Aalto University
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EFFECT OF PROJECT FINANCE ON PUBLIC INFRASTRUCTURE PROJECT APPRAISAL

Case study: Hailuoto Causeway

Master's Thesis
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Abstract

Public investment project appraisal is based on cost-benefit analysis of both the social and economic costs and benefits of a project. By taking into account both the social and economic effects, government agencies in charge of investing public funds aim to reach the socio-economically most advantageous end result.

Cost-benefit analysis compares projects based on the present values of their direct socio-economic costs and benefits but does not include evaluation of potential project finance arrangements. Project costs are implicitly assumed to be paid when the asset is ready for use, while the benefits produced by the project are received over a long forecast period. Including an evaluation of available financing arrangements can provide valuable additional information to public decision makers for allocating scarce public funds.

The aim of this study was to complement the information provided by cost-benefit analysis by examining two research questions: (1) "Effect of Project Finance on the Socio-economic Profitability of the Hailuoto Causeway project" and (2) "Expediting Project Start with off-budget Financing".

The research was carried out as a quantitative case study, using data about the socio-economic benefits and costs of the Hailuoto Causeway project estimated for the official project appraisal report. Three financial models were built to simulate (1) direct budget financing of the project as well as (2) debt financing via a public project company and (3) procurement of the project via a comprehensive service agreement, with the project financed and built by a private service provider. The effect of expedited project start was examined by testing delayed budget-financed project timelines against a PPP service agreement starting on time.

The results indicate that a long-term, debt-funded project finance arrangement can substantially improve the socio-economic profitability of a project when evaluated based on present values. The most significant factors affecting the effectiveness of project financing arrangements are the cost of debt financing, the societal discount rate used, length of the project's investment period as well as potential efficiency advantages of the private service provider in the PPP model. Private financing can be employed to finance projects outside public investment budgets. The results from the case study indicate that a budget constraint would need to delay the project by two to four years for a private financing arrangement to be socio-economically preferable over budget financing.

Based on the results different project characteristics call for different financing arrangements. Thus, an evaluation of available project financing arrangements should be considered to complement the cost-benefit analysis of a project.

Keywords Cost-benefit Analysis, Project Finance, Public Infrastructure

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Julkisten infrastruktuurihankkeiden arviointi perustuu hankkeen yhteiskunnalliset ja taloudelliset hyödyt ja kustannukset huomioivaan hyöty-kustannusanalyysiin. Huomioimalla sekä yhteiskunnalliset että taloudelliset vaikutukset julkisen sektorin investointipäätöksistä vastaavat päätöksentekijät pyrkivät yhteiskuntataloudellisesti parhaaseen lopputulokseen.

Hyöty-kustannusanalyysissä hankkeita verrataan niiden suorien yhteiskuntataloudellisten hyötyjen ja kustannusten nykyarvojen perusteella. Hankkeessa mahdollisesti hyödynnettävien projektirahoitusmallien arviointi ei kuitenkaan sisälly hyöty-kustannusanalyysiin. Hankkeen kustannusten oletetaan epäsuorasti tulevan maksettavaksi hankkeen valmistuessa, kun taas hankkeen tuottamat hyödyt saadaan vasta pitkän ennustejakson aikana. Käytettävissä olevien rahoitusjärjestelyjen arvioinnin sisällyttäminen hankearvioinnin yhteyteen voi tuoda arvokasta lisätietoa päätöksentekijöille ja tukea näin rajallisten julkisten resurssien mahdollisimman tehokasta käyttöä.

Tämän tutkimuksen tavoitteena oli täydentää hyöty-kustannusanalyysin tuottamaa tietoa tarkastelemalla kahta tutkimuskysymystä: (1) ”Projektirahoituksen vaikutus Hailuodon kiinteä yhteys -hankkeen yhteiskuntataloudelliseen kannattavuuteen” ja (2) ”Hankkeen aikaistaminen budjetin ulkopuolisella rahoituksella”. Tutkimus suoritettiin kvantitatiivisena tapaustutkimuksena hyödyntäen Hailuodon kiinteä yhteys -hankkeen virallista hankearviointia varten tuotettua ennustetietoa hankkeen yhteiskuntataloudellisista hyödyistä ja kustannuksista. Tutkimuksessa tuotettiin kolme taloudellista mallia, joilla simuloitiin (1) hankkeen suoraa budjettirahoitusta sekä (2) velkarahoitusta julkisen hankeyhtiön kautta ja (3) hankkeen hankintaa yksityiseltä palveluntuottajalta kokonaispalvelusopimuksena, missä yksityinen palveluntuottaja rahoittaa ja rakentaa hankkeen (PPP-malli). Hankkeen aikaistamisen vaikutusta tutkittiin vertaamalla viivästynyttä budjettirahoitettavaa hanketta ja suunnitellussa aikataulussa aloitettavaa PPP-hanketta.

Tulokset osoittavat, että pitkäaikainen projektirahoitusjärjestely voi parantaa hankkeen nykyarvoista yhteiskuntataloudellista kannattavuutta huomattavasti. Merkittävimmät projektirahoitusjärjestelyjen tehokkuuteen vaikuttavat tekijät ovat vieraan pääoman kustannus, yhteiskunnallinen diskonttokorko, hankkeen investointijakson pituus sekä PPP-mallissa yksityisen palveluntuottajan mahdollinen tehokkuusetu. Yksityisrahoitusta voidaan käyttää hankkeiden rahoittamiseen julkisten investointibudjettien ulkopuolella. Tapaustutkimuksen tulokset osoittavat, että budjettirajoitteen tulisi viivästyttää hanketta kahdesta neljään vuotta, jotta yksityisrahoitusjärjestely olisi yhteiskuntataloudellisesti kannattavampi vaihtoehto kuin budjettirahoitus.

Tutkimustulosten perusteella ominaisuuksiltaan erilaiset hankkeet vaativat erilaisia rahoitusjärjestelyjä. Tästä johtuen hankkeen hyöty-kustannusanalyysiä tulisi harkita täydennettäväksi mahdollisten projektirahoitusjärjestelyjen arvioinnilla.

Avainsanat Hyöty-kustannusanalyysi, Projektirahoitus, Julkinen infrastruktuuri

Preface and acknowledgements

This Master's thesis examines topics infrequently covered by academic research; public infrastructure investments, socio-economic cost-benefit analysis and project finance. As a soon-to-graduate finance student that has already made the transition to working life, I wanted to use this opportunity to familiarize myself, and the readers of this thesis, further with the academic theory and practical implications of subjects that for most people happen in the background but regardless affect each of our lives. Decisions about public infrastructure investments affect everyone each time they travel using public roads, enter a public hospital or attend a public education facility.

Gathering information for this study required combining academic research from several countries with reports produced by multinational co-operation bodies, Finnish government agencies and Finnish parliamentary committees. I would like to acknowledge the following specialists for their invaluable help in expanding my understanding of the subjects of this thesis, asking the right questions and just generally keeping me in the right path.

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Marjo Paavola, Pre-planning Specialist at North Ostrobothnia Centre for Economic Development, Transport and the Environment and Antti Soisalo, Project Manager of Destia for providing me with the background material of the Hailuoto Causeway project appraisal report.

Finally, my colleagues at CAPEX Advisors for their help in choosing the topic, sharing their extensive experience in project finance and making sure I had enough time to work on this thesis.

All discussion and conclusions included in this thesis are products of the author and should not be taken to represent views and opinions of the specialists named above, or the institutions they represent, unless explicitly referred to in the text.

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1. Introduction

Cost-benefit analysis of public infrastructure investment opportunities is performed based on estimated costs and forecast socio-economic benefits of an investment project over a long appraisal period. Socio-economic benefits include both direct financial benefits as well as social benefits that result directly from realization of the project. Costs included in the analysis consist of the direct costs associated with building and financing the infrastructure asset. Effects of potential project finance arrangements, however, are outside the scope of the analysis. Evaluating potential financing arrangements already in the project appraisal phase can provide valuable additional information to public decision makers as they allocate scarce public funds to projects. This study examines the effects of three different financing arrangements on the result of a cost-benefit analysis of a real Finnish public infrastructure project.

As a case study, I use the socio-economic costs and benefits estimated for the cost-benefit analysis of the Hailuoto Causeway, a project by the Finnish Transport Infrastructure Agency to build a fixed land connection between Finland's third largest island, Hailuoto, and mainland Oulu in North Ostrobothnia. I build models for three financing arrangements to study how they affect the results of the cost-benefit analysis. The first model, referred to as the Direct Budget Financing model, represents a theoretical base case without financing arrangements, with investment costs paid from the public budget as they are incurred. The direct budget financing model used in this study is not intended to represent the actual practice of how budget financing is applied, rather it serves as a base case for comparison against project finance models where costs are deferred until the project's operating period. Building on that base case model, I build two further models to simulate project finance arrangements that have previously been applied in the Finnish setting: the Project Company model and the PPP (Public Private Partnership) model. In the Project Company model, a project company owned and managed by a government agency is set up to manage the project and, using low-cost debt secured on the sovereign credit rating, finances it during construction and then amortizes the debt with interest over the project's 30-year appraisal period. In the PPP model the project is contracted out to a private service provider as a comprehensive service agreement. The basic structure of the PPP model is similar to that of the Project Company model; the Service Provider (a privately owned and operated project company) uses a highly levered capital structure to finance the project during construction and then amortizes the debt with interest during the project's 30-year

appraisal period. In addition, the PPP model includes three cost factors not included in the public sector-driven Project Company model. First, the Service Provider in the private sector-managed PPP model uses a small proportion of equity financing and compensates its investors with a return appropriate for an unlisted infrastructure investment. Second, the Service Provider incurs management overhead costs not included in the public Project Company, and third, the public sector incurs additional transaction costs due to the longer and more complex procurement process for PPP projects compared to projects paid for directly from the public budget.

Considering the additional cost elements associated with private financing, using the PPP model instead of the public sector driven models would make no sense without compensating benefits. Benefits associated with the PPP model include potential efficiency advantages resulting from private sector's more agile design processes, incentives to lower costs and the ability to transfer project risks away from the public sector. Further, PPP arrangements may enable financing outside public investment budgets, allowing for augmentation of public financing and enabling projects to take place earlier than budget financing would allow.

The research questions examined by this study are the following: (1) the effect of project finance on the socio-economic profitability of the Hailuoto Causeway project and (2) the effect of expediting project start with off-budget financing.

If the cost of financing is lower than the discount rate, a project finance arrangement should improve the present-value benefit-to-cost ratios, economic net present values and economic rates of return of investment projects purely due to the time value of money. I perform sensitivity analysis with regards to several factors that can be expected to impact the advantageousness of project finance; the societal discount rate, the interest rate, length of the project's investment period, the cost of private equity financing and the private sector efficiency advantage.

If a socio-economically profitable project does not fit into the public investment budget, there are two main options; delay the project until sufficient budget is available or use private financing to augment the public budget. I measure the opportunity cost of project delay in the direct budget financing model against the higher financing costs of the PPP model to find the length of delay needed to make private financing the preferable option. Further, I examine three scenarios with altered PPP model parameters to test for changes.

The core data for this study comes from the official Hailuoto Causeway Road Plan commissioned by North Ostrobothnia Centre for Economic Development, Transport and the Environment. Using the present values of the socio-economic costs and benefits reported in the cost-benefit analysis section of the road plan, I build a model to replicate the annual costs and benefits of the project. To build the two project finance models described above, I gather long-term interest rate data from public databases as well as data regarding infrastructure investment equity returns and the historical performance of PPP projects from academic literature. This data is complemented by insights received from discussions with professionals familiar with public infrastructure investments and Finnish PPP projects.

In the following chapter I provide a view into concepts relevant for this study. First, socio-economic cost-benefit analysis; the theoretical basis, general framework set by the European Commission for European Union Member States and the project appraisal practices of the Finnish Transport Infrastructure Agency, the agency responsible for executing transport infrastructure investments in Finland. Second, a brief look at the general characteristics of public infrastructure investments. Third, an overview of potential sources of financing for these investments. Sources of financing are divided into public budgets and private capital. I present information about the public budgeting process, sources of funds for budgets and the public project company model as it applies to this study. About private capital, I present a brief history of private financing, how it is applied to public investments, and the benefits and drawbacks compared to public budget financing. Fourth, I provide a look at the societal discount rate; a combination of uncertainty and time preferences used to discount the value of future generations' welfare into the present. As the fifth and final concept, I examine private equity investors' return requirements for public infrastructure investments; the current cost of equity and the factors that affect it.

2. Literature Review: Relevant Concepts

2.1. Cost-benefit Analysis

Cost-benefit analysis is, in its broadest definition, an analytical method of comparing the expected costs and benefits of different available investment opportunities. Methods falling under the general term are used by both private companies and public decision makers. This study focuses exclusively on the analyses of the public sector. In their 1978 seminal work, Robert Sugden and Alan Williams define cost-benefit analysis as a systematic method of project appraisal based on broad, social objectives taking into account all members of the public, irrespective of who is affected and of whether or not the effect is captured in a financial account (Sugden & Williams, 1978). Approached from such a perspective, cost-benefit analysis is a highly useful tool in evaluating public investment projects, as the nature of public decision-making differs materially from the return-driven investment decisions of private companies – public authorities invest money gathered from the public as taxes towards providing vital services to the society, with the goals of providing a platform for the society to function on and improving the overall welfare of that society.

Socio-economic cost-benefit analysis of a project requires the identification of all effects of the project, both benefits and costs, on the individual welfare of all members of the public affected by the project, and the measurement of those effects in a common unit, most often money (Sugden & Williams, 1978). In practice it is not possible to identify all effects a project will have over its lifetime and, as will be mentioned in the following section, in order to avoid double-counting it has become common practice to only include effects that are considered to result directly from the project, while indirect and wider effects are disregarded. According to the Guide to Cost-Benefit Analysis of Investment Projects issued by the European Commission, measuring these effects in monetary terms is achieved by calculating shadow prices for the costs and measuring the public's willingness-to-pay for the benefits. Shadow prices are theoretical values used to estimate the social opportunity cost of goods and services consumed as inputs to the project. They are used instead of market prices to avoid possible distortions due to market inefficiencies, for example government subsidies, monopoly mark-ups, tariffs, or unavailability of market prices. Project users' marginal willingness-to-pay measures the maximum amount consumers are willing to pay for a unit of a good or a service produced by the project, thus estimating the value of the outputs of the project to the society. (Sartori et al. 2014). When it comes to transport projects, especially when no road tolls are

applied (as is the case in Finland), proxies are needed to estimate public benefits such as travel time savings. For example, the International Transport Forum and the Finnish Transport Infrastructure Agency estimate travel time savings based on a combination of travel time saving and travel time reliability gain over the current situation resulting from the project, and the hourly value of travel time and the hourly value of travel time reliability (Veryard, 2016 and Ristikartano, Iikkanen & Mukula, 2013).

According to Sugden and Williams, a cost-benefit analysis begins with a problem, with a scope focused enough to provide a clear direction for the analysis but wide enough not to impose a pre-selected end result. Alternative solutions to the problem should be identified in the first stages of the analysis and some of the most promising alternatives should be compared in the cost-benefit analysis (Sugden & Williams, 1978); the Finnish Transport Infrastructure Agency typically compares three alternatives, of which one must be a "light project alternative" (0++), in which the project would be completed on a smaller scale. Other alternatives generally include a "scaled-down present state" (0-), where the current transport service is either closed or scaled down, a "present state" (0), where only routine maintenance and investments aimed at maintaining the current infrastructure are performed, and an "improved present state" (0+), where, in addition to "present state", investments aimed at maintaining the current service level for e.g. increased amount of users are made. These investments must be small compared to the project (Metsäranta & Laakso, 2011).

When all the costs and benefits of the project being appraised, both economic and social and affecting both direct participants and the wider society, have been identified and tallied up, the project should be undertaken if the gainers from the project could, in theory, compensate the losers while still retaining a net gain (Sugden & Williams, 1978).

2.1.1. Cost-benefit analysis framework based on European Union guidelines

The Guide to Cost-Benefit Analysis of Investment Projects (Sartori et al. 2014) published by the European Commission's Directorate-General for Regional and Urban Policy sets a framework that the Member States follow in defining their own project appraisal procedures. The latest version of the guidelines was published in 2014. European Union Member States seeking EU funding for their projects shall deliver an evaluation of their projects to the EU competent authority based on these guidelines. This subchapter provides an overview of the framework set by European Commission's guide.

The analytical framework of the cost-benefit analysis is built on the following five concepts:

1. Opportunity cost
2. Long-term perspective
3. Calculation of economic performance indicators expressed in monetary terms
4. Microeconomic approach
5. Incremental approach

"The opportunity cost of a good or service is defined as the potential gain from the best alternative forgone, when a choice needs to be made between several mutually exclusive alternatives" (Sartori et al. 2014). Investment decisions taken based on profit motives and price mechanisms may, in the presence of market imperfections, lead to socially undesirable outcomes. The cost-benefit analysis framework aims to value the input, output, and external effects of an investment project at their social opportunity costs in order to properly capture the return on investment to social welfare.

The cost-benefit analysis framework adopts a long-term perspective, with an analysis period of 10 to 30 years (sometimes even longer) depending on the sector of the project. Adopting a long-term perspective creates the need to set a proper time horizon, forecast future costs and benefits, adopt appropriate discount rates and perform a risk assessment to account for the uncertainty associated with long observation periods.

Cost-benefit analysis is based on a set of predetermined project objectives. These objectives are given monetary values as a part of the analysis, with all positive (benefits) and negative (costs) welfare effects of the project appraised. Economic Net Present Value (ENPV) and Economic Rate of Return (ERR) as the key indicators of profitability used for comparing and ranking competing projects or alternative investments.

The cost-benefit analysis is a microeconomic approach to evaluation of public investments. The impact of an investment project on the society as a whole is assessed via the calculation of economic performance indicators. The expected welfare changes, such as direct employment or external environmental effects realized by the project are reflected in the economic net present value, but indirect (e.g. on secondary markets) and wider effects (e.g. on public funds, employment, regional growth, etc.) should be excluded. Two reasons are given for excluding indirect and wider effects: First, these are usually transformed, redistributed and capitalized forms of direct effects and thus there exists a risk of double counting and second, there is little

practice on how to appraise these effects and thus appraisal would inevitably rely on assumptions, the reliability of which would be difficult to assess. Providing a qualitative description of these expected indirect and wider impacts is encouraged, however, to explain the contribution of the project to European Union regional policy goals.

The incremental approach means that the cost-benefit analysis compares a scenario where the project goes ahead to a counterfactual scenario without the project. This requires that a counterfactual scenario be defined based on what would happen without the project. In cases where the project is an entirely new asset, the counterfactual scenario would be one with no operations. If the project is aimed at improving an existing asset, there are two alternatives for the counterfactual scenario: Business as Usual (BAU) and Do-minimum. Despite the naming convention, Business as Usual is the minimum-effort scenario which should include the costs and revenues/benefits from operating and maintaining the service at a still-operable level. Do-minimum includes small adaptation investments that were programmed to take place regardless of the project. The Do-minimum counterfactual scenario thus includes higher costs and benefits, meaning that the incremental gains of the project are lower than when appraising against the Business as Usual scenario.

After the approach for the counterfactual scenario has been chosen and the associated cash flows defined, projections for cash flows of the proposed project are made, taking into account all the investment, financial and economic costs and benefits resulting from the project.

Finally, the difference between the cash flows in the with-the-project and the counterfactual scenarios is considered for analysis in the cost-benefit analysis. This means that the financial and economic performance indicators are calculated on the incremental cash flows only. (Sartori et al. 2014).

2.1.2. Appraisal practices of the Finnish Transport Infrastructure Agency

The project appraisal methods of the Finnish Transport Infrastructure Agency (FTIA, Väylävirasto) are set out in the 2011 Liikenneväylien hankearvioinnin yleisohje (General Appraisal Guide for Transport Infrastructure Projects) (this author's translation) (Metsäranta & Laakso, 2011) and specifically for roads in the 2013 Tiehankkeiden arviointiohje (Appraisal Guide for Road Projects) (this author's translation) (Ristikartano, Iikkanen & Mukula, 2013). This subchapter will provide an overview of the appraisal practices of the FTIA.

Project appraisal steps set out in the FTIA's General Appraisal Guide for Transport Infrastructure Projects (Metsäranta & Laakso, 2011) are:

1. Description of the Starting Point
2. Description of the Effects
3. Appraisal of the Project
4. Follow-up and post-project appraisal plan
5. Appraisal reporting and documentation

In description of the starting point, the transportation needs, design status, links to the larger transportation network and goals as well as costs related to the project are laid out. Project goals should aim for simplicity (avoiding overlapping traffic networks), wide coverage, accuracy and understandability. The description should also explain how the project connects to the wider transportation network, the role of the project in the traffic infrastructure design of the area and its role in national land use plans.

A comparison of the project to alternative project options, including at minimum the benchmark Business as Usual and/or Do-minimum counterfactual scenario in line with concepts 1. Opportunity Cost and 5. Incremental Approach of the 2014 European Commission Guide to Cost-Benefit Analysis of Investment Projects, as well as other identified options, is done in this step, and the cost estimates for each option are presented. Further, a traffic forecast is provided illustrating the expected trend growth of traffic volume and the impact of the project on demand for transportation.

In description of the effects, the significant effects influencing decision-making are chosen and the criteria, measures, goals and design parameters of those effects are described. In line with concept 2. Long-term perspective of the 2014 European Commission Guide to Cost-Benefit Analysis of Investment Projects, the benefit and cost effects of the project are estimated for the duration of the construction and the following 30 years of operation. Of the chosen project effects, the current status, forecast status in the benchmark scenario, the forecast status in alternative project options as well as the marginal effects of the project options over the benchmark scenario, in line with concept 5. Incremental Approach of the 2014 European Commission Guide to Cost-Benefit Analysis of Investment Projects are presented. The effects are described in quantitative terms whenever possible. If no quantitative information is available, the effects are described qualitatively.

