerty, J. (1996), *Project Financing. Asset-based Financial Engineering*, Wiley, New York, NY.

Finnish Government (2006a), *Finnish Companies Act 2006/624*, Edita, Helsinki.

Finnish Government (2006b), *Law on Taxation of Business Income 360/1968*, Edita, Helsinki (in Finnish).

Finnish Government (2006c), *Value Added Tax Law 1501/1993*, Edita, Helsinki (in Finnish).

Graham, J. and Harvey, C. (2005), "The long-run equity risk premium", *Finance Research Letters*, Vol. 2, pp. 185-94.

Grimsey, D. and Lewis, M. (2005), "Are public private partnerships value for money? Evaluating alternative approaches and comparing academic and practitioners views", *Accounting Forum*, Vol. 29, pp. 345-78.

Grout, P. (1997), "The economics of the private finance initiative", *Oxford Review of Economic Policy*, Vol. 13 No. 4, pp. 53-66.

Hall, M., Holt, R. and Graves, A. (2000), "Private finance, public roads: configuring the supply chain in PFI highway construction", *European Journal of Purchasing & Supply Management*, Vol. 6, pp. 227-35.

HM Treasury (2006), *PFI: Strengthening Long-term Partnership*, HM Treasury, London.

Kaleva, H. and Leiwo, K. (2006), *Economic Evaluation Principles and Analyses for Life Cycle Models*, KTI Property Information, Helsinki (in Finnish).

Kerr, M. (2006), "Building flexibility. New delivery models for public infrastructure projects", *Mondaq Business Briefing*, March 14.

Klein, M. (1997), "The risk premium for evaluating public projects", *Oxford Review of Economic Policy*, Vol. 13 No. 4, pp. 29-42.

Koppinen, T. and Lahdenperä, P. (2004a), "Road sector experiences on project delivery methods", *VTT Research Notes 2260*, VTT, Espoo.

Koppinen, T. and Lahdenperä, P. (2004b), "The current and future performance of road project delivery methods", *VTT Publications 549*, VTT, Espoo.

Koppinen, T. and Lahdenperä, P. (2007), "Realized economic efficiency of road project delivery systems", *Journal of Infrastructure Systems*, Vol. 13 No. 4, pp. 321-9.

Lahdenperä, P. (2008), "Financial analysis of project delivery systems. Road projects' operational performance data revisited", *VTT Research Notes 2445*, VTT, Espoo.

Lehtinen, M. (Ed.) (2005), *Public-private Partnerships in Provision of Office and Infrastructure Services*, Efeko, Helsinki (in Finnish).

Leviäkangas, P. (1998), "Determination of the market value of a privately financed infrastructure project – case of Järvenpää-Lahti motorway", *Symposium on Road Financing, Paris, World Bank, Washington, DC*, 4-6 November, pp. 323-32.

MacDonald, M. (2002), *Review of Large Public Procurement in the UK*, HM Treasury, London.

Mahdi, I. and Alreshaid, K. (2005), "Decision support system for selecting the proper project delivery method using analytical hierarchy process (AHP)", *International Journal of Project Management*, Vol. 23 No. 7, pp. 564-72.

Manley, J., Plantagie, J.W., Wilkins, M., Calder, P.B. and Flynn, B. (2006), "Evolution not revolution: rating the PPP sector 10 years on", *Infrastructure Finance Ratings: Public Private Partnerships Global Credit Survey 2006*, Standard & Poor's, London, pp. 14-18.

Merna, T. and Njiru, C. (2002), *Financing Infrastructure Projects*, Thomas Telford, London.

Molenaar, K., Songer, A. and Barash, M. (1999), "Public sector design/build evolution and performance", *Journal of Management in Engineering*, Vol. 15 No. 2, pp. 54-62.

Murto, R., Meriläinen, A., Tervonen, J. and Kiuru, J. (2002), "Motorway VT4 Helsinki-Lahti, post-evaluation of societal impacts", *Finnra Reports 51/2002*, Finnish Road Administration, Helsinki (in Finnish).

NAO (1998), *The Private Finance Initiative: The First Four Design, Build, Finance and Operate Roads Contracts*, National Audit Office, London.

NAO (2006), *Update on PFI Debt Refinancing and the PFI Equity Market*, National Audit Office, London.

National Treasury (2001), *Project Finance, Introductory Manual on Project Finance for Managers of PPP Projects*, National Treasury, Pretoria.

Oyentunji, A. and Anderson, S. (2006), "Relative effectiveness of project delivery and contract strategies", *Journal of Construction Engineering and Management*, Vol. 132 No. 1, pp. 3-13.

PartnershipsUK (2006), "Projects database", available at: www.partnershipsuk.org.uk (accessed December 13, 2006).

Price Waterhouse Coopers (2005), *Risk Premium in the Finnish Stock Market*, Price Waterhouse Coopers, Helsinki (in Finnish).

Reuters (2006), *Reuters Bond Details*, Reuters, London, (electronic service).

Rintala, K. (2004), "The economic efficiency of accommodation service PFI projects", *VTT Publications 555*, VTT, Espoo.

Road Administration (2003), *Procurement Strategy of the Finnish Road Administration (Finnra)*, Edita, Helsinki.

Road Administration (2006), "Cost comparison of E18 Muurla-Lohja life cycle project, January 21, 2006" (in Finnish), available at: www.tiehallinto.fi/ (accessed December 13, 2006).

Salmela, V., Saltevo, A., Tolvanen, R., Kuorikoski, P. and Numminen, P. (2003), "VT4 Helsinki-Lahti motorway, intermediate evaluation", *Finnra Internal Publications 9/2003*, Finnish Road Administration, Helsinki (in Finnish).

Shaoul, J. (2005), "A critical financial analysis of the private finance initiative: selecting a financial method or allocating economic wealth?", *Critical Perspectives on Accounting*, Vol. 16 No. 4, pp. 441-71.

Snell, M. (2002), *Cost-benefit Analysis for Engineers and Planners*, Thomas Telford, London.

Statistic Finland (2006), *Cost Index of Civil Engineering Works*, Statistic Finland, Helsinki.

Tervala, J., Raitanen, N. and Pelttari, R. (1996), "Introduction of private finance for roads in Finland, application of the shadow toll option on Main Road 4", *Publications L23/96*, Ministry of Transport and Communications Finland, Helsinki.

Welch, I. (2001), "The equity premium consensus revisited", *Cowles Foundation Discussion Paper No. 1325*, Cowles Foundation for Research in Economics at Yale University, Yale University, New Haven, CT.

**Corresponding author**
Pertti Lahdenperä can be contacted at: pertti.lahdenpera@vtt.fi