Effects commonly assessed in all transport infrastructure investments include:

- Effects on users (time and monetary effects)
- Effects on producers (route operation costs and freight/ticket revenue)
- Effects on the public economy (network maintenance costs and tax revenue)
- Effects on traffic safety (change in accident risk and accident costs)
- Effects on the environment (impact on emissions, exposure to noise and vibration as well as emission and noise costs)

In the appraisal of the project, the impact of the project is assessed via an impact assessment and a cost-benefit analysis. A feasibility study is carried out where major risks related to the decision to finance the project as well as the progress of the design and administrative processes are assessed. Based on the analyses in these three sections conclusions regarding the socio-economic effectiveness, impact and feasibility of the project are made.

The cost-benefit analysis forms a large part of this step. In the cost-benefit analysis the marginal difference in the value of an effect between the proposed project and the benchmark alternative is included. All effects that can be evaluated in monetary values with established procedures and clear valuation principles can be included in the analysis.

The base year (year 0) of the cost-benefit analysis is the year during which the project is completed and opened to traffic. Investment costs and effects on traffic during construction are taken into account from the beginning of construction to year 0. The effects of commissioning the investment are calculated for the full 30 years that follow commissioning. The present value of the effects is calculated by discounting those effects to year 0. The discount factor used is described in section 2.4.1.

Project benefits are typically cost savings, such as decreases in route operation costs or travel time. Negative effects are additional costs, such as increased maintenance or emission costs. Each benefit and cost item is accounted for only once.

Deductible taxes are not taken into account in the analysis, while non-deductible taxes (such as fuel and value added taxes paid by private persons) are.

Time, accident, emission and noise costs are increased by 1,125% (decreased from 1,5% in 2013) (Ristikartano et al. 2013) annually to account for an increase in the general income level. This adjustment is not done for other costs.

According to the General Appraisal Guide for Transport Infrastructure Projects (Metsäranta & Laakso, 2011) The present values of the benefits and costs in year 0 are determined by the following formula:

$B_p, C_p = \sum_{t=1}^{30} \frac{1}{(1+d)^t} (B_t, C_t)$ (1), where

B_p = Present value of benefits in year 0,

C_p = Present value of costs in year 0,

B_t = Present value of benefits in year *t*,

C_t = Present value of costs in year *t* and

D = Societal discount rate.

During construction investment costs and construction-related nuisances are incurred. The present values of these items in year 0 is determined by the following formula:

$I_p, Cr_p = \sum_{t=-n}^{0} \frac{1}{(1+d)^t} (I_t, Cr_t)$ (2), where

I_p = Present value of investment costs in year 0,

Cr_p = Present value of construction-related nuisances in year 0,

I_t = Present value of investment costs in year *t*,

Cr_t = Present value of construction-related nuisances in year *t* and

D = Societal discount rate

A part of the investment costs and construction-related nuisances can be incurred during years 1 to 30. These may consist of finishing work after opening to traffic and heavy maintenance investments during the appraisal period. These costs are discounted to the base year according to formula (1).

The residual value of the investment is a benefit received in year 30 (end of the appraisal period). The present value in year 0 of residual value is determined by the following formula:

$V_p = \frac{1}{(1+d)^{30}} (V)$ (3), where

V_p = Present value of the residual value of the investment in year 30 and

D = Societal discount rate.

The basic measure of socio-economic profitability is the benefit-to-cost ratio, which is calculated as:

$$\frac{B}{C} = \frac{B_p - C_p - Cr_p + V_p}{I_p} \quad (4)$$

A project is socio-economically profitable if its benefit-to-cost ratio is greater than one.

Sensitivity analysis with regards to the costs and benefits is done by scenario analysis, while the discount rate remains fixed. The sensitivity analysis is performed with regards to all uncertain factors that can have a significant impact on the end result and the choice of examined factors must be justified in the appraisal report. Common factors assessed in a sensitivity analysis are:

- investment cost,
- traffic forecasts,
- assumptions about development of land use and the wider transportation network and
- time savings.

The intervals used in the sensitivity analysis must be justified, e.g. uncertainty reported in the investment cost estimate must be used to define the intervals for investment cost and sources of uncertainty in the traffic forecast may relate to an uncertain population growth forecast, uncertainty in the demand estimation method, or the reliance of transport demand on a single or few parties. This means that the sensitivity intervals may not be defined arbitrarily. (Metsäranta & Laakso, 2011).

2.1.3. Potential additional benefits

The FTIA General Appraisal Guide for Transport Infrastructure Projects (Metsäranta & Laakso, 2011) defines the wider economic benefits of transport infrastructure projects as significant effects that are not included, directly or indirectly, in the direct user benefits. The guide recognizes the following as potential sources for wider economic effects:

- Corporate efficiency benefits in production or use of production inputs resulting from more efficient transport,
- Concentration benefits that flow from increased efficiency due to benefits of scale in production or utilization of accumulation factors (e.g. more efficient land use),

- Changes in companies' relative market shares (increased or decreased competition),
- Expansion or quickening of labor markets,
- Agglomeration effects = impact of changes in other markets (land, property, housing, labor) on the transportation system.

The probability and magnitude of wider economic benefits is greater in large projects that have wide-spread effects on the transportation system or that open traffic bottlenecks. Wider economic benefits should not be included in the cost-benefit analysis, but the degree of inclusion of these wider economic benefits, if any, in the calculation of direct benefits should be assessed. (Metsäranta & Laakso, 2011).

An important and contemporary reason for examining these wider economic benefits outside the established cost-benefit analysis framework is a decision of a parliamentary working group on the funding of infrastructure investments, given in February 2018, to recommend broader use of the "beneficiary pays" principle in infrastructure funding. According to the FTIA's 2019 publication Tie- ja ratahankkeiden kiinteistötaloudelliset vaikutukset ja kunnan rahoitusosuus (Economic Impact of Road and Rail Projects on Real Estate and the Financial Contribution of the Municipality) (this author's translation) (Metsäranta et al. 2019), developing national transport connections benefits municipalities and private property owners in the form of increased land value. While the main principle in the allocation of investment costs is that the government is responsible for road and railway costs and municipalities for street costs, and this is to remain the basis for funding negotiations, in some cases it may be justifiable to differ from the allocation of costs set out in this main principle (Metsäranta et al. 2019). Increases in real estate values mainly benefit landowners, who in turn are subject to government or municipality level taxes. When a municipality is the landowner-beneficiary of infrastructure investments, and the benefits from government-funded infrastructure (paid by all taxpayers) flow disproportionately to a single or few municipalities (benefiting the taxpayers in or around those municipalities), it may be justifiable to require those municipalities to pay a larger share of the infrastructure. This kind of cost allocation model could even enable projects that would not be beneficial from a national point of view.

So far, the beneficiary pays model has been used to collect payments from the cities of Hamina, Espoo and Helsinki as well as the state-owned airport manager Finavia in return for building railways serving these areas especially (Metsäranta et al. 2019). This payment model could potentially be used to fund the two high-speed rail links currently in planning process, Turun

Tunnin Juna between Helsinki and Turku and Suomi-Rata between Helsinki and Tampere. These rail links have widely been called socio-economically unprofitable (for example Kossila & Lehtola, 2019), but at the same time there is a lot of political pressure to build these connections. The municipalities along the new connections could use a part of their new revenue from increased property and municipal taxes as well as sale of land use rights to fund the projects. If the municipalities were unwilling to fund these projects, that could imply that they do not themselves believe in the profitability of these investments – thus, this kind of financing mechanism could result in public funding being more efficiently allocated to profitable projects.

2.2. Public Infrastructure Investments

This subchapter provides an overview of the characteristics of public infrastructure investments and how they are financed with public and private capital.

Public investment projects are often characterized by large size (high capital expenditure), a long gestation process, low direct monetary returns and high social impact (Grimsey & Lewis, 2002). For example, we may consider public hospitals, schools or transportation network. All three are substantial investments, requiring long planning, decision-making, appraisal and design periods as well as large amounts of capital. Once completed, they provide citizens with vital services that are either free at the point of use or heavily subsidized from public budgets. As both the service provider and the payer are typically public sector entities, generating financial returns does not play a role while cost efficiency is important.

These characteristics mean that the social benefits resulting from the project form a large part of the cost-benefit analysis of the public sector. Social benefits are non-financial in nature – such as public welfare, education and travel times – necessitating public funding from tax revenue; for this reason, social infrastructure investments have traditionally been viewed solely as public sector projects. The government does contract out functions such as design and construction work to private parties but has historically acted as both the funder and the financier. This has recently begun to change, however.

2.2.1. Sources of Financing

Financing for public infrastructure investments has traditionally come directly from the public budget. Government agencies receive their funding from the state as budget authorizations and

lack direct access to debt markets; although the government funds budgets partly with sovereign debt, from the agencies' point of view capital structure does not matter – budget funding is budget funding.

The project company model can be used to combine public budget funding with debt financing; a public authority injects equity capital into a project company created to manage a single investment project and commercial debt is used to a high degree to finance the investment.

Private equity capital can be employed via several public-private partnership models. In these models, the private sector finances the delivery of an asset and the public sector pays for use, either by subsidizing a market-based operating model or by funding the operation in full.

2.2.1.1. Public budgets

Public investment budgets and sources of public funds

In Finland, executing public transport infrastructure investments is the responsibility of the Finnish Transport Infrastructure Agency, which receives its funding from the state in form of budget authorizations. These budget authorizations are prepared by the Ministry of Finance based on spending limits set by the government in the General Government Fiscal Plan and annual budgets based on that plan. The General Government Fiscal Plan spans four years, corresponding to the length of a parliamentary election cycle, and its allocation between administrative sectors is revised annually. (Ministry of Transport and Communications, Finnish Transport and Communications Agency, Finnish Transport Infrastructure Agency & Finnish Meteorological Institute, 2019 and Ministry of Finance, 2019a). The state generates its revenue mainly from direct and indirect taxation (over 80% of funding) with the rest coming from other income including profit distributions of state-owned businesses, sales of state assets and public infrastructure user charges. Net borrowing fills for any remaining deficiency. (Ministry of Finance, 2019b).

The budget set for transport infrastructure is split into maintenance investments and separately designated development investments. Maintenance investments include routine maintenance, use (e.g. lighting expenses), repairs, maintenance, replacement and improvement investments, ice breakage, route ferries, traffic management, information and planning. Completely new transport infrastructure investments are made from the development investment budget. (Ministry of Transport and Communications, Finnish Transport and Communications Agency, Finnish Transport Infrastructure Agency & Finnish Meteorological Institute, 2019).

An important matter to note regarding investment budgets is that the budget places a limit on investment expenditure during one budgeting period; while this may sound obvious, it has significance for the choice of financing model. If investment costs are paid directly from the public investment budget, as in the traditional budget financed procurement model, the full cost of the investment must fit into the budget authorization. However, if procuring an infrastructure asset as a comprehensive service agreement, as is the case in public private partnership projects, only the portion of service payments to be made during the budgeting period must fit into the budget authorization (Goebel & Toivonen, 2019). This allows decision makers and the agency to effectively "borrow" funds from future budgeting periods in order to start an investment project earlier than would otherwise be possible. It should be noted, however, that these long-term contracts bind future budgets and thus reduce future governments' authority over budgeting (Ronikonmäki, 2019). Government agencies do not have a free hand in signing these kinds of long-term contracts and a parliament decision to grant budget authorization to a particular project is required in order to commit funds.

So far it has been established that government agencies receive their funding as budget authorizations directly from the state. It follows that from their point of view the capital structure used to fund investments does not play a role. However, the state uses debt to finance the budgets granted to agencies. Budgeted Finnish public expenditure for 2020 totals 57,7 billion euros, with public debt totaling just under double that at 110,5 billion at the end of February 2020 (Ministry of Finance, 2020 and Treasury of Finland, 2020). Further, the State Treasury rolls over (borrows and redeems) 15-20 billion euros of debt annually, around a third of the public budget (Ministry of Finance, 2020). Based on the state's real capital structure, the inclusion of capital structure in a comprehensive economic analysis may be justified.

Public project company model

One way to introduce capital structure into project evaluation is to apply the project company model. In the project company model, a project company is set up by a public authority to deliver a single project. In a model where private equity is not employed, the public authority funds the project company with a small amount of equity, often in the form of apportioned land or existing infrastructure assets. The project company then draws low-cost commercial debt secured on the sovereign credit rating to complete financing for the project (Ministry of Transport and Communications, 2019) and signs contracts with financiers, contractors, etc. as required by the project. Funding for debt service and operation may come from user charges

or government subsidies, in the case of Finnish transport infrastructure the source is typically the latter.

2.2.1.2. Private capital

Background on private financing

According to Grimsey and Lewis (2002), government has been the principal provider of infrastructure, at least outside the U.S., from at least the post-war period until the very end of the twentieth century. During the 1990s governments in developed economies started facing pressures to reduce public debt while simultaneously being called on to improve public services. This combined with other contemporary phenomena such as the rapid development of the financial markets, advanced investment vehicles and market demand for investments with steady return profiles have resulted in private sector finance taking a role in the financing of public infrastructure (Grimsey & Lewis, 2002). As traditional financial markets have become more competitive, investors have been incentivized to enter into new market sectors that require different kinds of expertise and value-added services (PwC, 2019): public private partnerships (PPPs) and other collaborations of private financiers and public procuring authorities.

In Finland, public authorities contract out design, construction, operation and maintenance work of public infrastructure investments to private parties, with few state companies remaining in these industries. However, the funding and financing of state-owned projects has historically come from the state. This chapter explores the relatively recent trend of using private capital to finance public investments. The public private partnership is so far the only private financing model used in Finland, hence most of the literature review will focus on PPPs.

Past

There have been individual concessions granted by public authorities to private parties since at least the 18th century, but widespread use of a procurement model where the public sector pays a private party to provide public services is a rather recent phenomenon. According to Grimsey and Lewis (2002), the first concession was granted to the French Périer brothers in 1782 concerning water distribution; the company built and operated the infrastructure to deliver drinking water to the city of Paris and the city paid the brothers for using the system. A privatized tunnel was discussed almost two centuries later in late 1950s in Hong Kong

(Grimsey & Lewis, 2002), this went ahead later in 1965 as a shared venture between private (80%) and public (20%) ownership (The Cross-Harbour (Holdings), 2005).

Widespread participation of the private sector in public infrastructure provision started in 1980s. According to Grimsey & Lewis (2002), the Commonwealth countries were the first to adopt systematic use of private financing, with Australia public/private sector infrastructure arrangements put in place in 1988 and UK Private Finance Initiative (PFI) schemes introduced in 1992. According to Brealey, Cooper and Habib (1996) the UK PFI schemes were utilized soon after their introduction to build and operate schools, hospitals and prisons. Privatizations and project finance have been the two principal ways of utilizing private capital in the UK model. National telecommunication networks have been widely privately operated, while especially in developing countries private companies have been founded to provide power generation locally (Brealey, Cooper & Habib, 1996).

In Finland private capital has so far only been employed to finance roads. Rail and hospital projects have been planned as PPP projects in the cities of Kokkola and Espoo, respectively, and reached the procurement process, but the Kokkola rail project was cancelled in 2011 and the Espoo hospital project was eventually procured as a design/build project due to the City of Espoo not receiving satisfactory offers for the PPP procurement. (Inframation Deals).

The first Finnish public private partnership (PPP) project was the E4 Helsinki-Lahti Motorway. The deal was closed in 1997, motorway opened to traffic in 1999 and the 15-year service period ended in 2012, with the project company Tieyhtiö Nelostie Oy handing the road over to The Finnish Transport Agency (Liikennevirasto) (now The Finnish Transport Infrastructure Agency (Väylävirasto)) (Yle 1999, 2012). The public private partnership model has since been used in three other motorway projects, E18 Muurla-Lohjanharju (2005), E18 Koskenkylä-Kotka (2011) and E18 Hamina-Vaalimaa (2015).

Present

According to the European Court of Auditors (2018), 1 749 contracts for PPP projects have been closed in the EU since the 1990s, with a total worth of 336 billion euro. In 2016, transport projects accounted for one third of the years' investment, ahead of healthcare and education (European Court of Auditors, 2018). Transport infrastructure is indeed a natural fit for PPP projects especially in countries where road tolls are used, as this toll revenue can be used to cover the state's service payment obligation to the service provider – with revenue-generating

projects the private sector has in some cases assumed demand risk, although this results in the service provider's need to price that risk. As a private company that operates a road has few ways to influence the road users' demand for that road, compensating the service provider for carrying demand risk is seldom efficient use of public funds.

In Finland there have not yet been privately financed public projects in sectors other than transport infrastructure. A law change in 2018 extended to municipalities certain legal exemptions concerning corporate taxation of companies delivering projects under a comprehensive service agreement, that formerly applied only to road and rail projects procured by the state (Parliament of Finland, 2018 and Ministry of Finance, 2018). This change enabled municipalities to procure contracts for projects as comprehensive services that include private financing. Immediately after the change, in December 2018, the City of Espoo launched the procurement process for the construction and maintenance over 20 years of a bundle of four schools, to be carried out under a single PPP project agreement (Inframation Deals). This marks both the first non-government agency and the first education PPP project in Finland. The procurement process has reached the final negotiations process, with a consortium of Finnish construction company YIT and French private equity investor Meridiam chosen as the service provider (Gallivan, R, 2019).

Future

Public debt levels of developed countries remain high, although on a slightly downward trend (Eurostat, 2020) at least in Europe. Private investors, financiers and construction companies, as well as other main parties included in outsourcing contracts for public assets are becoming more familiar with these types of arrangements as their use has proliferated across different geographical markets and business sectors. According to a 2018 fundraising report by Preqin, the capital amounts raised by infrastructure funds continued to increase in 2018, with early indicators showing 2019 to become another record year (Preqin, 2018). This increase in fund subscription shows that there is mutual demand for infrastructure private equity both from the public sector and private investors. Further, according to an article by PwC Corporate Finance (2019), private infrastructure investors are increasingly willing to invest in minority interest positions, relinquishing control over the asset in return for a steady and predictable return. This could allow the public sector to receive the benefit of private financing while still maintaining control over the public asset, freeing up public capital to other investments or decreasing public debt levels. The same article finds that infrastructure investors have taken a more active stance

on the traditionally passive asset class, offering ancillary services along fixed infrastructure assets and thus expanding the definition of the infrastructure asset class (PwC, 2019). The ancillary services referred to here could be something as simple as offering facility services to office space lessees, or something as comprehensive as investing in project companies engaging in public private partnership agreements with the public sector – providing a full design, build, finance, operation and maintenance package of public infrastructure assets. Based on these findings, the role of private capital in public infrastructure seems likely to grow in the future.

Benefits and drawbacks of private capital

Private capital has enabled many projects which would not otherwise have taken place. Increasing public debt levels, especially in developed economies, have forced the authorities to prioritize and consider which projects to procure with public funds (Grimsey & Lewis, 2002). Khanna et al. (2018) note that very high public debt levels in many economies limit governments' ability to invest, particularly in infrastructure, when investments are needed to support continued economic growth. The authors site realistic book revaluations of public assets as a potential source for financing their further development and maintenance (Khanna et al. 2018). As long as the investments made with private capital produce socio-economic benefits that return increased tax revenue, using private financing to augment public sector investment capacity can be justified. Because the investment costs are not paid up front in a PPP model but are instead spread out over the life of the asset, the financial return (increased tax revenue, reduced costs to the public) can be used to amortize the costs over the life of the project.

Public private partnership agreements place the private capital at risk; the procuring authority makes service payments to the service provider in return for the agreed service. If the service provider fails to deliver the service, or the service is not up to the agreed standards, the capital may be lost. The service provider thus has a better incentive to design, build, operate and maintain the project prudently than would be the case in a project where the contractor receives the full payment upon delivery of the asset. Using inferior construction materials to save on costs or employing the bare minimum number of staff, for example, could increase the probability of service payment deductions, resulting in a net loss for the service provider. Further, the PPP project companies (special purpose vehicles) are typically highly levered, with up to 90:10 debt-to-equity ratios being common for infrastructure projects in developed

markets (Inframation Deals, APMG International, 2019). The leverage further incentivizes the service provider to perform, as the lenders commonly have recourse to (at least some of) the owners of the project company who are then vulnerable to losses considerably above their invested capital.

Using private capital to finance investments when public sector debt is near unmanageable levels can lead to exceeding the public sector's capacity to service its financial obligations. If PPP arrangements are viewed by the state as enabling projects without increasing reported levels of public debt, this may incentivize the government to take on politically popular but socio-economically unprofitable projects, contributing further to a weak financial condition. Many countries, Finland included, treat financial liabilities from PPP contracts equivalently to public debt, and Eurostat regulations have required European Union Member States to do so by from 2004 if the state carries the construction, availability or demand risk associated with the project (IMF, 2004). Countries outside the European Union, however, have different practices and may only list the annual service payments as expenses, without acknowledging the remaining liability.

Private capital is almost always more expensive than public financing. Leviäkangas et al. (2016) find that the public sector in practice does not adjust their investment analyses for risk, while the private sector follows great care in doing so. A private company must earn a financial return on its owners' capital, while the public sector uses tax revenue to fund investments that result in socio-economic benefits to the public. While the contracting public authority can influence the size of the maximum return to the private investors by negotiating the size of the service payments, it must allow a reasonable equity return in order to attract the capital in the first place. This equity cost disadvantage is somewhat alleviated by the high leverage ratios of the PPP project companies; however, it should be noted that the cost of debt is almost always higher to a private company than to the public sector (e.g. IMF, 2004).

There has been a lot of discussion about the "right" or "reasonable" cost of equity in public sector projects using private financing. Leviäkangas et al. (2016) find that the risk-adjusted returns of PPP service providers have been substantially higher than those of public investors. Whitfield & Smyth (2018) note that as equity transactions concerning PPP project companies are private, there is scarce information available and this makes it very difficult to assess equity returns. However, they do find a substantial transaction volume in UK project company equity stakes, suggesting the returns make equity stakes attractive in the secondary market. Grimsey

& Lewis (2002) note that PPP project risk varies greatly depending on the specific project and is in principle not very different from private sector projects. However, a report by the European Court of Auditors found that, in 12 projects audited across different European Union Member States, risk allocation between the public and private sector was often inappropriate and ineffective, while the private equity investors earned returns of up to 14%, far out of line with the risks borne by the investors (Herics et al. 2018).

Provision of public services by the private sector has been justified by efficiency advantages of the private sector (e.g. IMF, 2004 and Herics et al. 2018). It is believed that, given appropriate incentives, private service providers can provide services with greater efficiency than the public sector, and thus it would make sense to pay private companies to provide the services using public funds. Further, public private partnership agreements allow risks associated with the service provision to be contractually transferred to the private service provider. This is especially beneficial in cases where a completely new infrastructure asset is being built, such as a road, a hospital or some other long-term fixed asset. Typically, in PPP service agreements the client (a public authority) has a contractual right to withhold payment upon a failure in adequate service provision and hence the private service provider will have strong incentives to ensure high levels of design, construction and service quality. As the same party is responsible for both the design of the asset as well as its maintenance and operation, it is in that party's interest to design the asset in the most efficient way possible in order to minimize costs and maximize returns.

Despite the sound theoretical reasoning behind public private partnerships, research on past projects has found mixed results with regards to efficiency and cost savings. Leviäkangas (2007, Leviäkangas et al. 2016) found that, in the case of Finland's first road PPP (E4 Helsinki-Lahti motorway) the project was delivered well ahead of the planned schedule and has performed very well, with high maintenance quality and few disruptions, but in the long run the state paid more than it would have with a traditional procurement. European Court of Auditors finds that most European PPP projects have been subject to considerable construction delays and cost overruns, although those projects displayed good levels of service and maintenance once completed. For most of the projects audited by the group no comparative analysis was made prior to choosing PPP as the procurement model, which may partly explain the subpar efficiency in these cases. (Herics et al. 2018).

To summarize, it seems that employing private capital can lead to high service and maintenance quality, but public sector oversight and prudent contracting is required to avoid cost overruns. Private capital has a considerable cost disadvantage compared to public funding, and it remains unclear whether operational efficiency benefits can exceed additional capital costs. One significant advantage of private capital, mentioned earlier in the previous subchapter on public budgets, is that it can often be used to fund investments when public funding is not available; as Leviäkangas (2007) argues, for projects with high socio-economic benefits private capital can be used to start the project sooner than public investment budgets would allow. In such cases the comparison is no longer between public and private financing, but between private financing and no (or delayed) project.

Sources of private capital

Private equity capital can be employed in public projects using several different procurement models with different levels of private and public sector participation. A distinction should be made regarding the term public private partnership; it is considered an umbrella term for any public-private collaborative financing model, but also has an established meaning referring to a model built around a privately-owned project company that receives service payments from the public sector once the asset is delivered and operational; the latter meaning will be used in this paper. Three common internationally used private financing models are the regulated asset base (RAB), the concession model and the public private partnership; of these, the public private partnership is the most relevant for Finland and will be covered in most detail.

According to Briggs (2019), in the regulated asset base (RAB) model the rate of return of the private party delivering and/or maintaining the public asset is regulated, as the name implies. In a greenfield investment, the procuring public authority determines a target cost for the project and invites tenders for the weighted average cost of capital (WACC); the party that is willing to accept the lowest WACC wins the tender competition. The private party will then finance, build and manage the asset and is compensated by the public authority so that the agreed return is achieved. The private party is partly accountable for any overspend with regards to the target cost, while being partly compensated for cost savings. In a brownfield project (e.g. privatization of an asset), the return basis will be linked to the price of the asset upon flotation (market value). (Briggs, 2019). According to Briggs (2019) and Forsdick (2019), in the RAB model the private contractor is paid already during the construction of the asset, and thus it enables the financing of capital-intensive, long-term projects using private capital.

However, since the contractor is only accountable for a part of any overspend, the model has been criticized for providing an "open cheque book" for the private sector and exposing the public authority to considerable cost risk (Briggs, 2019 and Forsdick, 2019).

According to the World Bank (2018) and Kuntaliitto (Association of Finnish Municipalities) (2019), in the concession model a private party is awarded a concession to manage an infrastructure system for a predetermined time period. The concession may include the private party taking over existing assets from the public authority (brownfield) or the design, build, financing, operation and maintenance (DBFOM) of a new asset (greenfield). The model can effectively be considered a narrow-scope monopoly granted to a private party for management of a certain piece of infrastructure. The private party typically carries all risks associated with the project, including demand risk, and receives all or most of its return in the form of user payments (World Bank, 2018 and Kuntaliitto, 2019). The concessionaire (private party) typically pays a periodical concession fee to the public authority, but in some cases the public authority may pay subsidies to the concessionaire. These cases may include infrastructure with insufficient market demand or the need to keep user charges low for social reasons. The concession model has been employed in Finland, for example in arranging public transportation. According to the Finnish Ministry of Transport and Communications (2006, 2012), private transport operators are awarded concessions to operate certain predetermined routes and depending on the route their compensation and service pricing may be market-based or contract-based (Ministry of Transport and Communications, 2006 and 2012). Using the concession model for procuring large infrastructure assets is problematic, as the construction and demand risks tend to result in high risk pricing by the concessionaire and financiers. The risk pricing issue could be alleviated if the public authority were to contractually assume some of the risks, but other procurement models are more suitable for large infrastructure projects.

According to Carter et al. (2017), in a public private partnership (PPP) model, also called the Build-Operate-Transfer model, a private service provider is responsible for completing design and construction, raising private financing for the project and maintaining the completed asset for a relatively long agreement period, typically 15-20 years according to the European Court of Auditors (2018). The service provider is compensated in the form of service payments, which may be based on availability, performance or use of the asset or a combination of these. The payment basis depends on the risk allocation agreed in the contract, with availability and performance basis utilized when demand risk is borne by the public authority and user volume

serving as the basis for payments when the demand risk is on the service provider. (Carter et al. 2017).

PPP model structure is based around a special purpose vehicle (SPV), often called a project company, set up by a private company or consortium of companies, that serves as the service provider to the public authority. The project company enters into an agreement with the public authority for delivery and maintenance of the asset and signs agreements with private contractors for construction, financing, maintenance, etc. An illustration of the SPV structure can be seen in figure 1. (Leviäkangas, 2016).

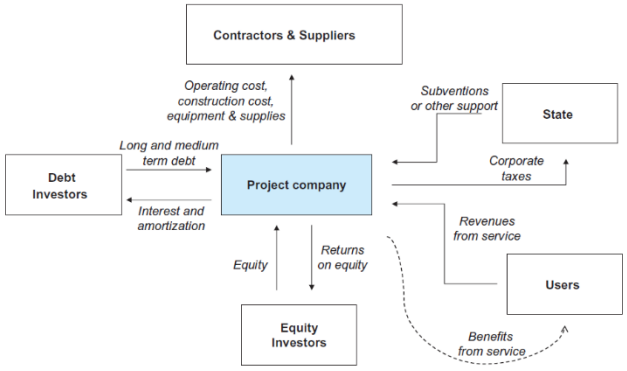

Figure 1. Illustration of a single project company ecosystem (Leviäkangas, 2016).

As seen in the diagram, all agreements between the public and the private sector are signed by the Project company. The State has an agreement with the Project company ("service provider") for delivery and maintenance of the asset or provision of a service. In Finnish PPPs, the State compensates the Project company for provision of the service in the form of service payments, conditional on availability and performance or realized use of the asset, while no agreement exists between Users and the Project company. The Project company pays corporate taxes on its revenue, thus decreasing the effective net cost to the State.

In case of fixed infrastructure, the main contractor under Contractors & Suppliers would be a large construction company, with the rest typically being its subcontractors. The main contractor (construction company) is almost always also an Equity Investor, though most of the equity typically comes from private equity funds. Debt typically comes from one or more commercial banks as well as special credit institutions (European Investment Bank, Nordic Investment Bank in the Nordics) and is secured against future cash flows of the project company. The future cash flows of the Project company, service payments from the State, are conditional on performance of the asset, resulting in significantly higher risks to Debt Investors and thus higher cost of debt than in the public project company model, where the State provides direct security; this is one of the main disadvantages of the PPP model.

The Project company builds and maintains the asset according to the service agreement with the State, uses its service payment cash flow to service obligations to Debt Investors and distribute equity payouts (dividends, interest on shareholder loans, etc.) to its Equity Investors.

At the end of the agreement period, the asset is handed over to the State and the Project company is dissolved.

2.3. Return Requirements of Public and Private Investors

This subchapter examines how the public sector and private investors set their return requirements for infrastructure investments. The public sector values future socio-economic benefits using the societal discount rate, while the private sector sets its equity return requirement at a level that provides a reasonable compensation for placing their capital at risk. Private companies must compete for their investors' capital with other investment opportunities, so their primary goal is to produce competitive financial returns for those investors, and they must generally make do with fewer financial resources than governments. On the other hand, the primary goal of the public sector is to maintain core infrastructure and services for the society, and funding comes primarily from tax revenue. This means that financial returns are less important and resources less limited, while social welfare is important.

2.3.1. Societal discount rate

How public authorities determine their discount factors varies between countries and between industry sectors. According to the FTIA General Appraisal Guide for Transport Infrastructure Projects, the societal discount factor used by the Finnish Transport Infrastructure Agency is based on a near-risk free return (such as government bonds of a state with a high credit rating) and a societal risk premium (Metsäranta & Laakso, 2011):

$Societal\ discount\ factor = r_f + societal\ risk\ premium$ (5), where

r_f = long-term risk-free return and

$societal\ risk\ premium$ = a country-specific risk premium consisting of the pure rate of time preferences and the risk of disaster.

The societal risk premium has no absolute reference value; the prevailing view is that it must be considerably lower than corporate discount rates because there is no risk of bankruptcy or significant asset value amortization associated with public projects (Metsäranta & Laakso, 2011). The societal risk premium and its components are based on the recommendation of the Swedish transport authority, Trafikverket.

Trafikverket uses a slightly different method for calculating the societal discount rate. Instead of the long-term risk-free return, their model incorporates the elasticity of the marginal utility of consumption and the growth of consumption per capita (Bångman, G. & Nordlöf, P. 2018):

$i = z + ng$, where

i = societal discount rate,

z = the pure rate of time preferences + the risk of disaster,

n = the absolute value of the elasticity of the marginal utility of consumption and

g = the rate of growth of consumption per capita.

The pure rate of time preferences of the public sector is affected by pure impatience; benefits now are worth more than benefits tomorrow - and by the uncertainty of the value of certain types of benefits in the future; for example, the utility received from convenient transportation may be less valuable in the future e.g. due to increase in working and shopping from home (these kinds of major societal changes are realistic during the long project appraisal periods). The risk of disaster accounts for the possibility that the asset is destroyed before the expected benefits are received (e.g. due to war or a natural disaster).

For the combination of pure rate of time preferences and the risk of disaster as well as the elasticity of the marginal utility of consumption, Trafikverket uses values determined by the working group HEATCO (Bickel et al. 2006) (Developing **H**armonised **E**uropean **A**pproaches for **T**ransport **C**osting and Project Assessment). HEATCO recommends 1,5 as the value of *z*, while the recommended base value for the elasticity of the marginal utility of consumption n is 0,7 and sensitivity testing with 1,0 is recommended. For rate of growth of consumption per capita *g*, a country-specific annual growth estimate of 1,8 percent is used. (Bångman, G. & Nordlöf, P. 2018 and Bickel et al. 2006).

The elasticity of the marginal utility of consumption means that as per capita consumption grows, the utility of consumers increases by *n* times the growth; this calculation thus approximates the welfare loss that would result from increasing taxation to fund an investment and is hence considered an appropriate measure for appraising the net utility gain from public investments (which are ultimately paid for by the taxpayers).

The *n* and *g* are disregarded in the Finnish model, while the pure rate of time preferences and the risk of disaster form the societal risk premium. The reference values provided in the 2011

FTIA General Appraisal Guide for Transport Infrastructure Projects for each of these two factors is 2,0% (Metsäranta & Laakso, 2011), higher than the HEATCO recommendation. This may have been increased to partly account for the omission of *n* and *g*. At the time of publication of the 2011 guide, the discount rate recommended by the Finnish Transport Agency was (2% + 2%) = 4%. This was decreased to 3,5% (without disclosing changes in the constituents) in the 2013 update of the Appraisal Guide for Road Projects (Ristikartano, Iikkanen & Mukula, 2013). Based on the development of the cost of public debt during those years, it seems likely that the decrease was due to a decrease in the risk-free rate. Hence the societal risk premium component seems to have remained at 2,0% since 2011.

As the analysis performed in this study is intended to represent the public decision-makers' point of view, the current societal discount rate of 3,5% will be used in the financial models to discount socio-economic costs and benefits to the present.

2.3.2. Cost of equity in public private partnerships

As noted in section 2.3.2, private equity financing is considerably more expensive than public financing. As noted by Whitfield & Smyth (2018), there exists little public information about realized equity returns in public private partnerships. However, in case of infrastructure investments, reported target returns of unlisted infrastructure investment funds present a suitable proxy, as large equity funds do invest in public private partnership equity stakes (e.g. Meridiam infrastructure fund invested in the Espoo four schools PPP in 2019 (Gallivan, 2019)). According to Preqin's 2015 report on European infrastructure fund performance, 60% of unlisted infrastructure funds target an equity IRR of 12,5% or less, while 34% target an IRR between 10% and 12,5% (Preqin, 2015). This leaves 26% of the funds targeting a return of less than 10%. Deloitte reports target and actual IRRs of European infrastructure funds as most commonly being between 10% and 12%, down from the 12% to 14% range in their 2013 review. Deloitte cites increased competition as a major cause for the decrease. (Deloitte, 2016).

Investment-specific characteristics are likely to determine the return requirement of a specific investment within this range. According to the Hailuoto Causeway Project Appraisal report (Soisalo et al. 2018), the Hailuoto Causeway project consists of building a causeway and two bridges in a marine environment, in the vicinity of an environmentally sensitive protected area. Marine projects of this scale are uncommon in Finland and contractors can reasonably be expected to have relatively little experience with them, so the project can be expected to carry more risk than an average road project, but likely still less than a hospital or a nuclear power

plant project. Failures in service provision could entitle the client (the FTIA) to service payment deductions, while incidents during construction near the protected environment could potentially result in additional liabilities, causing financial risks to the PPP service provider. On the other hand, counterparty risk, meaning the risk that the contracting authority defaults on its payment obligations, is very low as the counterparty is effectively the Finnish state (credit rating AA+/Aa1) (State Treasury of Finland, 2020).

Considering these factors, a private equity return requirement of 10% will be used as a baseline parameter in the PPP model. This is near the middle of the range provided in the reports by Preqin (2015) and Deloitte (2016). Due to limited data on realized equity returns in PPP investments, the cost of equity will be an important factor of interest in the sensitivity analysis.

3. Research Questions

3.1. Effect of Project Finance on the socio-economic profitability of the Hailuoto Causeway project

Cost-benefit analysis used to evaluate Finnish public infrastructure investments compares projects based on their direct socio-economic costs and benefits, discounted to the year of project completion using the societal discount rate. The analysis does not include evaluation of potential financing arrangements, instead project costs are implicitly assumed to be paid when the asset is ready for use, while the benefits produced by the project are received later.

Evaluating potential financing arrangements already in the project appraisal phase can add valuable information for decision makers. By using external financing, the investment cost can be spread out over the life of the project instead of being paid when the project is ready for use, so that the costs are amortized as the benefits are received. Using external capital to finance the investment increases the nominal total cost of the project, but as long as the cost of debt is lower than the societal discount rate (as has been the case for most Northern European governments for more than a decade), the present value of costs will decrease while the benefits remain the same.

I build three financial models to test the effects of different project finance arrangements on the socio-economic profitability of the Hailuoto Causeway project. I use data from the Hailuoto Causeway Road Plan to replicate the annual socio-economic cost and benefit flows of the project over its 30-year appraisal period, then build the first model where the investment costs are assumed to be paid when they are incurred during construction. This model, referred to in this study as the Direct Budget Financing model, serves as a base case. The second is the Project Company model, where a project company is assumed to be set up by the public sector to finance and manage the project. The public-sector owned project company will finance the project with low-cost debt secured on the sovereign credit rating and amortize the investment cost during the 30-year appraisal period. The third is the Public Private Partnership (PPP) model, where the whole project is assumed to be contracted out to a private party as a comprehensive service agreement. In this model a private service provider will build the causeway and manage it during the 30-year appraisal period, while the public authority pays an annual service payment for use of the asset. The PPP model has been chosen as the actual

financing model of the Hailuoto Causeway project (Finnish Transport Infrastructure Agency, 2020).

Using these three financial models, I examine the following research questions:

1. Using project finance to defer negative cash flows into the future should improve the benefit-to-cost ratio, economic rate of return and economic net present value of the Hailuoto Causeway project.
   1.1. The relative advantage of project finance should increase with the societal discount rate.
   1.2. The relative advantage of project finance should increase with length of the investment period.
   1.3. The relative advantage of project finance should decrease as the reference interest rate increases.
   1.4. Performance of the PPP model should decrease as the cost of equity increases.
   1.5. Performance of the PPP model should improve as the private sector efficiency advantage increases.

3.2. Expediting project start with Off-budget Financing

As described earlier, the public sector can use procurement models employing private financing to effectively "borrow" funds from future budgets and start a project earlier than public investment budgets would allow. Doing so reduces the budget available in future periods but can result in net cost savings when used to finance projects with large enough financial benefits. The Hailuoto Causeway is projected to result in net cost savings to the public sector, as the annual service payment paid to the service provider should be substantially lower than the annual cost of the ferry service currently in place.

I examine the following research question using the Direct Budget Financing and PPP models:

2. Using a procurement model employing private equity financing to expedite project start should improve the benefit-to-cost ratio, economic rate of return and economic net present value of the Hailuoto Causeway project compared to delaying investment until sufficient budget is available.

4. Data

4.1. Hailuoto Causeway Project Appraisal Report

The official Hailuoto Causeway Road Plan forms the main part of data used in this study. The road plan includes a project appraisal report that has been completed according to the guidelines of the Finnish Transport Infrastructure Agency, detailed in chapter 2.1.

In accordance with the guidelines, three investment options were explored:

- Do-minimum scenario (Option 0) where the ferry connection between the mainland and Hailuoto is maintained at the current service level.
- Scenario where the service level of the ferry connection is improved by increasing service frequency and running the ferry around the clock (currently the ferry does not run during nighttime) (option 0+),
- Building a fixed connection using a causeway and two bridges (option 1).

The appraisal period for benefits and costs is 2021-2051, with a construction period of two years. This means that investment costs are incurred in 2019 and 2020, while 2021 serves as the base year (year 0).

Benefits of the chosen option 1 are reported as marginal improvements (or impairments) over option 0. Benefits are estimated over the appraisal period, discounted to year 0 using the current societal discount rate, 3,5% and reported in 2017 price level. Time, accident and emissions costs (reported as positive/negative benefits) are indexed by 1,125% annually from year 0.

To transfer project costs into year 0, interest accrued during construction is calculated to compensate for the period capital is tied up in the project. Like benefits, costs are also reported in 2017 price level.

Table 1. Cost-benefit summary of Hailuoto Causeway. Source: Hailuoto Causeway Road Plan (Soisalo et al. 2018).

Costs (Cost index of civil engineering works 111,7; 2010=100)	**76,4**
Design and planning	0,5
Construction	73,33
Interest accrued during construction	2,57
Indirect and avoided investments	0
Benefits	**125,12**
Route administrator expenses	102,91
Maintenance costs	*102,91*
User travel costs	9,24
Time costs	*22,86*
Vehicle costs (incl. taxes)	*-13,62*
Transport costs	1,51
Time costs	*5,42*
Vehicle costs (incl. taxes)	*-3,91*
Effect on safety	-3,96
Accident costs	*-3,96*
Environmental impact	4,83
Emissions costs	*4,83*
Noise costs	*0*
Impact on public finances	7,16
Fuel tax and VAT	*7,16*
Residual value	7,1
Residual value at end of appraisal period	*7,10*
Disadvantages during construction	-3,67
Benefit-to-Cost ratio	1,64

The costs and benefits of the Hailuoto Causeway (option 1) over maintaining the current ferry service (option 0) can be seen in Table 1. Majority of the benefits (over 80%) come from Route administrator expenses, as the ferry service (annual cost of 5,8 MEUR in 2017 price level) can be discontinued and replaced with basic road maintenance (estimated annual cost of 0,3 MEUR in 2017 price level).

The second-largest benefit comes from User travel costs; travel times are cut significantly, while vehicle costs for road users are increased (negative benefit). Unlike maintenance costs, which are a direct benefit to the FTIA and only indirectly affect the public via reduced public spending, time costs are a direct benefit to the public. Increasing vehicle costs negate a part of the benefit, but the tax portion of that cost increase goes back to public sector benefits.

Impact on public finances is the third largest benefit; this comprises fuel tax and value added tax on fuel paid by private persons. These taxes are reported separately as they can be estimated

with a reasonable accuracy; vehicle taxes are reported together with other vehicle costs as they cannot be reliably separated from other costs. (Soisalo et al. 2018).

4.1.1. Data treatment

The project appraisal report provides the socio-economic costs and benefits by item as total present values over the 30-year appraisal period (see Table 1. in the previous subchapter). In order to determine the nominal annual values, I build a model where the costs and benefits are distributed on a timeline defined according to the cost-benefit analysis guidelines, with construction costs and negative construction period benefits (disadvantages during construction in Table 1.) occurring during years $t_{-2} - t_{-1}$ and benefits during years $t_o - t_{30}$. The societal discount rate used in the report, 3,50%, is used to calculate annual nominal values from the reported present values over the 30-year appraisal period, using the built-in *goal seek* iterative function in Microsoft Excel to find the nominal total.

After finding the annual nominal costs and benefits, I make several adjustments to the data to make it more suitable for financial modelling.

First, in the report *Maintenance costs* are reported as savings of option 1 (causeway) over option 0 (ferry). The maintenance costs of the causeway are estimated to be 0,3 MEUR annually. This 0,3 MEUR is added back to maintenance cost savings (increasing the absolute value of benefits), while a corresponding amount is added as an annual expense (adding a cost item to the timeline).

Second, I redefine the base year, t_0, as the year of construction start. In the cost-benefit analysis year t_o is set to the year of project completion and opening-to-traffic. Treating the year of opening-to-traffic as year t_o should make projects with different investment period lengths more comparable, as the investment period length will only affect the interest accrued during construction and not the discount factors used to discount benefits produced by the project. However, this study focuses on the effects of project finance arrangements in the context of a single project and tests the effects with different investment period lengths. Thus, redefining year t_o as the time the investment is started, as is common practice in financial analysis, facilitates assessing the behavior of different project finance arrangements when the time between financing drawdown and receiving benefits changes.

Third, as this study's base case model (direct budget financing) assumes that investment costs are paid as incurred during the construction period, the item interest accrued during

construction is not used in the models built for this study. To define the base cost for the causeway asset, the interest accrued during construction reported in Table 1. is added to construction costs, resulting in total construction costs of [73,33 + 2,57 = 75,9 MEUR]. The interest cost is added to the construction costs because they are reported in the original year t_o of the project appraisal report. The interest cost item compensates for discounting the construction costs to this study's year t_o, which is year t_{-2} of the appraisal report.

Fourth, the appraisal report and the General Appraisal Guide for Transport Infrastructure Projects (Metsäranta & Laakso, 2011) state that the appraisal period for an infrastructure project is 30 years. The appraisal report also states that the appraisal period (benefit estimation period after construction) is from 2021 to 2051, which is actually 31 years. It is not clear how this is addressed in the report's background calculations. I set the timeline in my financial models to years t_0 to t_{31}, with the construction period spanning t_0 to t_1 and the operating period from t_2 to t_{30} and assume that the reported benefits accrue in 30 years. The same assumption is made for all three financial models and should thus have no effect on the results of this study.

Table 2. Annual discounted costs and benefits iterated by the author from the Hailuoto project appraisal report.

Project phase		Investment	Investment	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation
																								20	21	22	23	24	25	26	27	28	29	30
Costs																																		
(Cost index of civil engineering works 111,7; 2010=100)	76,4	38,45	37,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Design and planning	0,5	0,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Construction	73,33	36,67	36,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Interest accrued during construction	2,57	1,29	1,29	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Indirect and avoided investments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits	125,12	-1,87	-1,80	6,11	5,92	5,73	5,55	5,37	5,20	5,03	4,87	4,72	4,57	4,42	4,28	4,15	4,01	3,89	3,76	3,65	3,53	3,42	3,31	3,21	3,10	3,01	2,91	2,82	2,73	2,65	2,56	2,48	2,40	9,43
Route administrator expenses	102,91	0,00	0,00	5,31	5,13	4,95	4,79	4,62	4,47	4,32	4,17	4,03	3,89	3,76	3,63	3,51	3,39	3,28	3,17	3,06	2,96	2,86	2,76	2,67	2,58	2,49	2,41	2,32	2,25	2,17	2,10	2,03	1,96	1,89
Maintenance costs	*102,91*	*0,00*	*0,00*	*5,31*	*5,13*	*4,95*	*4,79*	*4,62*	*4,47*	*4,32*	*4,17*	*4,03*	*3,89*	*3,76*	*3,63*	*3,51*	*3,39*	*3,28*	*3,17*	*3,06*	*2,96*	*2,86*	*2,76*	*2,67*	*2,58*	*2,49*	*2,41*	*2,32*	*2,25*	*2,17*	*2,10*	*2,03*	*1,96*	*1,89*
User travel costs	9,24	0,00	0,00	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,31	0,31	0,31	0,31	0,31	0,30	0,30	0,30	0,30	0,30	0,29	0,29	0,29	0,28	0,28	0,28	0,28	0,27	0,27	0,27	0,26	0,26
Time costs	*22,86*	*0,00*	*0,00*	*1,02*	*1,00*	*0,98*	*0,95*	*0,93*	*0,91*	*0,89*	*0,87*	*0,85*	*0,83*	*0,81*	*0,79*	*0,77*	*0,76*	*0,74*	*0,72*	*0,71*	*0,69*	*0,67*	*0,66*	*0,64*	*0,63*	*0,61*	*0,60*	*0,59*	*0,57*	*0,56*	*0,55*	*0,53*	*0,52*	*0,51*
Vehicle costs (incl. taxes)	*-13,62*	*0,00*	*0,00*	*-0,70*	*-0,68*	*-0,66*	*-0,63*	*-0,61*	*-0,59*	*-0,57*	*-0,55*	*-0,53*	*-0,52*	*-0,50*	*-0,48*	*-0,46*	*-0,45*	*-0,43*	*-0,42*	*-0,41*	*-0,39*	*-0,38*	*-0,37*	*-0,35*	*-0,34*	*-0,33*	*-0,32*	*-0,31*	*-0,30*	*-0,29*	*-0,28*	*-0,27*	*-0,26*	*-0,25*
Transport costs	1,51	0,00	0,00	0,08	0,08	0,07	0,07	0,07	0,07	0,06	0,06	0,06	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,03	0,03	0,03	0,03	0,03	0,03	0,03
Time costs	*5,42*	*0,00*	*0,00*	*0,28*	*0,27*	*0,26*	*0,25*	*0,24*	*0,24*	*0,23*	*0,22*	*0,21*	*0,21*	*0,20*	*0,19*	*0,18*	*0,18*	*0,17*	*0,17*	*0,16*	*0,16*	*0,15*	*0,15*	*0,14*	*0,14*	*0,13*	*0,13*	*0,12*	*0,12*	*0,11*	*0,11*	*0,11*	*0,10*	*0,10*
Vehicle costs (incl. taxes)	*-3,91*	*0,00*	*0,00*	*-0,20*	*-0,19*	*-0,19*	*-0,18*	*-0,18*	*-0,17*	*-0,16*	*-0,16*	*-0,15*	*-0,15*	*-0,14*	*-0,14*	*-0,13*	*-0,13*	*-0,12*	*-0,12*	*-0,12*	*-0,11*	*-0,11*	*-0,10*	*-0,10*	*-0,10*	*-0,09*	*-0,09*	*-0,09*	*-0,09*	*-0,08*	*-0,08*	*-0,08*	*-0,07*	*-0,07*
Effect on safety	-3,96	0,00	0,00	-0,18	-0,17	-0,17	-0,17	-0,16	-0,16	-0,15	-0,15	-0,15	-0,14	-0,14	-0,14	-0,13	-0,13	-0,13	-0,13	-0,12	-0,12	-0,12	-0,11	-0,11	-0,11	-0,11	-0,10	-0,10	-0,10	-0,10	-0,09	-0,09	-0,09	-0,09
Accident costs	*-3,96*	*0,00*	*0,00*	*-0,18*	*-0,17*	*-0,17*	*-0,17*	*-0,16*	*-0,16*	*-0,15*	*-0,15*	*-0,15*	*-0,14*	*-0,14*	*-0,14*	*-0,13*	*-0,13*	*-0,13*	*-0,13*	*-0,12*	*-0,12*	*-0,12*	*-0,11*	*-0,11*	*-0,11*	*-0,11*	*-0,10*	*-0,10*	*-0,10*	*-0,10*	*-0,09*	*-0,09*	*-0,09*	*-0,09*
Environmental impact	4,83	0,00	0,00	0,22	0,21	0,21	0,20	0,20	0,19	0,19	0,18	0,18	0,18	0,17	0,17	0,16	0,16	0,16	0,15	0,15	0,15	0,14	0,14	0,14	0,13	0,13	0,13	0,12	0,12	0,12	0,12	0,11	0,11	0,11
Emissions costs	*4,83*	*0,00*	*0,00*	*0,22*	*0,21*	*0,21*	*0,20*	*0,20*	*0,19*	*0,19*	*0,18*	*0,18*	*0,18*	*0,17*	*0,17*	*0,16*	*0,16*	*0,16*	*0,15*	*0,15*	*0,15*	*0,14*	*0,14*	*0,14*	*0,13*	*0,13*	*0,13*	*0,12*	*0,12*	*0,12*	*0,12*	*0,11*	*0,11*	*0,11*
Noise costs	*0*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Impact on public finances	7,16	0,00	0,00	0,37	0,36	0,34	0,33	0,32	0,31	0,30	0,29	0,28	0,27	0,26	0,25	0,24	0,24	0,23	0,22	0,21	0,21	0,20	0,19	0,19	0,18	0,17	0,17	0,16	0,16	0,15	0,15	0,14	0,14	0,13
Fuel tax and VAT	*7,16*	*0,00*	*0,00*	*0,37*	*0,36*	*0,34*	*0,33*	*0,32*	*0,31*	*0,30*	*0,29*	*0,28*	*0,27*	*0,26*	*0,25*	*0,24*	*0,24*	*0,23*	*0,22*	*0,21*	*0,21*	*0,20*	*0,19*	*0,19*	*0,18*	*0,17*	*0,17*	*0,16*	*0,16*	*0,15*	*0,15*	*0,14*	*0,14*	*0,13*
Residual value	7,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	7,10
Residual value at end of appraisal period	*7,10*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*7,10*
Disadvantages during construction	-3,67	-1,87	-1,80	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Benefit-to-Cost ratio	1,64																																

Table 3. Annual nominal costs and benefits after data treatment detailed in subchapter 4.1.1 (note additional cost item line for Maintenance costs.)

Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Project phase		Investment	Investment	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation	Operation
Costs	**85,40**	**38,45**	**37,95**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**	**0,30**
Design and planning	0,5	0,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Construction	73,33	36,67	36,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Interest accrued during construction	2,57	1,29	1,29	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Indirect and avoided investments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance costs	9	0,00	0,00	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30
Benefits	**214,94**	**-1,74**	**-1,74**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**6,62**	**26,54**
Route administrator expenses	173,51	0,00	0,00	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78	5,78
Maintenance costs	*173,51*	*0,00*	*0,00*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*	*5,78*
User travel costs	9,92	0,00	0,00	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33
Time costs	*31,69*	*0,00*	*0,00*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*	*1,06*
Vehicle costs (incl. taxes)	*-21,77*	*0,00*	*0,00*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*	*-0,73*
Transport costs	2,41	0,00	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Time costs	*8,66*	*0,00*	*0,00*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*	*0,29*
Vehicle costs (incl. taxes)	*-6,25*	*0,00*	*0,00*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*	*-0,21*
Effect on safety	-5,49	0,00	0,00	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18
Accident costs	*-5,49*	*0,00*	*0,00*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*	*-0,18*
Environmental impact	6,70	0,00	0,00	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
Emissions costs	*6,70*	*0,00*	*0,00*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*	*0,22*
Noise costs	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Impact on public finances	11,45	0,00	0,00	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38
Fuel tax and VAT	*11,45*	*0,00*	*0,00*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*	*0,38*
Residual value	19,93	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	19,93
Residual value at end of appraisal period	*19,93*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*19,93*
Disadvantages during construction	-3,48	-1,74	-1,74	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Benefit-to-Cost ratio	2,52																																

Table 2. displays the annual discounted costs and benefits iterated based on the reported totals, their timing (construction costs in years -2 to -1, benefits in 0 to 30, residual value in 30) and the discount rate used (3,5%). Table 3. displays the nominal annual costs and benefits after data treatment; an additional cost line item is added for maintenance costs and the timeline is compressed to 32 years (two-year investment period and 30-year appraisal period). The results for the financial models are calculated based on these annual socio-economic cost and benefit flows, adding financing costs (Project Company and PPP) and management overhead as well as deducting a possible efficiency advantage factor (PPP).

4.2. Interest Rates

Interest rate data is used to estimate the cost of financing to the public sector in the project company model and to the service provider in the public private partnership model.
The 2019 average annual rate of euro-based 30-year maturity ICE swap rate benchmark is used as the reference interest rate (St. Louis Fed, 2020). The longest available maturity for Finnish government bonds is currently 10 years, so the ICE swap rate is used as a proxy to represent the current market estimate of a 30-year government bond rate. A 30-year interest rate is necessary due to the 30-year appraisal period used in this study, but the use of a swap rate as a proxy for the purposes of this study should not be understood to refer to the use of interest rate swap agreements in the actual project finance arrangements (although they may be used in some cases). An interest rate margin as well as a loan arrangement fee based on that margin are added on top of the swap rate for the service provider in the PPP model. The public project company is assumed to not pay a margin nor an arrangement fee on its debt, due to its' debt being secured on the high sovereign credit rating and the state being a large market participant.

The interest rate margin for the private sector is based on a consensus estimate provided to the author by parties familiar with PPP projects and Finnish financial markets. The interest rate margin estimate was current as of Fall 2019.

The 30-year swap rate used as a reference interest rate in this study is 0,77%. The interest margin for the service provider is 1,20%, resulting in a total cost of debt of 1,97% for the private sector.

4.3. Assumptions related to the PPP Service Provider

Several assumptions regarding the cost structure of the PPP service provider have been made in order to calculate the costs of the PPP model in the baseline scenario. These estimates are based on several PPP infrastructure projects the author is familiar with as well as on discussions with parties experienced in working with PPP projects. The financial statements and cost structures of PPP project companies are private, the agreements between public authorities and PPP service providers are confidential, and no accurate information on actual realized interest rates, equity returns, cost structures or contractual treatment of risks is available. Thus, the author's estimates serve as a baseline around which sensitivity analysis is performed.

The PPP service provider, being a much smaller market participant than the state, is assumed to pay an arrangement fee on its debt contracts. The arrangement fee is defined as a percentage

of the interest rate margin and is calculated as the resulting percentage amount (35% * 1,2% = 0,42%) times the total amount of debt before any capitalized interest or other fees. The arrangement fee is paid as a one-off in the beginning of the investment period.

The PPP service provider is assumed to have an initial capital structure of 10% equity, 90% debt. The service provider will pay the debt off during the 30-year appraisal period and the capital structure will change accordingly. Baseline value for the equity return requirement is set at 10%.

The concept of the efficiency advantage of the private sector is based on the assumption that a private company will design and build an asset more efficiently when it is incentivized to do so, e.g. when the cost savings contribute to its profit. The efficiency advantage is applied to model calculations by deducting a percentage amount from the total capital expenditure and maintenance costs of the project, so that the private sector capital expenditure becomes, in the case of a 10% efficiency factor, [(100% – 10%) * 75,9 = 68,31 MEUR] and the annual maintenance cost becomes [(100% - 10%) * 0,3 = 0,27 MEUR]. A baseline efficiency advantage value of 0% will be used due to inconclusive evidence regarding the existence and magnitude of any efficiency advantage. Effect of a potential efficiency advantage will be examined in the sensitivity analysis section.

In a PPP project a special purpose company is set up to act as the service provider, managing the project and signing contracts with all associated parties (contracting public authority, construction and maintenance companies, financiers and investors). In addition to construction and financing costs associated with delivering the project itself, the service provider must cover its administrative overhead, insurance costs and contract-related legal fees, among others. For the purposes of this study, the author has received a confidential estimate of the typical level of these costs in a similar PPP project from parties familiar with Finnish and international PPP projects.

As well as additional costs related to the PPP contract itself, the public authority typically incurs substantially higher transaction costs than in the case of traditional budget-financed procurement. The transaction costs result from the more involved procurement process of the PPP model compared to traditional procurement and include tender compensation costs paid to tenderers who submitted bids but were not selected, the public authority’s preparation costs and other process costs. The transaction costs are paid by the public authority up-front in the beginning of the project. They are not paid to the project company but are incurred by the

procuring public authority as a part of the procurement process and must be taken into account in comparing the different procurement models. For the purposes of this study, the author has received a confidential estimate of the typical level of these costs in a similar PPP project from parties familiar with Finnish and international PPP projects. The transaction cost item added to the PPP model includes only costs in excess of typical procurement costs of traditional budget financed projects and hence transaction costs are not included in the direct budget financing and project company models.

The service provider pays taxes from its profits according to the Finnish corporate tax rate, 20%. The service provider starts turning profit when revenue from the service payments exceeds the maintenance and financing costs as well as depreciation of the causeway asset (30-year straight-line depreciation is assumed). Tax revenue flows to the public sector and effectively reduces the net service payment paid by the public authority, hence taxes are taken into account when calculating the benefit-to-cost ratios, economic rates of return and economic net present values for the public sector by netting the corporate taxes received against the costs incurred by the public authority.

4.4. Discount Rates

The societal discount rate used by the public authority to discount costs and benefits is set at 3,5% according to the FTIA Appraisal Guide for Road Projects (Ristikartano, Iikkanen & Mukula, 2013). The service provider discounts its post-tax, post-debt service cash flows with the cost of equity, which is set at 10% based on the reported target returns of unlisted infrastructure funds from reports by Preqin (2015) and Deloitte (2016). The service payment paid by the public authority is set at a level that provides the required equity return to the private investors.

4.5. Assumption Summary

Model assumptions used in the financial model calculations are listed in Table 4. below.

Table 4. Assumption summary.

Model	Assumption	Value	Comment	Source
All				
	Socio-economic benefits	214,94 MEUR	Nominal values iterated from Hailuoto Causeway cost-benefit report + annual maintenance cost saving 0,3 MEUR.	Hailuoto Causeway Road Plan (Soisalo et al. 2018) + data treatment by author detailed in chapter 4.1.1
	Socio-economic costs	85,4 MEUR	Nominal values iterated from Hailuoto Causeway cost-benefit report + annual maintenance cost 0,3 MEUR.	Hailuoto Causeway Road Plan (Soisalo et al. 2018) + data treatment by author detailed in chapter 4.1.1
	Societal discount rate	3,50 %	Discount rate applied by the public sector on its socio-economic costs and benefits.	Finnish Transport Infrastructure Agency 2013 Appraisal Guide for Road Projects (Ristikartano, Iikkanen & Mukula, 2013)
	Investment period length	2 years	Period during which construction costs are incurred.	Hailuoto Causeway Road Plan (Soisalo et al. 2018)
	Operating period length	30 years	Period for which socio-economic benefits are forecast.	Hailuoto Causeway Road Plan (Soisalo et al. 2018)

Project Company & PPP				
	Reference interest rate	0,77 %	Average daily ICE euro-denominated swap rate in 2019.	ICE Swap Rates, 12:00 P.M. (London Time), Based on Euros, 30 Year Tenor. Economic Research data from Federal Reserve Bank of St. Louis.
PPP				
	Corporate tax rate	20 %	Finnish corporate tax rate in 2020.	Finnish Tax Administration.
	Public sector transaction costs	Confidential	Costs paid by the public authority in year t_0 in the PPP model.	Consensus estimate provided to the author by parties familiar with Finnish and international PPP projects.
	Service provider management overhead	Confidential	Paid annually by the Service Provider, amount similar to annual maintenance costs.	Consensus estimate provided to the author by parties familiar with Finnish and international PPP projects.
	Interest margin	1,20 %	Added to the reference interest rate for the Service Provider.	Consensus estimate provided for the author by parties familiar with PPP projects and Finnish financial markets (current as of Fall 2019).
	Debt arrangement fee	35% of interest margin	One-time payment by the Service Provider in year t_0.	Consensus estimate provided for the author by parties familiar with PPP projects and Finnish financial markets (current as of Fall 2019).

	Cost of equity	10 %	Service payment is set to provide the Service Provider with its target return.	Target returns reported by unlisted infrastructure funds, based on reports by Preqin (2015) and Deloitte (2016).
	Private sector efficiency advantage	0 %	Exploring the efficiency advantage left to sensitivity analysis due to inconclusive evidence.	Studies on historical performance of PPP projects, for example IMF (2004), Herics et al. (2018), Leviäkangas (2007), Leviäkangas et al. (2016).

The assumptions are grouped into general data used for all models, data specific to the Project Company and PPP models (the reference interest rate) and data used only for the PPP model. The table lists the value used for baseline calculations before sensitivity analysis, clarifying comments where necessary and data source. Please see the references chapter for further details on sources.

5. Methodology

This chapter details the financial models built to assess the effects of different project financing arrangements and explains the key parameters as well as outputs from the models.

5.1. Financial Models

I build three financial models to assess the effects of project finance on the socio-economic profitability of the Hailuoto Causeway project. The benefit-to-cost ratio (BCR), economic rate of return (ERR) and economic net present value (ENPV) are the main outputs from these models. Factor-by-factor sensitivity analysis will be performed to address uncertainty regarding the baseline parameters. The key focus points in the sensitivity analysis will be:

1. The societal discount rate (all models),
2. the length of the investment period (all models),
3. the reference interest rate (Project Company and PPP Model),
4. the cost of equity (PPP Model) and
5. private sector efficiency advantage (PPP Model).

Further, the effect of project delay due to a budget constraint will be explored in a scenario analysis, with the performance of the PPP model with baseline assumptions being compared against direct budget financing with project start delayed from one to six years. Scenario analysis will be used instead of a factor-by-factor sensitivity analysis, as exploring and reporting multiple variations of all the model factors for eight different models (PPP model and direct budget financing starting in $t_0 \ldots t_6$) would not be feasible.

5.1.1. Direct budget financing

The direct budget financing model is built using cost and benefit data from the project appraisal report included in the Hailuoto Causeway Road Plan after data treatment detailed in chapter 4.1.1. The benefits and costs are assumed to be incurred as set out in Table 3. This model includes no external financing, assumes that investment costs are paid up front and acts as the baseline for comparison against the two project finance models. This model is not intended to represent the actual practice of how public budget financing is applied, but to serve as a base case without financing against which the effects of external financing are examined. In practice direct budget-financed projects may include elements of debt financing.

5.1.2. Project company

In the project company model, a project company set up and managed by a public authority finances the project with debt secured on the sovereign credit rating. Costs and benefits are assumed to result from the project like in the direct budget financing model, but instead of paying the costs up front the project company uses 100% debt financing and repays the debt with interest over the appraisal period. The debt is drawn in years $t_0 \ldots t_1$, the interest rate is fixed at 0,77% and interest is capitalized into total debt during the construction period; thus, the public authority is assumed to only incur a negative cash flow of -0,50 MEUR in year t_0 for Design and planning, as these costs would be incurred for a large part before the start of the project. Deferring the costs in this manner brings them in line with the benefits resulting from the project, allowing equal application of the discount factor to both costs and benefits.

5.1.3. PPP model

In the PPP model scenario, a public authority contracts the project out as a comprehensive service agreement. A private service provider builds and maintains the causeway over the 30-year appraisal period and is compensated by service payments made by the public authority when the asset is available for use. Benefits are assumed to remain the same as in the two previous scenarios, while costs are affected by the efficiency advantage of the private sector, the increased cost of capital as well as potentially expedited project start. The project can potentially be started earlier than in the other models due to the reduced budgetary requirement described in chapter 2.2.1.1. Finally, it is assumed that the public authority incurs additional transaction costs owing to the complex nature of the procurement process associated with PPP arrangements.

In the baseline scenario, the service provider's interest margin is 1,20%, resulting in a total interest rate of 1,97% together with the reference interest rate of 0,77%. The service provider will also pay an arrangement fee equal to 0,35% of the interest margin times the amount of debt (Construction costs before capitalized interest). Capital structure of the project company is assumed to be 10% equity and 90% debt. The return requirement (cost of equity) of the equity investors is 10%. The baseline efficiency advantage of the private sector is assumed to be 0%; due to inconclusive evidence regarding the existence of an efficiency advantage, applying the efficiency factor is left to the sensitivity analysis.

The PPP service provider makes a profit from service payments paid by the contracting public authority. The annual service payment is fixed for the 30 years of operation and its size is

optimized to provide the service provider with its equity return requirement, 10% in the baseline scenario. When the service provider's service payment revenue exceeds its total costs, the company produces a profit and pays corporate taxes. The corporate taxes received reduce the effective net service payment paid by the public authority. This results in three separate calculations within the PPP project model; first, cash flow calculation of the service provider, second, accounting income calculation of the service provider for determining corporate tax to be paid, which goes back into the cash flow calculation, and third, cash flow calculation of the public authority for determining the benefit-to-cost ratio, the economic rate of return and the economic net present value of the project.

6. Results

The results of this study, outputs from the three financial models, are detailed in this chapter. Subchapters 6.1. and 6.2. provide a detailed look into the results regarding research questions (1) and (2). Subchapter 6.3. contains factor-by-factor sensitivity analysis regarding research question (1) and subchapter 6.4. contains scenario analysis regarding research question (2). Subchapter 6.5. includes a summary table of findings along with a brief discussion.

6.1. Effect of Project Finance on the Socio-economic Profitability of the Hailuoto Causeway Project

The accumulation of costs for the three financing models can be seen in Figure 2.

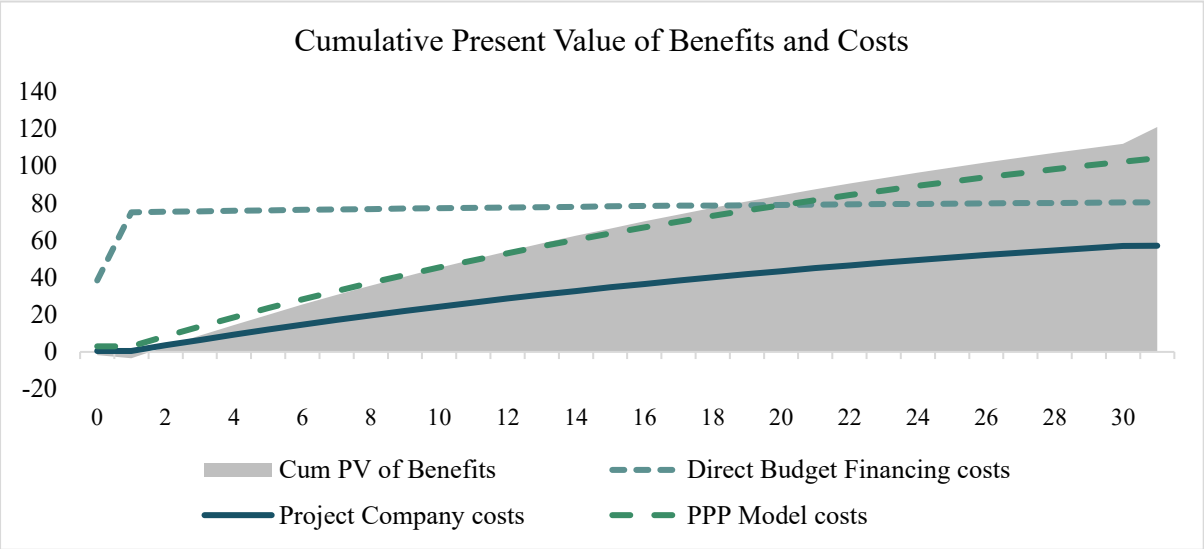

Figure 2. Cumulative Present Values of Hailuoto Causeway benefits and costs.

In the direct budget financing model, investment costs are incurred during the two-year investment period, after which only 0,3 MEUR annual maintenance costs are paid. The cost profiles of the project company and PPP model options are similar, with the PPP model having significantly higher costs due to the increased cost of financing and management overhead. Unlike in the PPP model, the present value of costs in the project company model is lower than in the direct budget financing option despite the higher nominal costs.

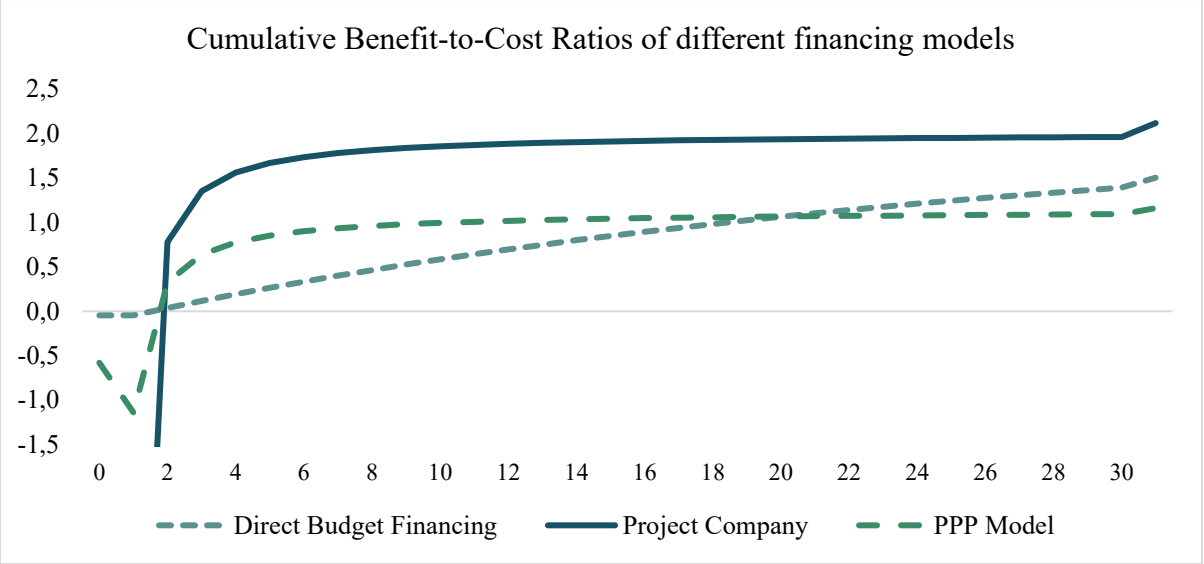

Figure 3. Cumulative Benefit-to-Cost Ratios of Direct Budget Financing, Project Company and PPP models.

Figure 3. displays the cumulative benefit-to-cost ratios (BCR) of the project with the different financing models. The project company and PPP model start with deeply negative initial ratios because there is a negative benefit during construction but, unlike in direct budget financing, no significant costs in the denominator. The negative benefit consists of nuisances caused by the construction site to the surrounding area, such as noise and vibration. As expected based on financial theory, the project company model maintains the highest benefit-to-cost ratio throughout the project, ending up with a ratio of 2,12. The benefit-to-cost ratio of the PPP model exceeds direct budget financing from opening-to-traffic until year 18, ultimately ending up with a ratio of 1,16. The benefit-to-cost ratio of the direct budget financing option is 1,50, below the 1,64 provided in the Hailuoto project appraisal report due to factors discussed in the data treatment section in chapter 4.1.1. The project would be socio-economically profitable with all financing options, as no model has a BCR of under one.

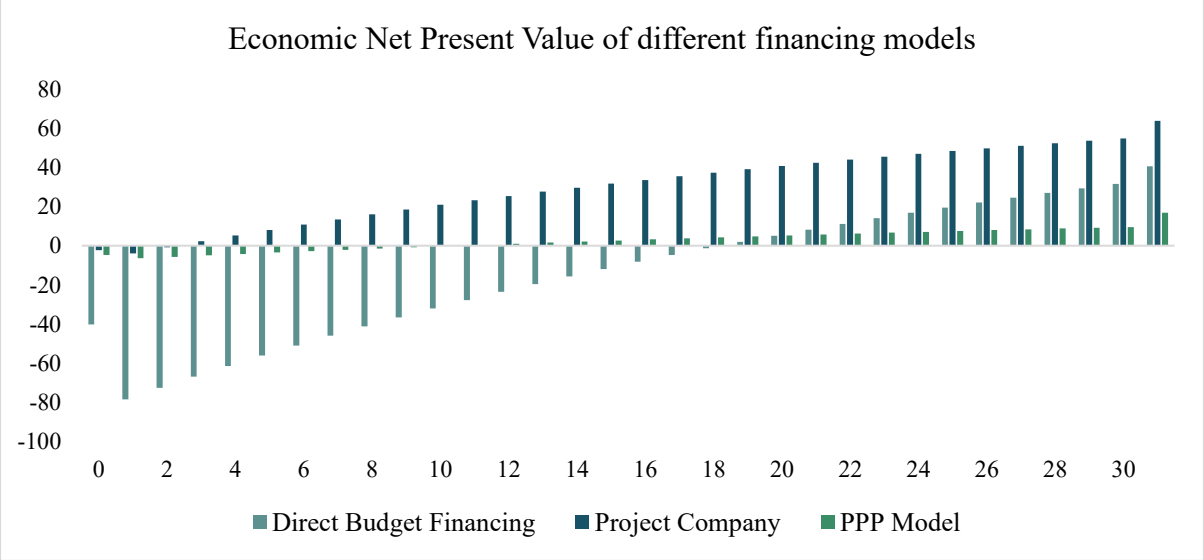

Figure 4. Economic Net Present Value (ENPV) of the different financing models.

Figure 4. displays the economic net present value (ENPV) of the project with the three financing options. The project company model has the highest ENPV at 63,9, MEUR, with direct budget financing following at 40,5 MEUR and PPP model being the least economically advantageous option with an ENPV of 16,8 MEUR.

Figure 5. displays the economic rates of return (ERR) of the project for the three financing models. Unlike with the benefit-to-cost ratio and the economic net present value, the economic rate of return of the PPP model exceeds direct budget financing. This results from the earlier positive cumulative cash flows of the PPP model, which are assumed to be reinvested at the ERR rate in the calculation. The ERR of the project company model is again highest at 62,5%, with PPP and direct budget financing models following at 12,9% and 6,8%, respectively.

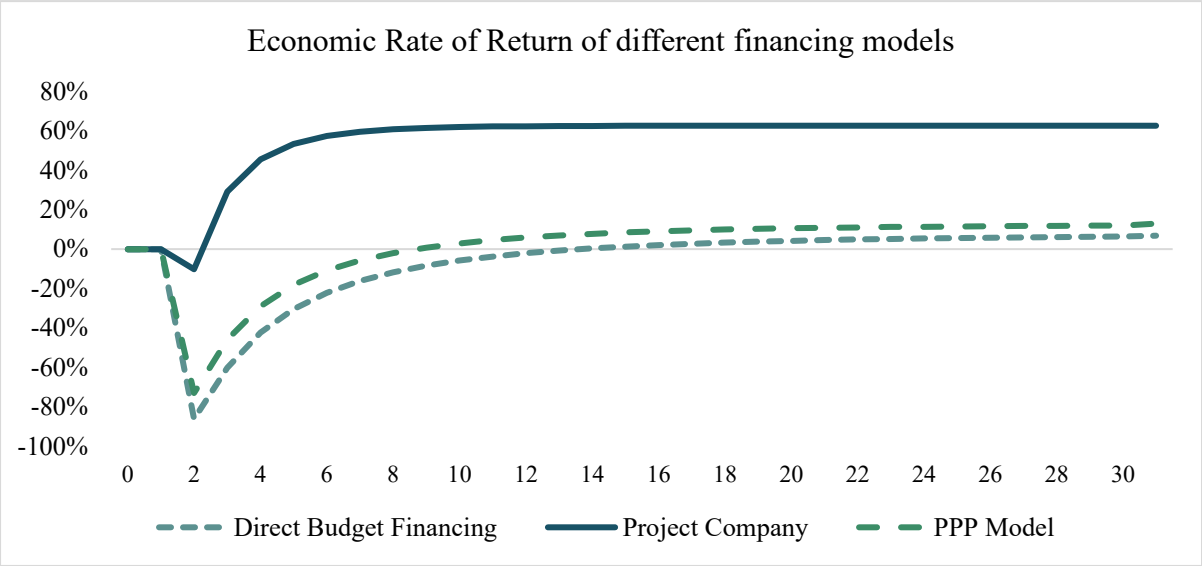

Figure 5. Economic Rate of Return (ERR) of the different financing models.

6.2. Expediting Project Start with Off-budget Financing

The socio-economic benefits of a project can potentially be realized earlier by using private financing to augment public investment budgets. I test the effect of delay on the socio-economic profitability of the project by constructing timelines for delayed investment and operating periods, starting in years $t_0 \ldots t_6$. A negative opportunity cost, equal to the net benefit (socio-economic benefits less operating costs of the new project) forgone by delaying the project, is added to the delayed project timelines for the years during which those benefits would have been received if the project was started on time. The nominal value of this opportunity cost of delay is [6,62 – 0,3] = 6,32 MEUR. The opportunity cost is discounted to year t_0 of the delayed project, thus the marginal opportunity cost of a one-year delay decreases when the total delay increases. The appraisal period remains 30 years for the delayed timelines.

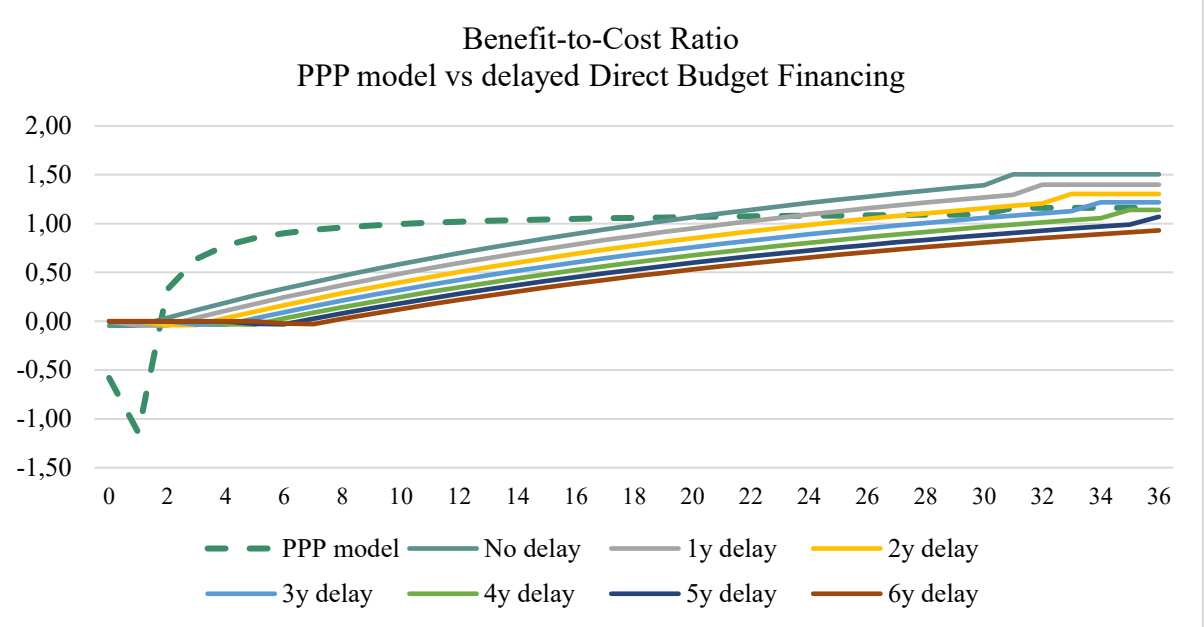

Figure 6. Benefit-to-Cost ratios of PPP Model and Direct Budget Financing with increasing delays.

Figures 6. And 7. illustrate the cumulative benefit-to-cost ratios and economic net present values of the PPP model started in year t_0 compared to direct budget-financed projects starting from $t_0 \ldots t_6$. With this paper's baseline assumptions, the budget constraint would need to delay the start of the project for four years for the PPP model to be more socio-economically profitable than waiting for sufficient budget for direct budget financing.

These results show that the budget constraint-related delay required to make the PPP model socio-economically preferable to waiting for sufficient budget corresponds to the four-year span of the General Government Fiscal Plan. Since the project does not fit into the fiscal plan, the agency must make a choice between using more expensive but still profitable private

financing or waiting until the next budgeting period. It is difficult to predict what new project opportunities emerge and how political decision-makers view those projects. If there are more socio-economically profitable project opportunities than fit into public investment budgets, this may lead to good projects being abandoned. Due to these reasons it may be justifiable to use the PPP model even though the costs exceed those of budget financing.

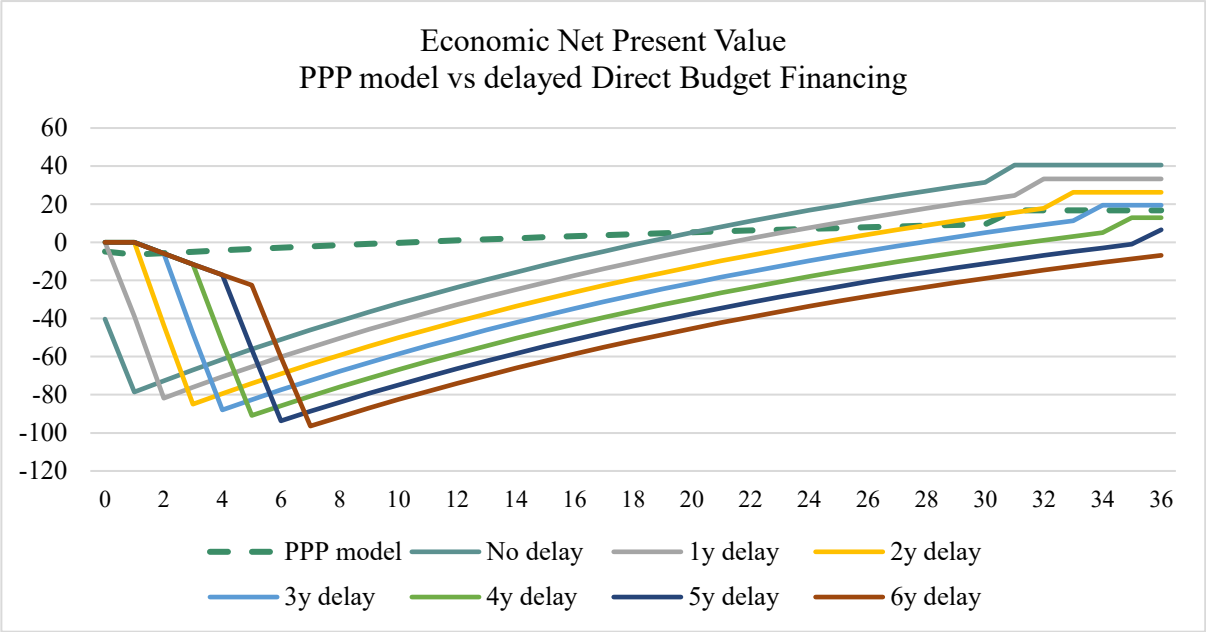

Figure 7. Economic Net Present Values of PPP Model and Direct Budget Financing with increasing delays.

In the following section different assumptions are explored to find further insight into the relative advantages of these financing models.

6.3. Sensitivity Analysis

So far it has been shown that the socio-economic profitability of public infrastructure investments, measured in present values, can be improved by using external financing, particularly the project company model. Next, sensitivity analysis will be performed to assess the effects of changes in key assumptions made in these analyses.

The three models are compared to see how their benefit-to-cost ratios, economic rates of return and economic net present values react to changes in key model parameters and if and how these changes alter the models' comparative advantages. All analyses are conducted ceteris paribus to isolate the effects of individual factors.

With the direct budget financing model, only the discount rate and investment period length can be analyzed since that model does not include financing assumptions. The project company model introduces the reference interest rate as an additional factor, while the PPP model features two further factors concerning the private sector: the cost of equity and the efficiency advantage of the private sector.

6.3.1. Societal discount rate

The benefit-to-cost ratio (BCR) and the economic net present value (ENPV) of the three models are measured as the societal discount rate is altered between 2,00% and 4,00% with 0,25% intervals.

Figure 8. shows the effect of 0,25% interval changes in the discount rate on the benefit-to-cost ratio of the three models. We see that the BCR of the direct budget financing model is significantly affected by increases in the discount rate, while the effect on the project company and PPP models is significantly smaller. In the latter two models benefits and costs occur at the same time, negating the effect of the discount rate on their ratio. Thus, it can be stated that, ceteris paribus, increasing discount rates improve the relative profitability of models using external financing. This is reflected in the economic rates of return of the three models, with the breakeven rates being 6,8%, 62,5% and 12,9% for direct budget financing, project company and PPP model, respectively. This means that, should the societal discount rate exceed 6,8%

the benefit-to-cost ratio of the direct budget financed project would fall under one and the project would be considered socio-economically unprofitable without external financing.

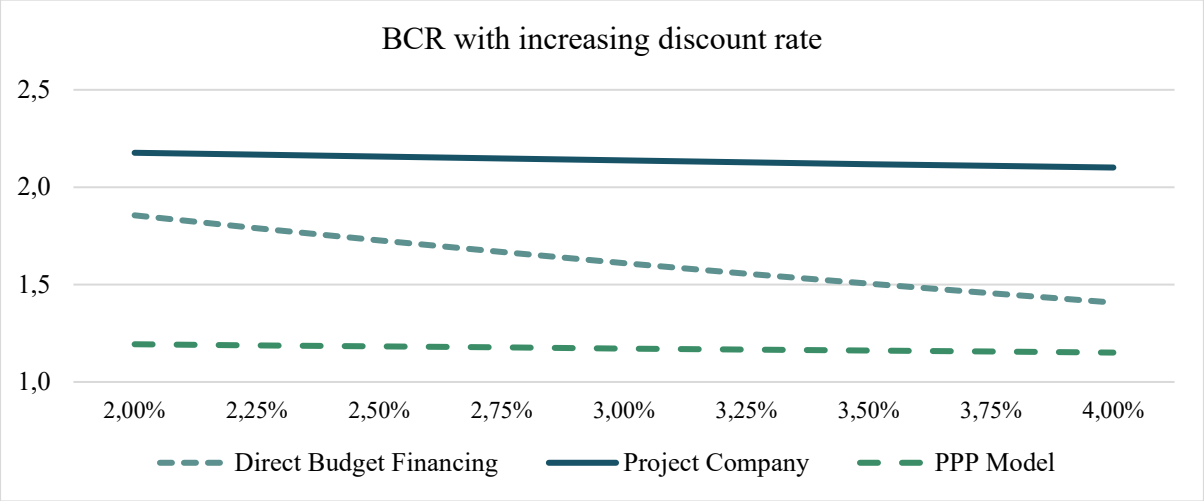

Figure 8. Benefit-to-Cost ratio with increasing discount rate.

Figure 9. shows the effect of the same changes in the discount rate on the economic net present value of the project. As with the BCR, the ENPV of direct budget financing approaches the PPP model as the discount rate increases.

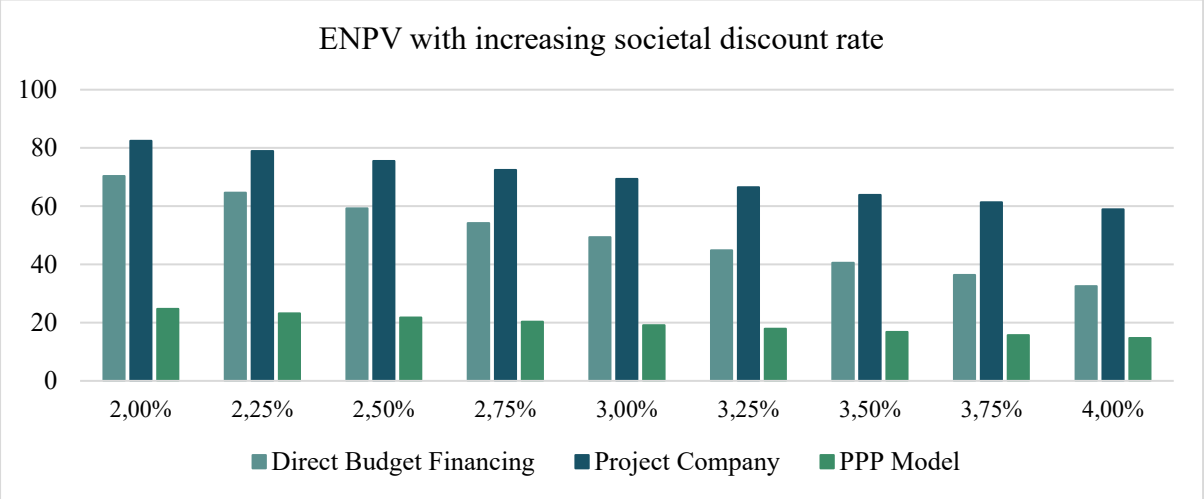

Figure 9. Economic Net Present Value with increasing societal discount rate.

It is of course not realistic to assume that the discount rate could be set independently of the cost of debt, as the cost of sovereign debt forms a part of the societal discount rate. If the cost of financing increased along with the discount rate, it would reduce the advantage of the project company and PPP model options over the direct budget financing option. However, the individual effect of the discount rate is presented here in keeping with ceteris paribus to isolate the effect of a single factor.

6.3.2. Length of the investment period

The length of the investment period, during which only costs and negative benefits (e.g. construction period nuisances) are incurred, should have a significant effect on the comparative performance of each financing model. The BCR, ERR and ENPV are measured as the investment period length is changed between 1 (-1 to the baseline) and 10 (+8 to the baseline) with one-year intervals.

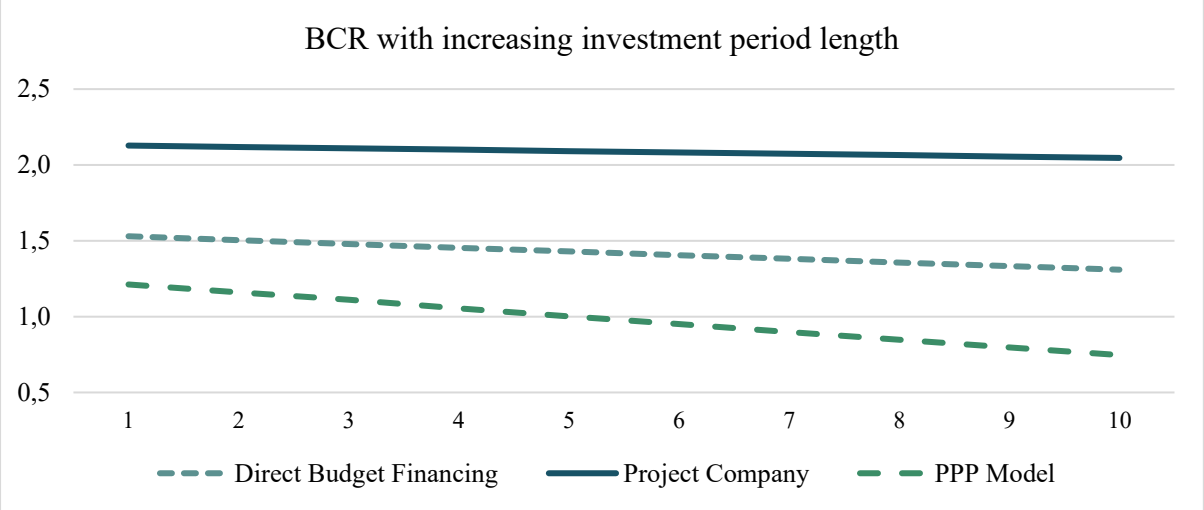

Figure 10. Benefit-to-Cost Ratio with increasing investment period length.

Figure 10. displays the BCR for increasing investment period lengths. We see that the benefit-to-cost ratio of the project decreases with increasing investment period length. The present value of the socio-economic benefits received from the project decreases as those benefits are deferred further into the future. This effect is most pronounced for the PPP model and significant also for direct budget financing, while impact on the project company model is very small. The project would no longer be socio-economically profitable as a PPP with an investment period of six years.

The change in the ERR when length of the investment period increases is displayed in Figure 11. The ERR decreases exponentially as the investment period lengthens, the change being more pronounced for increases in the short end. ERR of the PPP model crosses direct budget financing between years 4 and 5 and goes to zero in year 6, while the ERR curve of project company flattens out at slightly above 20% in year 10 (and does not change considerably for

longer periods, not displayed here), remaining above direct budget financing even for a 10-year investment period.

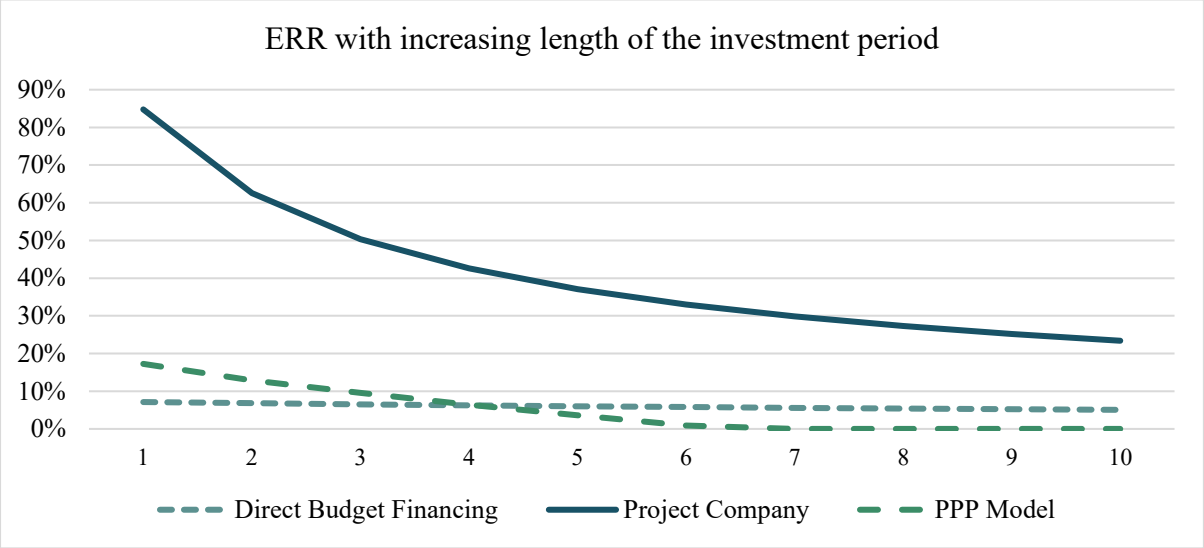

Figure 11. Economic Rate of Return with increasing investment period length.

Figure 12. displays the ENPV with different investment period lengths. As with the BCR, the project company shows best performance with all tested investment period lengths, with the difference to direct budget financing increasing with longer investment periods. The PPP model performs the worst, with negative ENPVs for investment periods of six years or more.

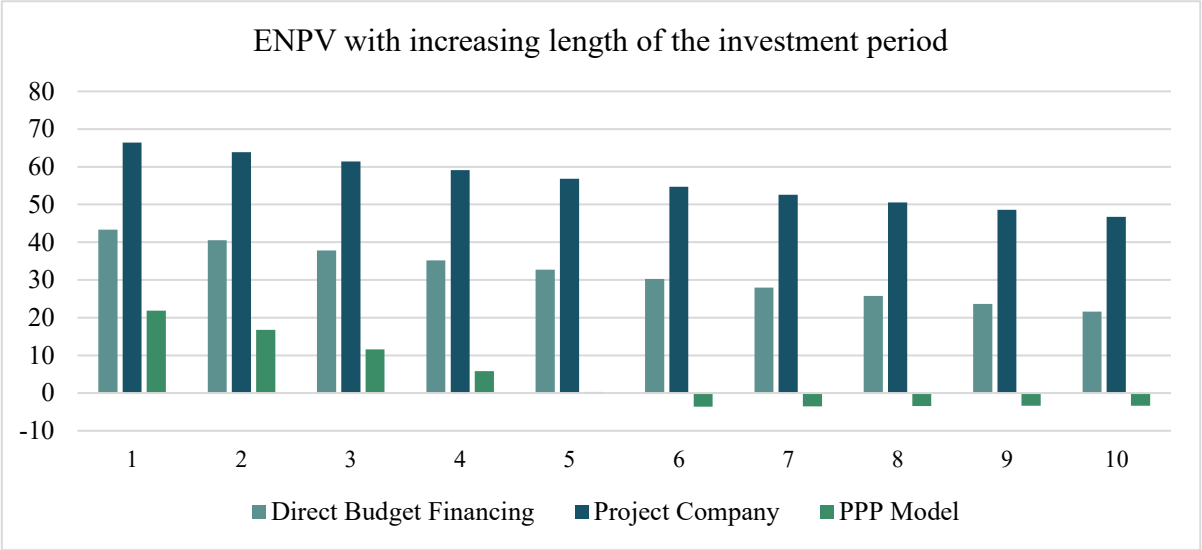

Figure 12. Economic Net Present Value with increasing investment period length.

The rapid decrease in the PPP model's performance metrics with a lengthening investment period is explained by the private equity return requirement. As the service provider's equity investors demand a 10% annual return on equity and the service provider will be paid only after the investment period, the service payment paid by the public authority in the operating period must be increasingly large to produce the return demanded by the investors – while the public

sector discounts future cash flows with a 3,50% discount rate, the investors discount their payoffs (service provider's post-debt service, post-tax residual cash flows) with the cost of equity – 10%.

Based on these results, it can be stated that financing a project with debt placed in a project company increases profitability compared to financing the costs directly from the public budget. The effect is more pronounced for projects with long investment periods, while private equity financing is best suited for projects with early investor payoffs.

6.3.3. Reference interest rate

The BCR, ERR and ENPV of the three financing models are measured when the reference interest rate increases from 0,50% to 4,0% with 0,25-percentage point intervals. The PPP model includes the baseline assumptions of 90% debt financing and 1,20% interest rate margin (added to the reference rate).

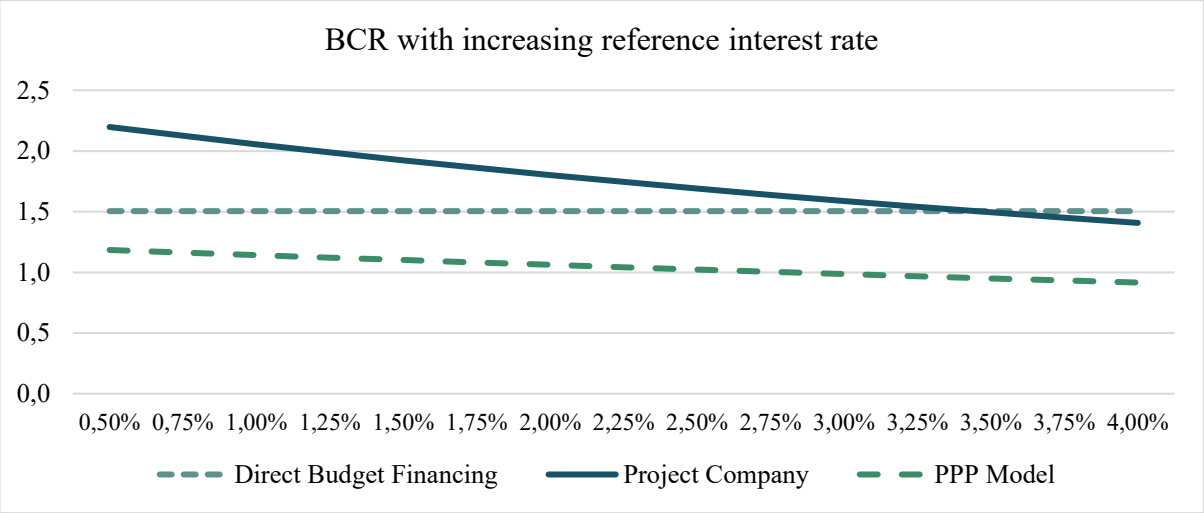

Figure 13. Benefit-to-Cost ratio with increasing reference interest rate.

Figure 13. displays the effect of increasing reference interest rate on the BCR. The line representing the project company model crosses direct budget financing when the reference interest rate matches the applied societal discount rate, 3,50%. This happens because the advantage received from deferring negative cash flows results from the cost of financing being less than the value placed by the payer on having more funds available for current consumption. The benefit thus disappears when the cost of financing matches the discount rate. The BCR of the PPP model is less affected by the reference interest rate for several reasons: first, the interest rate margin on the private sector debt remains constant, meaning a 0,25 percentage point change in the reference rate is a much smaller proportional change than if the total cost of debt consisted entirely of the reference rate. Second, the PPP service provider is 90% debt-financed

instead of 100% as is the case with the public project company. Third, as the PPP service provider pays taxes on its profit, the increasing interest payments are partly compensated for by the increasing value of the tax shield of debt.

Based on these findings, it can be stated that applying external financing increases the present-value benefit-to-cost ratio of a project as long as the cost of external financing is lower than the discount rate used. It should be noted that the breakeven point for the interest rate is not exactly the same as the discount rate because of the higher nominal total costs of the externally-financed project resulting from sources other than pure interest, such as the costs of setting up and managing a separate project company and any debt arrangement fees that could result (although not assumed here for the project company model).

Figure 14. displays the ERR of the financing models with increasing reference interest rates.

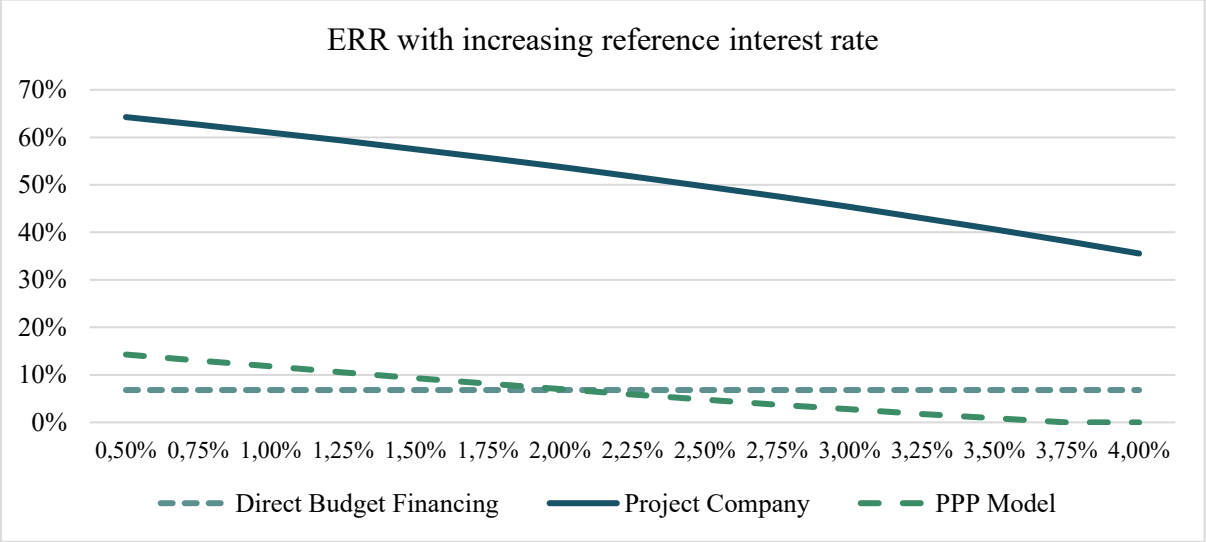

Figure 14. Economic Rate of Return with increasing reference interest rate.

Unlike the BCR and ENPV, the ERR of the PPP model is almost double the ERR of direct budget financing with the baseline assumptions. This is due to the front-loaded positive net benefit flow profile of the PPP model compared to direct budget financing. The ERR of the PPP model is less affected by the increasing interest rate than the ERR of the project company for the reasons mentioned earlier. The ERR of the PPP project falls below direct budget financing around a reference interest rate of 2,00%, at which point the service provider's project life average weighted average cost of capital (WACC) is 4,33%.

Figure 15. displays the ENPV for the financing models with increasing reference interest rates. Everything written about the BCR applies to the ENPV; breakeven point for project company and direct budget financing occurs just below 3,50% reference interest rate, while the PPP project is no longer socio-economically profitable with reference interest rates at 3,00% or above (WACC 4,88%).

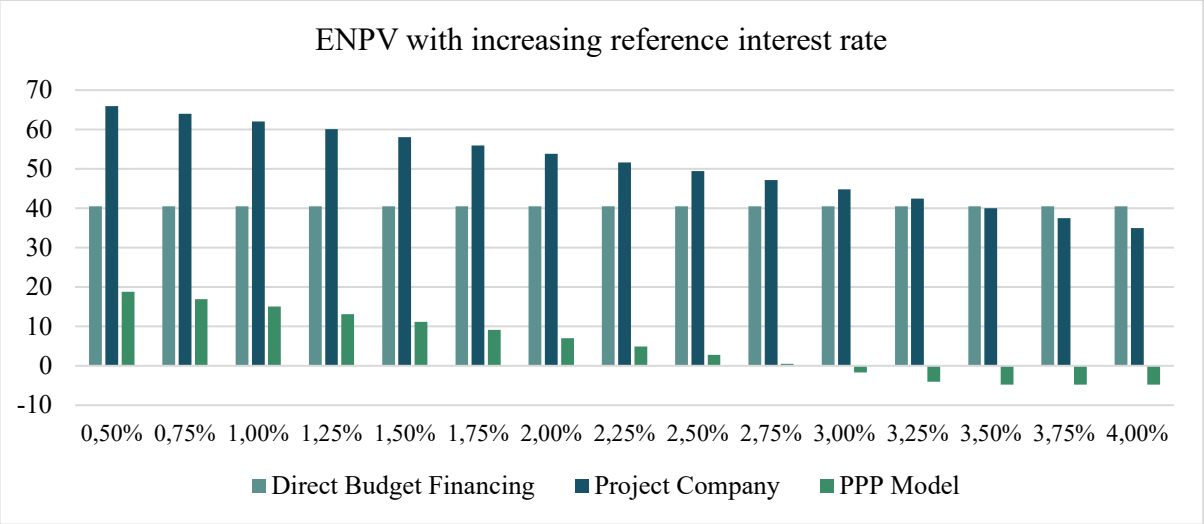

Figure 15. Economic Net Present Value with increasing reference interest rate.

6.3.4. Cost of equity

The performance of the PPP model relative to the direct budget financing and project company models is examined as the cost of equity – the return requirement of the PPP service provider's equity investors – changes.

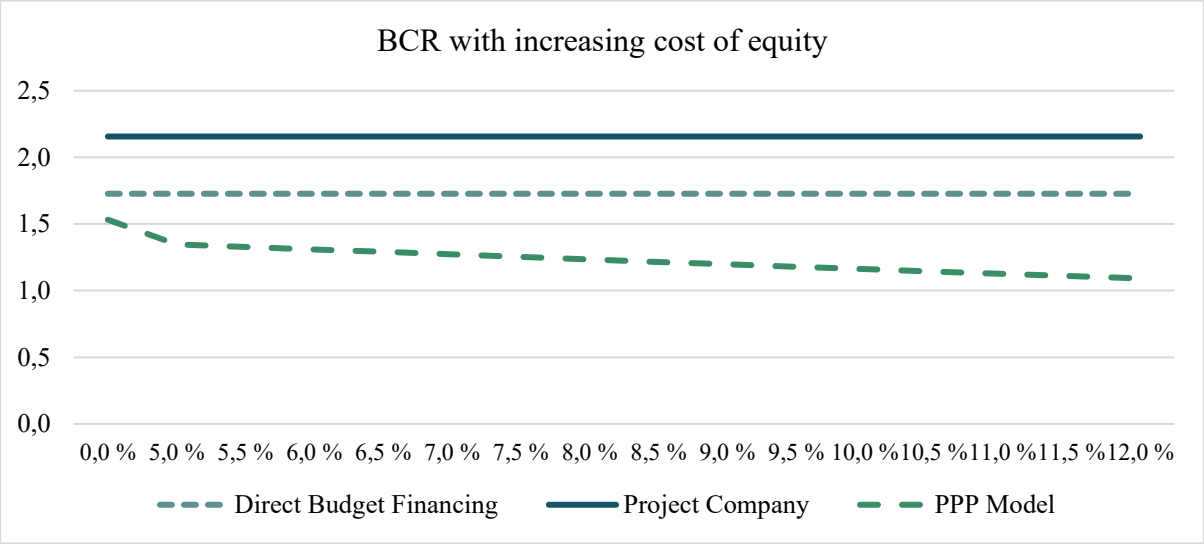

Figure 16. Benefit-to-Cost Ratio with increasing cost of equity.

Figure 16. displays the BCR when the cost of equity increases. With the other baseline assumptions static, the PPP model cannot break even with direct budget financing even with

zero-return equity investment. The benefit-to-cost ratio of the PPP model does not suffer significantly from increasing equity return requirements, as the decrease in the benefit-to-cost ratio between 5,0% and 12,0% cost of equity (140% increase) is only 0,26 or 19%, while an increase from the baseline 10% to 11% (10% increase) would only decrease the BCR by 0,03 or 3%.

Figure 17. displays the ERR when the cost of equity increases. ERR of the PPP model remains between direct budget financing and project company models over the full tested range.

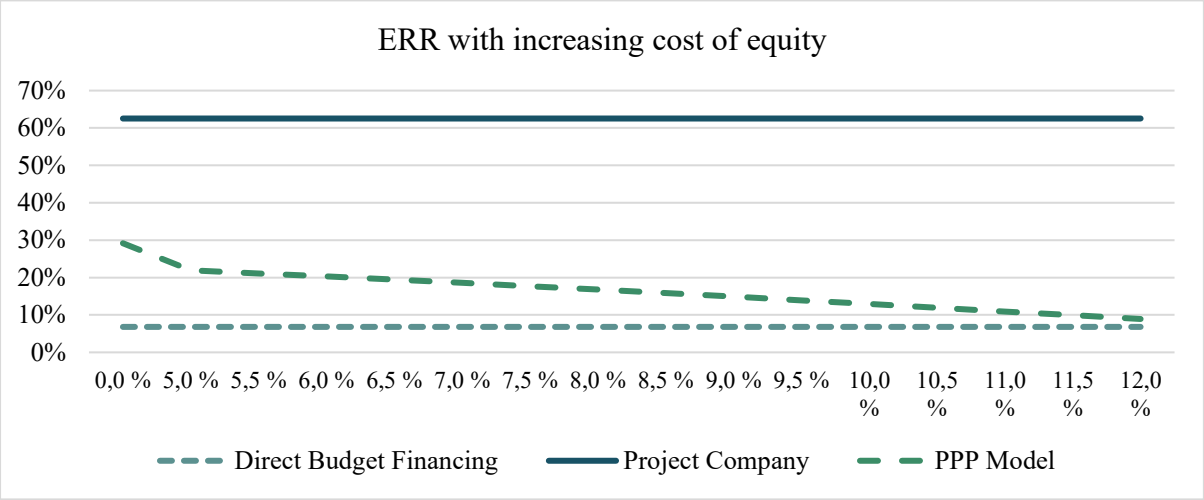

Figure 17. Economic Rate of Return with increasing cost of equity.

Figure 18. displays the ENPV when the sector cost of equity increases. As with the benefit-to-cost ratio, the PPP model cannot break even with any cost of equity.

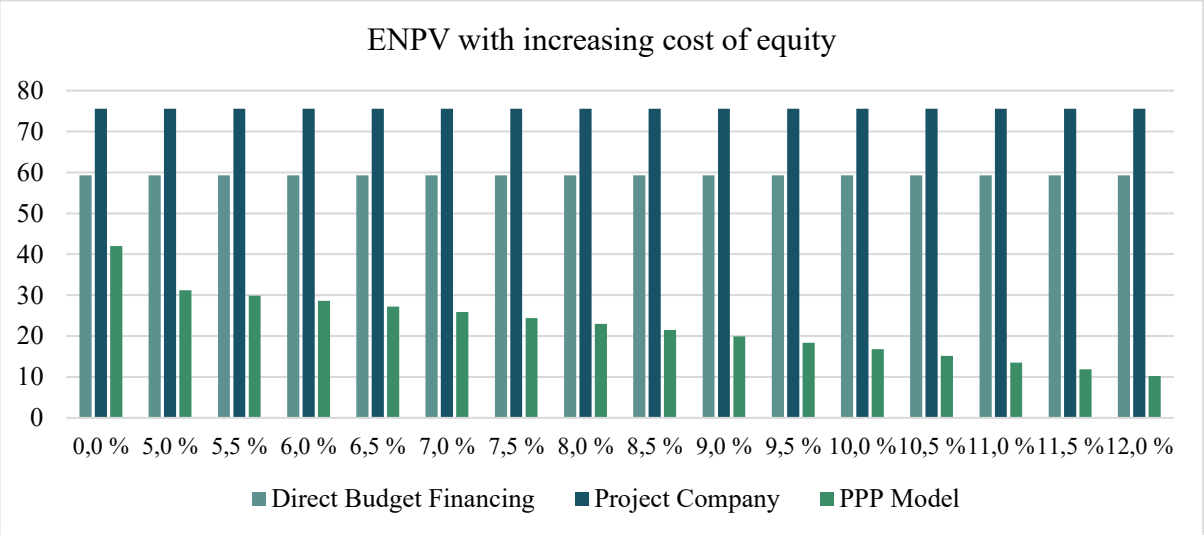

Figure 18. Economic Net Present Value with increasing cost of equity.

6.3.5. Private sector efficiency advantage

The concept of the private sector efficiency advantage is built on the assumption that the private sector, if given sufficient degrees of freedom in project design and execution, can design and deliver a project with lower costs than would be the case in a traditional budget-financed procurement, especially if the private sector is allowed a part of the cost savings as an additional return and is thus incentivized to find efficiencies. There is, however, little evidence on how construction and maintenance costs of PPP projects compare with other procurement methods. This is because the companies acting as PPP service providers are private and not required to publicize their cost structures.

Figure 19. displays the BCRs for the three financing models when the efficiency advantage of the private sector increases from 0% to 20% with one percentage point intervals as well as the breakeven points where the PPP project option is equal with direct budget financing and external financing, 25,7% and 50,9% respectively.

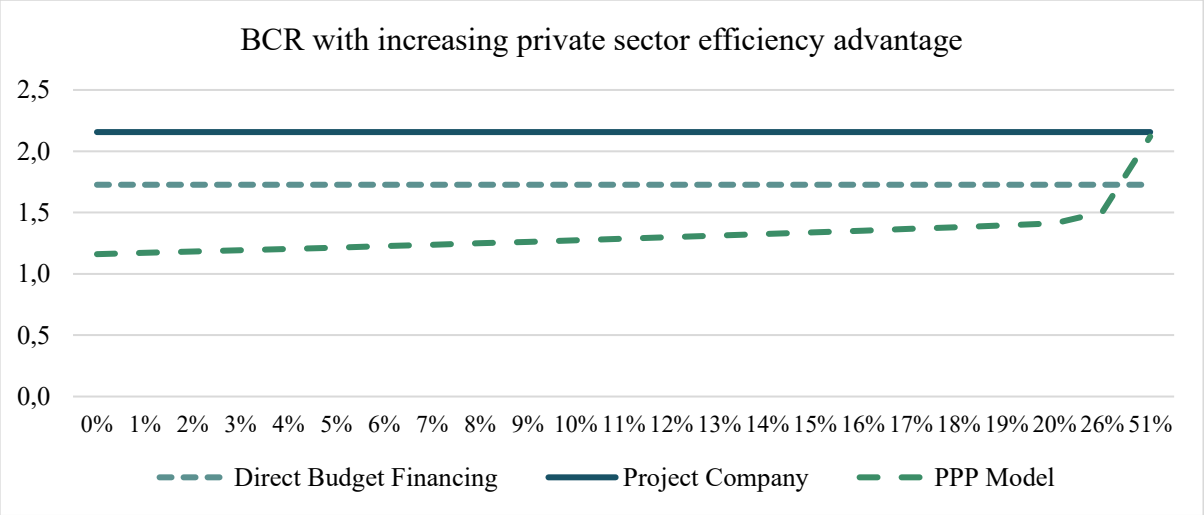

Figure 19. Benefit-to-Cost Ratio with increasing private sector efficiency advantage.

Figure 20. displays the ERR for the three financing models with the same efficiency advantage intervals. Finally, figure 21. displays the ENPV for the three financing models with the same efficiency advantage intervals. The same breakeven points as with the benefit-to-cost ratio apply. These results show that potential efficiency advantages alone are inadequate to make the PPP project option competitive. However, depending on the project 10% to 20% cost savings could well be feasible, covering a significant portion of the additional financing costs associated with the model.

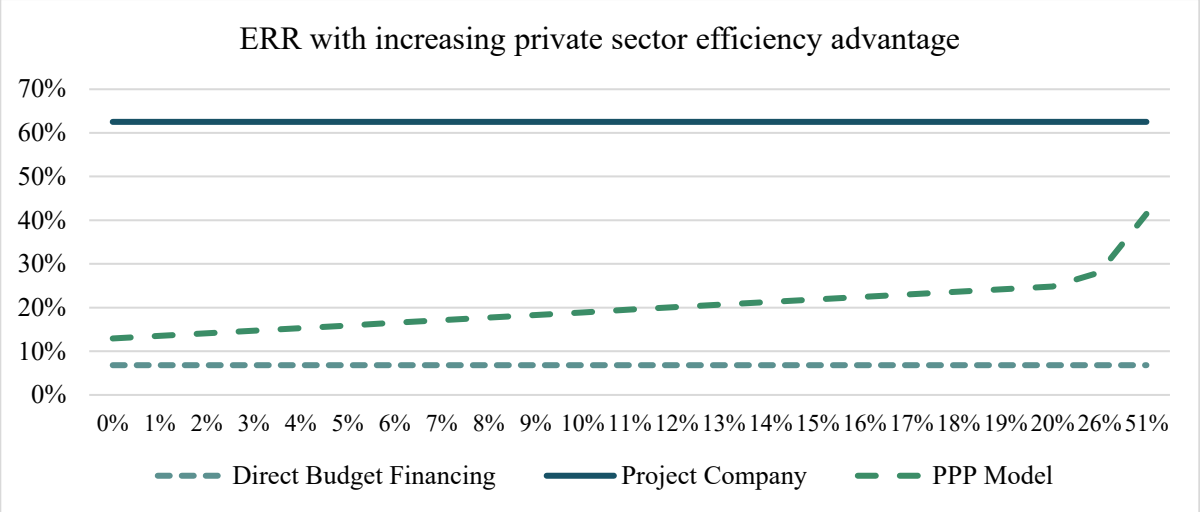

Figure 20. ERR with increasing private sector efficiency advantage.

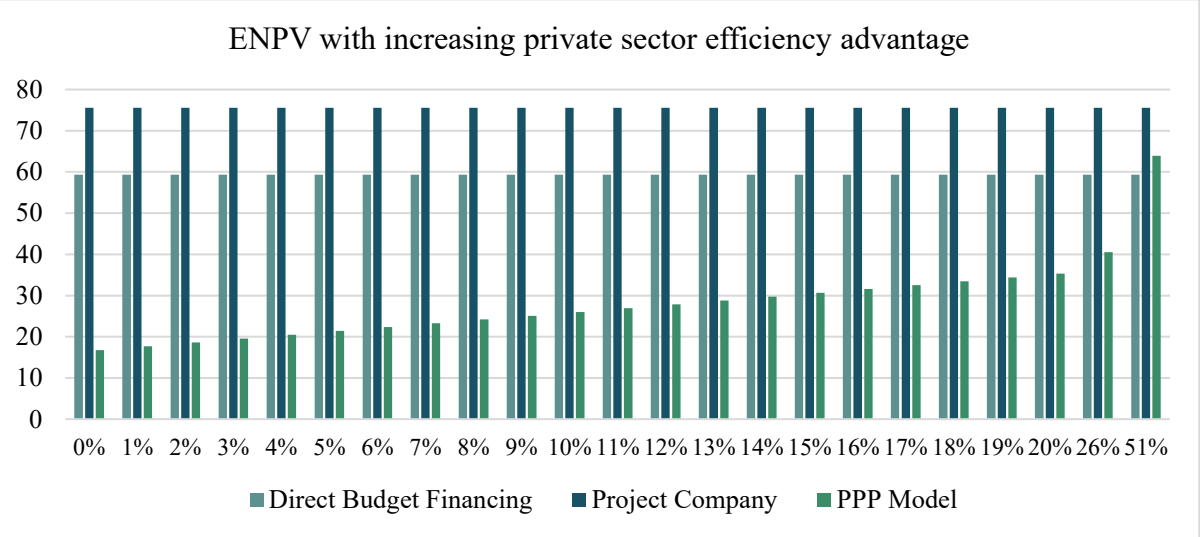

Figure 21. ENPV with increasing private sector efficiency advantage.

A combination of the examined factors could potentially significantly improve the performance of the PPP option; the baseline assumptions about the interest rate margin and the efficiency advantage factor used in this study are rather conservative – the interest rate margin could well be lower than 1,2%, while the efficiency advantage would likely be positive instead of 0%. Further, a project with a larger capital expenditure would have better opportunities for cost savings via the efficiency advantage factor – the Hailuoto project is rather small and is viewed by some as being too small to be contracted as a PPP, with a capital expenditure of only 75,9 MEUR. In a project involving a new type of infrastructure, or infrastructure with which public authorities are otherwise unfamiliar with, the innovation capability and expertise of the private sector harnessed via a PPP model could bring significant advantages compared to a public sector-driven project model.

6.4. Scenario Analysis

In this section the direct budget financing model will be compared with the PPP model in three different scenarios. Assumptions regarding the direct budget financing model will be kept constant, while assumptions regarding the PPP model are altered to examine the effect on the required direct budget financing project delay that would make the PPP model option socio-economically preferable.

In the base scenario, budget constraints would have had to delay the project for four years for the PPP model to be the preferred option. The three scenarios examined are:

1. Cost of Equity decreases from 10% to 8%
2. Private Sector Efficiency Advantage increases from 0% to 10%
3. Combined effects of 1. and 2.

6.4.1. Scenario 1

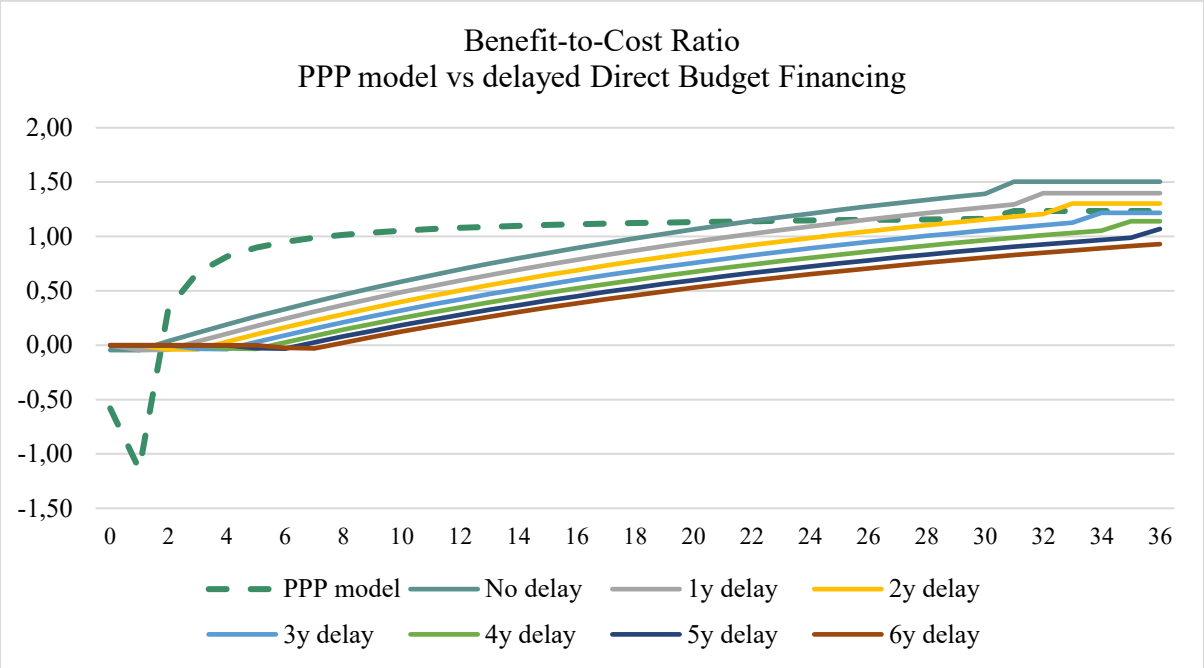

Figure 22. Benefit-to-Cost Ratio with 8% Cost of Equity.

Figures 22. and 23. show the BCRs and ENPVs for the PPP model and direct budget financing models with project starts in years $y_0 \ldots y_6$. A decrease in the cost of equity to 8% (ceteris paribus) reduces the delay required from four to three years.

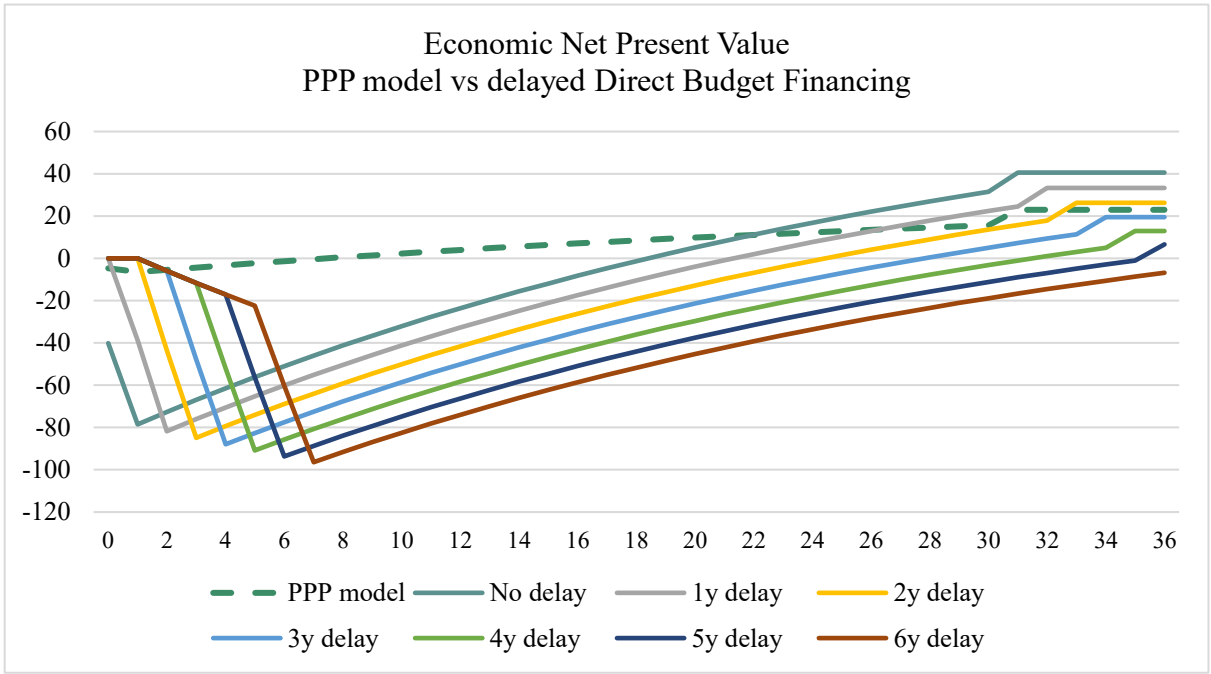

Figure 23. Economic Net Present Value with 8% Cost of Equity.

6.4.2. Scenario 2

Figures 24. and 25. show the BCRs and ENPVs with a 10% private sector efficiency advantage being applied to the costs in the PPP model. The 10% efficiency factor has the same effect as a two-percentage-point decrease in the cost of equity, reducing the delay needed from four years to three. The absolute effect is slightly larger, however.

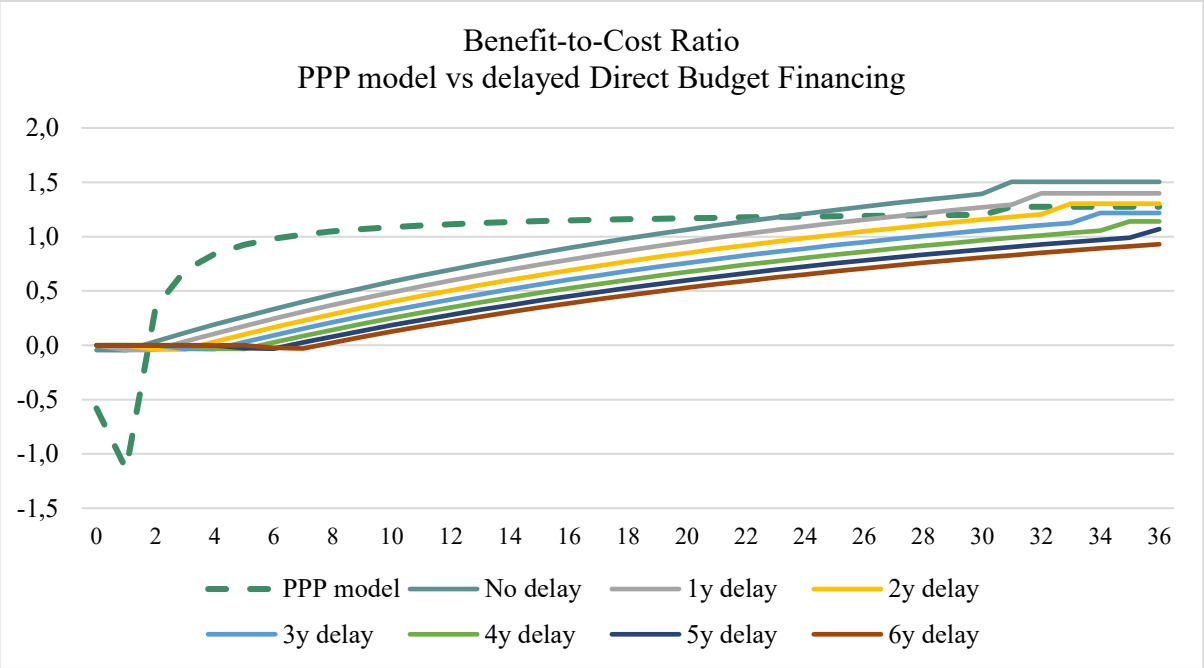

Figure 24. Benefit-to-Cost Ratio with 10% Private Sector Efficiency Advantage.

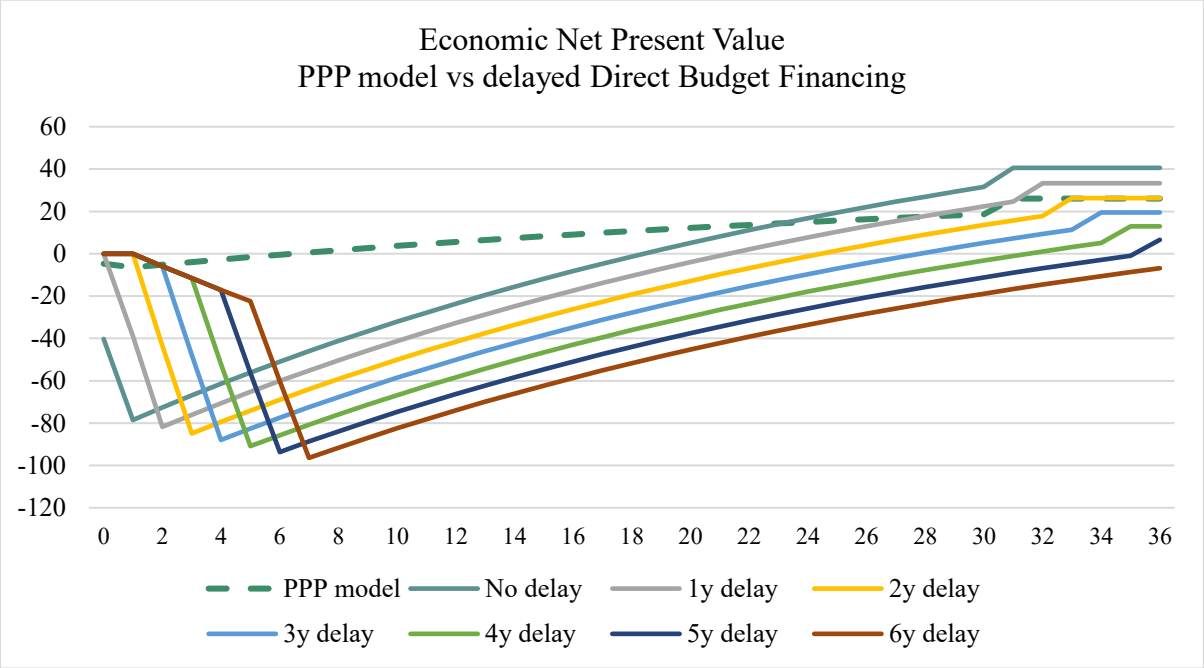

Figure 25. Economic Net Present Value with 10% Private Sector Efficiency Advantage.

6.4.3. Scenario 3

Figures 26. and 27. show the combined effects of scenarios 1 and 2: 8% cost of equity combined with a 10% reduction in capital expenditures and maintenance costs in the PPP model. The required delay decreases further to two years.

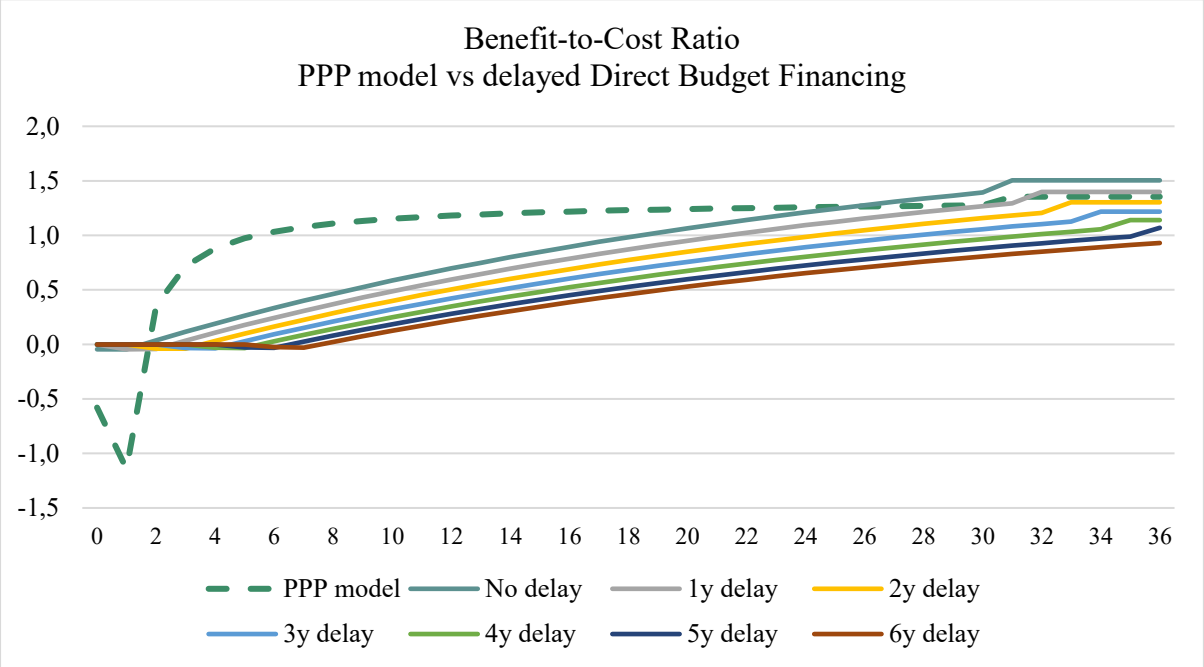

Figure 26. Benefit-to-Cost Ratio with 8% Cost of Equity and 10% Private Sector Efficiency Advantage.

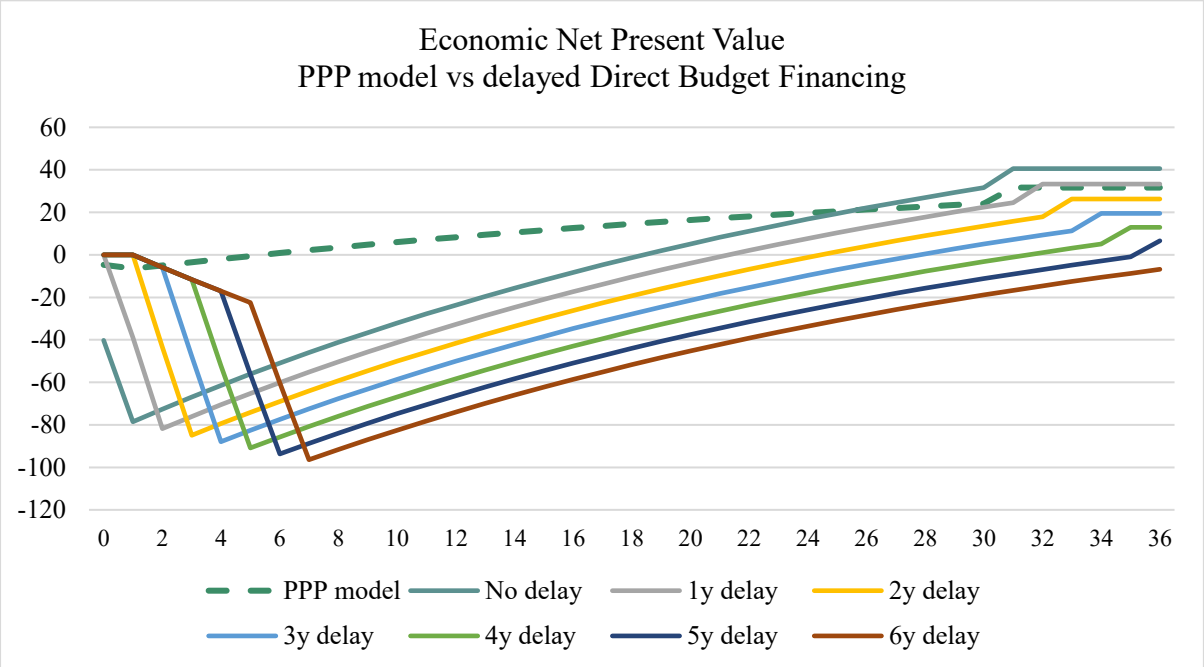

Figure 27. Economic Net Present Value with 8% Cost of Equity and 10% Private Sector Efficiency Advantage.

6.5. Summary of Findings

The results are summarized in Table 5. below based on findings examined in this chapter.

Table 5. Summary of Findings.

Research Question	Finding	Comment
Using project finance to defer negative cash flows into the future should improve the benefit-to-cost ratio, economic rate of return and economic net present value of the Hailuoto Causeway project	Significant improvement in BCR and ENPV with Project Company model, only ERR improved with PPP model.	Timing costs to coincide with benefits improves net present value, but the improvement is not enough to cover additional costs of the PPP model.
The relative advantage of project finance should increase with the societal discount rate	Significant improvement for Project Company and PPP.	
The relative advantage of project finance should increase with length of the investment period	Moderate improvement for Project Company, significant decrease for PPP.	PPP model seems to not suit long investment periods due to investors' equity return demands.
The relative advantage of project finance should decrease as the reference interest rate increases	Yes, effect larger for Project Company, advantage disappears as cost of financing approaches discount rate.	Effect smaller for PPP due to lower leverage and presence of other financing costs in addition to reference interest rate.
Performance of the PPP model should decrease as the cost of equity increases	Yes, moderate effect.	Cost of equity forms a relatively small share of the PPP financing costs.
Performance of the PPP model should improve as the private sector efficiency advantage increases	Yes, significant effect.	Construction and maintenance cost improvements significant but not enough to cover the

		higher financing costs in a project of this size.
Using a procurement model employing private equity financing to expedite project start should improve the benefit-to-cost ratio, economic rate of return and economic net present value of the Hailuoto Causeway project compared to delaying investment until sufficient budget is available	PPP model is preferable over direct budget financing with a delay of four years.	A four-year delay pushes a project onto the next budgeting period, introducing high uncertainty about future budget allocation.
Tested with two-percentage point decrease in the cost of equity	PPP model is preferable over direct budget financing with a delay of three years.	Delaying the project does not guarantee receiving budget financing, as there is rarely sufficient budget available to finance all good projects.
Tested with 10% increase in private sector efficiency advantage	PPP model is preferable over direct budget financing with a delay of three years.	Delaying the project does not guarantee receiving budget financing, as there is rarely sufficient budget available to finance all good projects.
Tested with combination of lower cost of equity and higher efficiency	PPP model is preferable over direct budget financing with a delay of two years.	Delaying the project does not guarantee receiving budget financing, as there is rarely sufficient budget available to finance all good projects.

Distributing investment costs over the project appraisal period using low-cost public debt in the project company model improved the appraisal metrics. However, additional costs in the PPP model led to lower performance with regards to the benefit-to-cost ratio and economic net present value than the direct budget financing option. The PPP model improved the economic rate of return compared to direct budget financing, however, due to delayed commitment of capital, allowing investment of public funds into other profitable projects as well. This finding supports the use of the PPP model in presence of abundant profitable investment opportunities, especially if there are constraints to raising public debt for the project company model.

In the sensitivity analysis, the societal discount rate was found to be highly influential, with increasing discount rates significantly affecting project profitability in the direct budget financing model but having very little effect in the project company and PPP models – thus the relative advantage of the two latter models increases with the discount rate. Reference interest rate was found to be significant in the debt-funded project company and PPP models and showed that the profitability-enhancing effects of external financing exist only when the cost of financing is lower than the societal discount rate. The PPP model failed to produce these benefits as its financing cost exceeds the baseline discount rate (3,5%) – construction and maintenance cost efficiency would need to be 25,7% lower to make up for the higher financing costs. Length of the investment period proved to be a moderately significant factor. The longer the time between incurring costs and receiving benefits, the greater the potential benefit from using low-cost external financing to spread the costs out over the life of the project. For projects with long investment periods, only the public project company model is feasible, as the performance of the PPP model decreases rapidly with longer investment periods due to the high private equity return requirement. This can be alleviated by making so-called milestone payments to the PPP service provider already during the investment period, tied to reaching pre-determined stages of completion. In this example case the cost of equity had relatively little effect on the results. This is an interesting finding, especially when considering how much attention is paid to private equity payoffs from public projects; PPP service providers have typically very debt-weighted capital structures, in this case 90% debt to 10% equity. For this reason, any reasonable increase in the cost of equity has little effect on the overall cost of the project to the public. The private sector efficiency advantage has a large effect on the profitability of the PPP model. In this example case the efficiency advantage would have needed to be 25,7% for the PPP model to break even with direct budget financing. It would be hard to argue that the private sector could be this much more efficient in construction and

maintenance, but if we consider the value of risk transfer to be reflected in the efficiency factor that level could be feasible. Further, as has been mentioned the Hailuoto Causeway is small for a PPP project and there are limited options for innovation and cost savings; the comparative standing of the PPP model could be different in a larger project owing to the private sector efficiency advantage alone.

Expediting project start by financing the project with private capital was found to be profitable if the budget constraint was expected to delay the project by four years or more. Testing with the equity return requirement lowered to 8% decreased the required delay to three years. Testing with a 10% private sector efficiency advantage factor similarly decreased the required delay to three years, but the effect on costs was greater than that of a two-percentage point decrease in the cost of equity. Combining the lower cost of equity with the higher private sector efficiency factor further decreased the required delay to two years.

7. Conclusions

This study has examined how evaluating different project finance arrangements can affect results of public infrastructure project appraisal. The cost-benefit analysis data from the Hailuoto Causeway project appraisal report was fed into three different financial models to assess the effects of external financing. The Hailuoto Causeway project was modelled as a direct budget financed project, as a project managed by a public sector-owned, 100% debt-financed project company and as a private capital-financed public private partnership project.

The project company model showed the best results for the benefit-to-cost ratio, the economic rate of return and the economic net present value. The project company has access to very low-cost debt secured on the sovereign credit rating, deferring investment costs while incurring very low financing costs. The direct budget financing model, representing a base case with investment costs paid up front and no financing involved, was second in both benefit-to-cost ratio and economic net present value, while the public private partnership model was second in the economic rate of return but performed the worst in terms of the benefit-to-cost ratio and the economic net present value. The PPP model carries high additional costs not present in the two public sector models, namely administrative and insurance costs of the service provider, higher costs of debt financing as well as the private equity return requirement. The PPP model returned a better economic rate of return than direct budget financing, explained by delayed commitment of capital enabling investment of public funds in other profitable projects.

A significant advantage of the PPP model is the ability to augment public investment budgets. When faced with a budget constraint, the public authority has three options: delay the project until a new budgeting period, procure the project as a PPP or abandon the project. If the project is socio-economically profitable (benefit-to-cost ratio over one) the options to be explored are of course the first two. Delaying results in forfeiting socio-economic benefits for the duration of the delay, while procuring as a PPP increases the financing costs of the project. Delaying may eventually lead to abandoning the project or delaying for a longer time than is optimal, as future project opportunities, budget sizes and political priorities are difficult to predict. On the other hand, to be procured as a PPP the project must be socio-economically profitable enough to carry the additional costs of the PPP model; in this example case the baseline benefit-to-cost ratio of direct budget financing is 1,50 against 1,16 of the PPP model. If the project is not profitable enough to be procured as a PPP and does not fit into the investment budget, it may eventually be abandoned even if its benefit-to-cost ratio is over one.

A significant factor regarding the PPP model not comprehensively covered by this study is risk transfer. In a PPP model, the service provider assumes responsibility for project design, construction, and service provision (and sometimes others as well, such as demand). Transferring risks to the service provider carries positive value for the public authority that should be taken into account; if the service provider fails to provide the comprehensive service according to contract, and the failure is due to factors under the responsibility of the service provider, the public authority can withhold payment. This study assumes that the public authority makes the full amount of service payments to the service provider throughout the project appraisal period, e.g. deductions are not modeled. No data is available on realized payment deductions in availability-based PPP contracts, so in this study the private sector efficiency advantage variable is assumed to capture both the direct project-related efficiencies (e.g. construction and maintenance cost savings) as well as the value of risk transfer and potential service payment deductions.

Based on these findings, evaluating potential project financing options could be worthwhile already in the project appraisal phase, even if their effects are not integrated into the cost-benefit analysis itself. Public sector debt, secured on the sovereign credit rating, is the most efficient way of spreading project costs out over the life of the project but places a strain on public balance sheets. Private equity-financed models, such as PPPs, place the debt on the balance sheets of private sector companies, easing the strain on already burdened public balance sheets. Further, in the Finnish setting they allow government agencies to start investment projects outside investment budgets, although signing long-term investment contracts with private financiers requires a special budget authorization from the Parliament and so PPPs do not grant government agencies access to “open checkbooks”. PPPs incur additional financing and procurement costs on the public sector and for that reason are only suitable for projects that are socio-economically profitable enough to carry them. This leads to the idea that private capital should be used to finance highly profitable investments that do not have a high enough priority to secure direct financing from investment budgets – using private capital can enable socio-economically profitable projects that would otherwise be abandoned due to insufficient public budget or other constraints, benefiting both the public and the private sector as the name public private partnership implies.

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